PROJECT:	Bull Run Filtration Project
PROJECT NUMBER:	W02229
PREPARED BY:	Christopher Bowker
DATE:	August 31, 2018
SUBJECT:	Filtration Plant Key Decisions and Process

1.0 Executive Summary

In August 2017, the Portland City Council voted to construct a water filtration treatment facility to meet the treatment requirements for *Cryptosporidium*. On December 18, 2017 the Oregon Health Authority-Drinking Water Services (OHA) and the Portland Water Bureau (PWB) signed a bilateral compliance agreement that laid out a schedule for construction of a new filtration treatment system on the Bull Run Supply by September 30, 2027. The approved filtration schedule includes three primary phases – Planning, Design, and Construction. It will take approximately 10 years until the treatment facility is operational.

The Bull Run Filtration Project (filtration project) will be one of the largest PWB projects to date. PWB has already begun the planning phase of this project, which included answering four preliminary questions related to filtration of the water supply: project delivery (procurement) method, plant capacity, location, and filtration technology. The results from this process were four preferred alternatives that the project will build upon moving forward.

To reach a decision, each question was evaluated and discussed by the project team (which included stakeholders with broad technical and organizational representation) and the Executive Committee (comprised of PWB Management Team members) at a series of workshop sessions between January and June 2018. Three consultants were hired to assist in gathering and understanding relevant information for these decisions: Barney & Worth (community outreach), HDR (procurement, location, and capacity), and Jacobs (decision framework and filtration technology).

Technical memorandums were used to explain and document this process. Three of the decisions (capacity, location, and filtration technology) used a decision-making process generally referred to as a decision framework, which is discussed in the first document enclosed herein. This decision framework was used to help compare and contrast more complex issues related to these questions. The development and application of the decision framework components were accomplished through the workshops. Decisions were made by the Executive Committee.

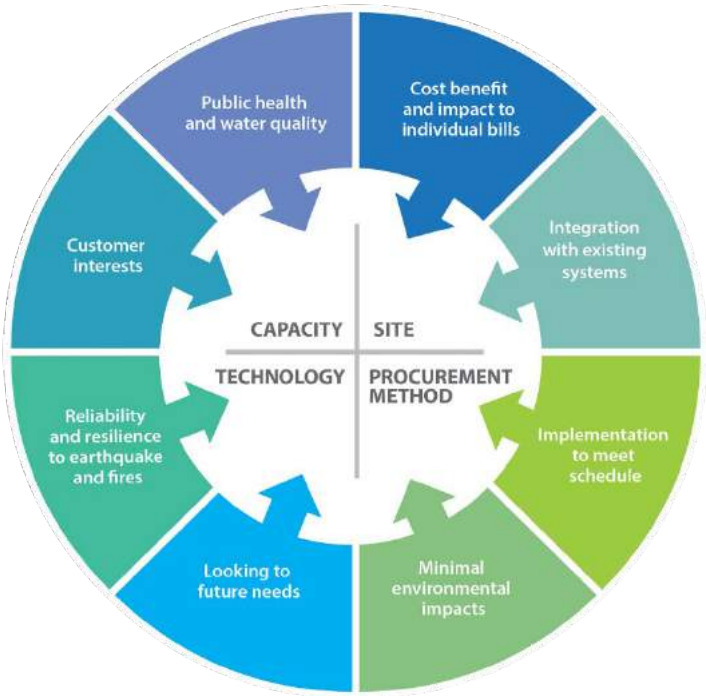
The collection of documents enclosed herein represents the initial work performed during the planning phase of the Bull Run Filtration Project and includes technical memorandums on the decision framework, the four key questions, as well as supporting documents. These documents are summarized below.

Decision Framework

The capacity, location, and filtration technology decisions were complex and had multiple components to consider and weigh. With consultant support, PWB produced a decision framework comprised of building blocks that provided the specific steps to reach the decisions. This framework was paramount to reaching these decisions because it designated who was included in the process, established their roles within the process, provided continuity of decision-making across the three decisions, clarified how conclusions would be reached, structured the inclusion of important values in the process, and characterized how information was presented in workshop settings. This information was captured in the Decision Framework technical memo (Document 1).

Once the framework was established, the next step was to identify and prioritize community and PWB values that were important and relevant to the filtration project, resulting in a values hierarchy. Values were the guiding principles to be considered when making decisions and were used to characterize, understand, and communicate tradeoffs. Criteria were then developed that supported these values. Specific and measurable performance scales were then identified that could be used to evaluate and compare alternatives; these are specific to each fundamental decision. The values, criteria, and performance scales were developed using surveyed community input and project team input. The organization of values, their descriptions, and the criteria that refine the values are incorporated in the Values Hierarchy.

Finally, a decision model was developed. Utilizing weighted scenarios and data-plots, the model incorporated the values, criteria, and performance evaluation into a structure allowing for comparative assessment of the alternatives considered for each of the four key areas.



Developing the decision framework, values hierarchy and decision model standardized a methodical evaluation process, assured incorporation of community and PWB values, and transparently displayed how pre-planning phase filtration decisions were reached.

Filtration Plant Alternative Delivery

The planning, design, construction, and commissioning of a filtration plant is estimated to cost between $350 and $500 million. In order to minimize project delivery risk and cost and schedule impacts, PWB evaluated alternative delivery (AD) procurement methods as allowed under ORS 279.015 and compared them to traditional design-bid-build (DBB or “low bid”).

The Filtration Plant AD Methods technical memo (Document 2) described three potential AD methods available to deliver the filtration plant design, construction, and commissioning; discussed the

advantages/disadvantages of each compared to traditional Design-Bid-Build (DBB) procurement; and presented a comparison of the alternatives to assist in the determination of the most appropriate delivery method for the filtration project. These three methods are Construction Manager/General Contractor (CM/GC), Fixed-Price Design-Build (FPDB), and Progressive Design-Build (PDB).

To select an AD method, a workshop was held with the consultants, PWB, and City of Portland procurement staff. The purpose of the workshop was to describe the contractual arrangements for DBB, CM/GC, FPDB, and PDB; differentiate the AD methods by their specific characteristics; and compare each AD method and its advantages over DBB with a list of criteria specific to the filtration plant project and PWB concerns.

The starting considerations for the workshop are summarized below:

- All three alternative delivery (AD) methods would reduce project schedule compared with the standard DBB approach. This is due to the elimination of the need to bring the design to 100% completion prior to the advertisement and bidding period required in DBB procurement. In addition, design and early construction activities can occur concurrently. In each case, the selection of the eventual contractor is done early in the design process.
- All three AD methods would require an exemption to competitive bidding under ORS 279.015. However, none would limit competition, and all have the potential to save costs through the shorter delivery schedule and collaborative working relationships they promote.
- All three AD methods have been successfully used by public works agencies in the U.S. However, the default selection would be CM/GC, unless one of the other two options proves superior.

The delivery methods were then evaluated for their ability to satisfy primary PWB considerations under four main categories: project-specific attributes, PWB culture, management and reporting, and past experience. The workshop discussion on these topics revolved around the varied experience of the participants, including current City experience with PDB.

In the workshop, staff deliberated on what AD method best met PWB's project needs. The participants determined that CM/GC procurement was the most advantageous method for delivery of the filtration project. CM/GC would allow greater control of project decision-making, as well as engineering and operations input into the facility design. CM/GC is also anticipated to maximize Disabled/Minority/Women/Emerging Small Business (D/M/W/ESB) participation in both the design and construction contracts. Additionally, PWB has successful prior experience with CM/GC and was more confident in its application for the filtration project.

Filtration Plant Capacity

The capacity decision was a complex decision based on forecasted demands and population growth. The project team and Executive Committee reached a conclusion with the assistance of the decision framework. PWB staff identified the criteria and performance scales used as part of the decision-making process to identify the plant capacity. The performance scales applied to the capacity decision were considered independently of two other key areas: location and filtration technology. The choice of capacity then informed the choice of location and filtration technology.

The capacity decision includes considerations for future demands, level of service goals (both quantity and quality), costs (capital and operations and maintenance) or different filtration plant capacity and supplementary supply alternatives), and other factors. The Filtration Plant Capacity Alternatives technical memo (Document 3) presents the initial plant capacity alternatives, likelihood of need to rely on other PWB management strategies to meet peak demands, applicable decision model criteria related to capacity, and evaluation of each capacity alternative.

Five capacity alternatives for the future filtration plant were initially identified by PWB and HDR (Table 1). The capacity for each alternative was established based on a combination of the physical constraints of the existing Bull Run supply system and PWB demand projections.

Both the 200 mgd capacity and 100 mgd capacity alternatives were found to be unsuitable and eliminated from further consideration. The 200 mgd capacity was rejected from further consideration because it is 40 mgd higher than the projected PDD of 160 mgd in a stress year for 2045 (i.e., the highest demand day between 2027 and 2045). A 100 mgd capacity facility was also rejected because it would not meet system demand up to 50 percent of the time and alternative management strategies would be needed on a regular basis. This is inconsistent with PWB's groundwater policy (Appendix B).

The remaining alternatives were carried forward for evaluation using the decision model and criteria. The range of 115 – 120 mgd was reduced to 115 mgd to simplify the subsequent analysis. Similarly, the range of 135 – 145 mgd became 145 mgd. The potential plant capacities of 115, 145, and 160 mgd took into consideration the projected peak daily demand (PDD), peak 3-day demand (P3D) in a stress year (an unusually warm and dry year) for 2045, and their ability to consistently meet projected PWB water system demands.

Table 1: Initial Capacity Alternatives

Capacity (mgd)	Description
200	Approximately equal to maximum Bull Run conduit capacity
160	Slightly higher than the projected 2045 PDD and P3D demands in a stress year
145	Covers 90% of 2045 PDD and P3D demands in a stress year
115	Slightly higher than the projected 2045 PDD and P3D in a weather normalized year.
100	Slightly higher than the projected 2045 summer average demand in a weather-normalized year

The project team, with agreement from the Executive Team, used the results of the decision model to first remove the 115 mgd alternative from further consideration. This alternative provided the fewest overall benefits to PWB in most of the evaluation scenarios that the team considered and discussed, as well as having the highest cost per unit value of the three modeled scenarios.

The scoring between the 145 mgd and 160 mgd alternatives was very similar. After another analysis of the criteria, with and without scoring, the project team and the Executive Committee merged the two alternatives into a single conclusion.

It was decided that the desired capacity is 160 mgd, with an understanding that the capacity ultimately constructed may be somewhat smaller. This could be due to subsequent decisions about siting and

filtration technology as well as later design choices. However, the lowest installed capacity that the PWB would accept is 145 mgd. This decision of a desired capacity and hard lower limit provides adequate direction at this early phase of the project and reflects PWB's current understanding of projected PDD, while providing flexibility during treatment plant design in the coming years.

Filtration Plant Site Alternatives

Based on previous studies, six sites were evaluated for their ability to host a filtration-type treatment facility: Carpenter Lane, Lusted Hill (with expansion), Headworks, Larson's Ranch, Powell Butte, and Roslyn Lake (see Figure 1). These sites were selected on their anticipated ability to meet essential criteria.

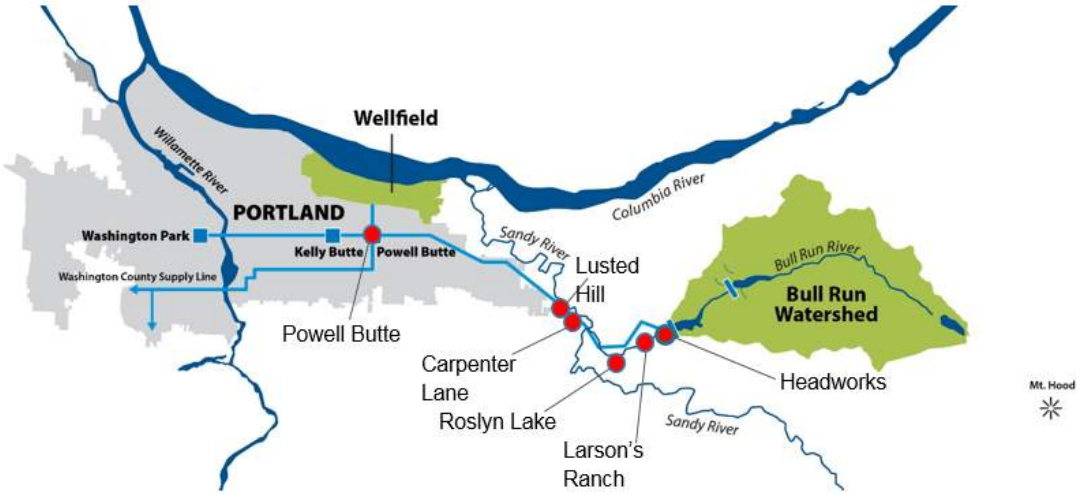


Figure 1: Approximate locations of the six potential filtration sites reviewed.

The location decision was likely the most difficult decision to make. Although the decision framework was used, the final two sites were essentially equal in their value scores. Compounding this was the added difficulty of anticipating how the Bull Run supply transmission system may change in the future. HDR coordinated closely with PWB and their other consultants, Jacobs and Barney & Worth, to develop the criteria and performance scales that drove the location decision. The site was selected after a plant capacity was identified, (see Filtration Plant Capacity Alternatives), but before the filtration technology was determined.

Several major considerations exist that affected site choice such as cost/benefit impacts, meeting future needs, and regulatory compliance. The team developed specific siting criteria that supported these broader values. The criteria used in the evaluation were: maximizing gravity flow, site proximity to existing and future conduit rights-of-ways (ROWs), site size, site slopes and geologic conditions, and impacts to the compliance schedule.

The six potential filtration facility sites were evaluated for their ability to meet these essential criteria. Sites needed to meet all essential criteria or else were considered to have a fatal flaw. Table 2 summarizes each sites' ability to meet the essential criteria (using a pass/fail scoring). Four of the sites failed to meet all essential criteria. Only two sites, Carpenter Lane and Lusted Hill, passed all essential criteria and were therefore evaluated further using the decision framework.

Table 2. Pass/Fail Results of How Well Each Initial Site Met the Essential Criteria.

Site	Hydraulic Grade Line	Proximity to Conduits	Tax Lot Size	Slopes and Geologic Hazards	Schedule
Carpenter Lane	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**
Headworks	Fail	Pass	Fail	Fail	Pass
Larson's Ranch	Fail	Pass	Pass	Pass	Pass
Lusted Hill	**Pass**	**Pass**	**Pass (with site expansion)**	**Pass**	**Pass**
Powell Butte	Pass	Pass	Pass	Pass	Fail
Roslyn Lake	Fail	Pass	Pass	Pass	Pass

The results from the decision model were discussed at length by the project team and the Executive Committee. The scores for both the alternatives were very close in all three weighting scenarios and the filtration team and the Executive Committee were split between the two sites. A major concern with expanding Lusted Hill was related to part of the area being zoned as Exclusive Farm Use (EFU), although the site had other benefits. Receiving a conditional land use approval on EFU zoned land was identified as a significant hurdle. Team members with more extensive knowledge of state land use decisions felt an approval was unlikely to be granted. Others felt that even if an approval could eventually be granted, the approval process would be drawn out to the point where it would likely prevent PWB from meeting the compliance deadline.

The team was very concerned about the risk to the schedule of siting the facility within an EFU zone. To be better informed about this risk, the Executive Committee consulted with the City Attorney. The City Attorney's opinion was that, in this situation, attempting to build on EFU land would be an unacceptable risk to the schedule. Therefore, Carpenter Lane was selected by the Executive Committee as the preferred filtration plant site.

Filtration Plant Filtration Technology

The filtration technology decision was made with the assistance of the decision framework and is captured in the Filtration Plant Technology Assessment (Document 4). Jacobs coordinated closely with PWB and their other consultants, HDR and Barney & Worth, to identify the criteria and performance scales that PWB staff used as part of the decision-making process to identify the filtration plant technology. The performance scales applied to the technology decision were considered after capacity and location were determined because these may have impacted the technology decision.

The Environmental Protection Agency (EPA) recognizes several filtration strategies for compliance with the Surface Water Treatment Rules, including the latest Long-term 2 Enhanced Surface Water Treatment Rule that sets out treatment requirements for *Cryptosporidium* removal and inactivation. These technologies include granular media filtration, membrane filtration, slow sand filtration, cartridge and bag filtration, and diatomaceous filtration. Of these filtration technologies, there are no known large (greater than 50 mgd) cartridge, bag, or diatomaceous earth filtration facilities. Therefore, the team proposed to focus the evaluation on the remaining three technologies.

The consultant team met with PWB and identified a list of filtration benefits that would have measurable impact on evaluating the differences among the remaining three filtration technologies being considered. These filtration benefits are based on the benefits originally described by PWB to City Council in the August 1, 2017 memo identifying the probable benefits of filtration over UV treatment. Potential benefits of filtration are as follows:

- Provide pathogen removal for *Cryptosporidium, Giardia*, bacteria and viruses
- Produce biologically stable water
- Reduce disinfection by-products
- Increase supply reliability
- Reduce distribution system flushing, and lower turbidity levels
- Reduce iron and manganese concentrations
- Improve water quality stability; reduce lead and copper release at customer taps
- Reduce water quality impacts due to warmer weather (such as algae)
- Reduce organic discoloration events
- Improve ability to respond to changes in regulations
- Increase ability to meet several critical service levels
- Treat a sustained elevated turbidity event
- Reduce customer cost of water treatment at the tap

The three technologies were then evaluated for their ability to provide the above desired system benefits. For evaluation purposes, some pre- or post-treatment measures were assumed so that PWB could evaluate the full treatment systems ability to achieve the required desired benefits of filtration. This was done to develop capital and operating costs so that decision-makers could fairly evaluate the alternatives. Actual pre- or post-treatment processes will be determined later. None of the treatment configurations for slow sand filtration provided a good or excellent rating for all filtration benefits. Therefore, it was recommended that only granular media filtration and membrane filtration be evaluated for potential filtration technology to use on the Bull Run supply.

These two technologies were then compared using the decision model. In all three weighing schemes, granular media filtration resulted in higher performance. Granular media filtration provides greater value at less cost while providing the desired filtration benefits. The membrane filtration option costs more and provides less value. The project team and Executive Committee selected granular media filtration as the preferred treatment technology.

Supporting Documents

Included are two documents that provided supporting information not listed in the appendices of the above technical memoranda: the Preliminary Geotechnical Study and the Carpenter Lane Site Evaluation memo. The Preliminary Geotechnical Study and the Carpenter Lane Site Evaluation memo were used to confirm the suitability of Carpenter Lane and will continue to be used in future site-specific evaluations, such as when considering environmental impacts and permitting needs.

Technical Memo

Date:	September 5, 2018
Project:	Bull Run Filtration Project 699275.01.03
To:	Portland Water Bureau Filtration Decision Team
Copy to:	David Peters, PE and Michelle Cheek, PE – Portland Water Bureau
Prepared by:	Dan Speicher
Approved by:	Kelly Irving
Subject:	**Filtration Plant Decision Process**

1.0 Introduction

In August 2017, the Portland City Council voted to build a water filtration treatment facility to meet the treatment requirements associated with Cryptosporidium. On December 18, 2017, the Oregon Health Authority – Drinking Water Services (OHA) and the Portland Water Bureau (PWB) signed a bilateral compliance agreement that laid out a schedule for construction of a new filtration treatment system on the Bull Run Supply by September 30, 2027.

The approved filtration schedule includes three phases – Planning, Design, and Construction. Following the August 2017 City Council approval, the Bull Run Filtration project was initiated in fall 2017. In December 2017, PWB staff and consultants began the pre-planning task as part of the Planning Phase.

Part of this pre-planning task was to make four key decisions related to filtration of the water supply: project delivery method, filtration plant capacity, site suitability, and filtration technology. Three of the decisions (filtration plant capacity, site suitability, and filtration technology) used the decision process described in this document. The project delivery method did not require the use of this process. The decision process was supported by a Filtration Team which included technical representation from throughout the PWB organization. Decisions were made by the Executive Committee comprised of PWB management team members.

Three distinct yet interrelated components were produced to assist the Filtration Team and the Executive Committee in reaching these decisions – a Decision Framework, Values Hierarchy, and Decision Model. The development and application of these components were accomplished through a series of workshop sessions between February and June 2018.

The first component, the Decision Framework, designated who was included in the process, clarified how conclusions would be reached, structured the inclusion of important values in the process, and characterized how information was presented and facilitated.

The second component, Values Hierarchy, is a description and ordering of the values most important to the community and PWB. Values are the guiding principles that must be considered when making decisions and are used to characterize, understand and communicate tradeoffs.

The third component, the Decision Model, incorporated the values, criteria, and performance evaluation of the viable alternatives into a structure allowing for comparative assessment of the alternatives within each decision. The Decision Model brings together the possible alternatives within each decision,

displays the performance of the alternatives against the values, and demonstrates the trade-offs of values for the decision makers. Similar results were produced for each of three filtration decisions. The results of the Decision Model evaluation are found in the separate decision technical memoranda.

The combination of the Decision Framework, Values Hierarchy and Decision Model generated and codified the process, assured incorporation of community and PWB values, and transparently displayed the insight that went into reaching the filtration decisions. Although these components supported, informed, and structured the decision process, the team involved made the decisions.

This technical memorandum presents the development of these three parts: Decision Framework, Values Hierarchy, and Decision Model. This memorandum is not intended to repeat material in the separate technical memoranda associated with each individual decision (capacity, site, technology). Rather, this memorandum is designed to capture the development and application of the framework, hierarchy and model that structured and supported reaching the filtration decisions.

This document serves to record the decision-making process and provide a process description for any interested party.

2.0 Background

In 2010, PWB navigated through a decision process associated with another decision effort. At that time, PWB and the consultant team applied a structured decision process to provide direction and reach decisions with the initiation of a 30 percent design.

The factors affecting those decisions, which predicated the use of a structured decision process, were:

- A very short time frame in which to make decisions — roughly a 6-month window
- The likely multiple objectives that would need to be considered in the approach; in particular, a combination of social, environmental, and financial (triple bottom line) criteria
- The large number of stakeholders and other interested parties, mainly internal to PWB
- The significant interest those stakeholders and interested parties had in the decisions
- The large expectation of communication with those stakeholders and interested parties
- The differing perspectives those stakeholders would likely have concerning a direction or decision
- The diverse sets of data that were to be generated as part of the assessment

All of these characterizations contributed to the need to develop a structured, exhaustive, and transparent decision process that involved a large number of stakeholders, interested parties, and yet still produced decisions within the required time frame.

The success of that previous decision process was the basis for applying a similar process when the City concluded that filtration was the preferred technology for Bull Run water treatment. Reaching decisions associated with filtration had many similarities to the previous decision process, including:

- A relatively short time frame in which to make decisions — roughly a 6-month window
- Multiple values from both PWB and the community that needed to be considered in the approach

- A large number of PWB stakeholders, and a significant interest by those stakeholders in the decisions
- A large and diverse set of external stakeholders
- Differing perspectives that those stakeholders would likely have concerning a direction or decision
- The diverse sets of data that were to be evaluated as part of the assessment, and
- Three unique yet interrelated decisions (capacity, site, technology) that had to be considered in a consistent way

These factors, once again, required the development of a structured, comprehensive, and transparent decision process that involved a large number of stakeholders, and still produced decisions within the required time frame.

3.0 Decision Framework

Reaching the three decisions required the assistance of a Decision Framework. This Decision Framework designated who must be included in the process to reach effective conclusions in workshop settings, clarified how conclusions would be reached, structured the inclusion of the Values Hierarchy and Decision Model to apply across all the decisions, and characterized how information would be presented and facilitated in the workshop settings.

With consultant support, PWB produced a Decision Framework comprised of building blocks that provided the specific steps to reach the decisions. This Decision Framework was paramount to reaching these decisions because it established structure among all the participants, provided continuity of decision-making across the three decisions, and clarified the participants and their roles within the process.

Figure 1 presents the resulting Decision Framework.

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Figure 1. Decision Framework

Portland Water Bureau – Filtration Decision Support: Decision Framework

March 9, 2018

This placemat displays and describes the building blocks of the Filtration Decision Framework

Framework Introduction

1 Decision Context

Four decisions will be reached by July 1, 2018; three will use this framework:
- Site selection/suitability
- Capacity
- Filtration Technology

2 Framework Defined

This decision framework provides the structure and associated components to assist PWB in comparing the options and reaching agreement on the preferred option within each decision in the required time-frame.

3 Framework Provisions

The framework provides:
- Consistent and managed decision-making structure
- Clarity of who holds decision authority
- Incorporation of both community and PWB values

4 Framework Intent

Application of the decision framework is intended to:
- Ensure decisions reflect community and PWB values
- Provide transparency to the decision process
- Assure decisions endure

5 Framework Components

A. Values hierarchy
B. Criteria/performance measures
C. Decision-maker designation
D. Workshop schedule
E. Workshop elements

Framework Components Details

A Values Hierarchy

The hierarchy captures and structures the values of both the community and PWB. Decision makers consider the tradeoffs among these values to reach a conclusion. Values will include cost, water quality/ public health, resiliency/reliability, community concerns, and implementation among others.

B Criteria/Performance Measures

Criteria refine the values into measurable components. Performance measures are the specific scales used to gauge the performance of the options against the criteria. Criteria and associated performance measures are developed for each value and customized for the decisions.

C Decision-Maker Designation

Consultants: Explainers. Translators. Trusted advisors. Bring examples and proof. Provide data and analysis. Resources.

PWB Technical Team: Provide guidance, leadership, and support to decision process. Participate. Provide recommendations.

PWB Executive Committee: Provide input, perspective, and questions. Validate with Mike Stuhr. Make decisions.

Mike Stuhr: Provide validation of direction and decisions.

D Decision Workshop Schedule

Feb 28	o Recognition of values o Agreement upon decision making framework
Mar 21	o Validation of information collection, analysis methodology, technical memo production o Comparative position determination
Apr 18	o Capacity conclusion
May 23	o Site conclusion
Jun 20	o Filtration conclusion

E Workshop Elements

Prepared for and shared/ accomplished within meetings:
i. Technical analysis
ii. Comparative position
iii. Define, characterize, and compare
iv. Consensus style
v. Executive Committee decision

Workshop Elements Details

i Technical Analysis

The PWB/consultant technical team will apply the values, criteria, and performance measures to the options associated with each decision. They will prepare a summation of the resulting option performance for review and discussion at the workshops. This is designed to be a starting point for reaching decisions.

ii Comparative Position

Each decision will have a comparative position. This comparative position serves as both the baseline from which other options are considered and value trade-offs are compared. A comparative position may be the minimum requirement within the decision and/or an option maximizing specific values.

iii Define, Characterize, Compare

Each decision will have at least two touches – introduction at the March 21st workshop and detailed review and conclusion at a decision workshop. At the decision workshops, the technical teams will Define the options; Characterize factual advantages and disadvantages; and, Compare the options benefits against cost.

iv Consensus Style

All steps within this decision framework - validation of values; agreement to the comparative position; definition, characterization, and comparison of options; discussion in the meetings - will be conducted in the style of consensus. This includes the decisions reached by the Executive Committee.

v Executive Committee Decision

Recommendations will be concluded by the technical team and the Executive Committee (Chris Wanner, Edward Campbell, Teresa Elliott, Gabriel Solmer) at the dedicated meetings. The Executive Committee will validate the conclusion with Mike Stuhr, and make a decision within 2 days of each workshop.

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Three rows organize the building blocks of the Decision Framework in Figure 1:

- Framework Introduction
- Framework Components Details
- Workshop Elements Details

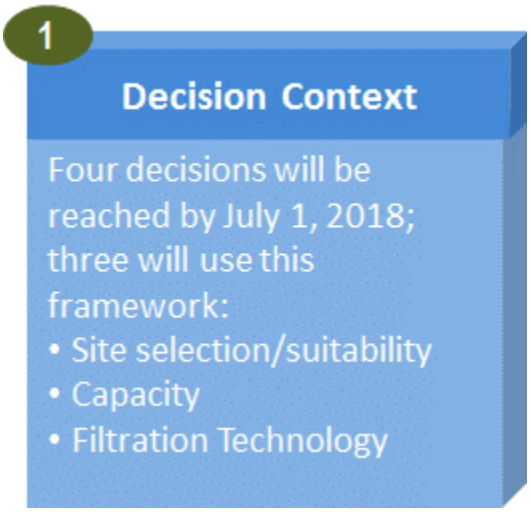
Each building block within each row is described below.

3.1 Framework Introduction

Five building blocks comprise the Framework Introduction. The five blocks include:

- Decision Context
- Framework Defined
- Framework Provisions
- Framework Intent
- Framework Components

These first five building blocks set the stage for what the framework was meant to do. Review and agreement of these items within the PWB team assured that the framework was being designed and implemented in a way to meet the collective needs of the participants.



Decision Context: A total of four decisions were part of the water filtration planning:

- Project delivery model
- Site selection/suitability
- Capacity
- Water Filtration Technology

The project delivery model recommendation was reached on January 30, 2018 and was not part of the application of this Decision Framework. The other three decisions used this Decision Framework to reach agreement and conclusions by July 1, 2018.

2

Framework Defined

This decision framework provides the structure and associated components to assist PWB in comparing the options and reaching agreement on the preferred option within each decision in the required time-frame.

Framework Defined: This Decision Framework was designed to provide the structure for effectively and efficiently reaching agreement and conclusions with the three filtration decisions. Viable alternatives were presented, analyzed and reviewed within each decision. The framework assured these alternatives were appropriate and thoroughly and uniformly considered. The outcome of the effort described in this building block is the framework as a whole shown in Figure 1.

3

Framework Provisions

The framework provides:

- Consistent and managed decision-making structure
- Clarity of who holds decision authority
- Incorporation of both community and PWB values

Framework Provisions: This framework was designed to provide many items in supporting the decision process. In particular, the framework was designed to provide a consistent and managed structure, clarity of how participants were involved in the decision-making, and assurance that the values of both the community and PWB were incorporated into the process.

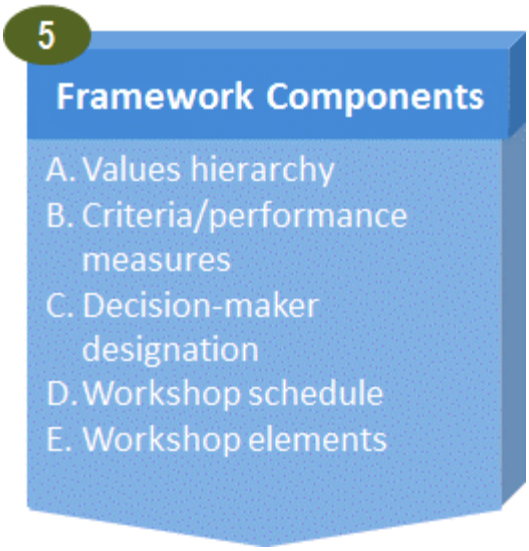
Framework Intent: The framework was designed to deliver many results. The intent was a listing of the primary outcomes that were expected through the application of this framework. The development and implementation of this framework was expected to ensure the reflection of community values, offer transparency to the decision process, and lend to the endurance of the decisions.

4

Framework Intent

Application of the decision framework is intended to:

- Ensure decisions reflect community and PWB values
- Provide transparency to the decision process
- Assure decisions endure



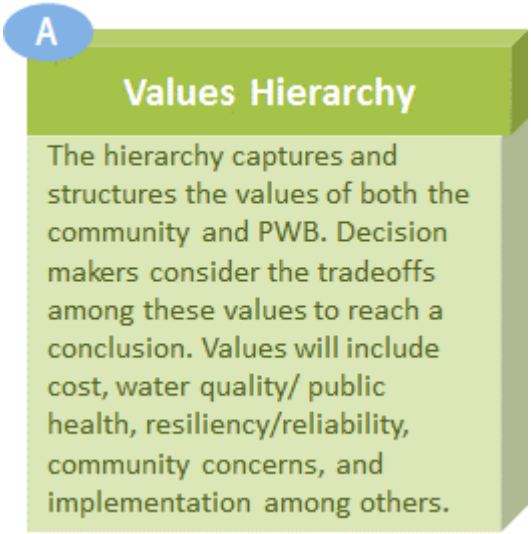
Framework Components: Five components made up the structure of this Decision Framework. These components were specifically selected to deliver the framework intent and reach the conclusions of the three decisions. Each of these components is further defined below in Framework Component Details.

3.2 Framework Components Details

There are five framework components, as introduced in the last building block of the Framework Introduction above. These five components are further detailed in these building blocks:

- Values Hierarchy
- Criteria/Performance Measures
- Decision Makers Designation
- Workshop Schedule
- Workshop Elements

Values Hierarchy: The Values Hierarchy is a listing of the most important values of PWB and the community. Values serve as the primary means to compare the performance of alternatives within each decision. The decisions must be focused upon what tradeoffs take place among these values. An alternative that maximizes the values may be the most preferred. If one alternative does not maximize performance across all values, the decision makers must consider what tradeoffs among values are appropriate. The Values Hierarchy is a primary component within the decision framework and is described in much greater detail in a subsequent section of this document.



B

Criteria/Performance Measures

Criteria refine the values into measurable components. Performance measures are the specific scales used to gauge the performance of the options against the criteria. Criteria and associated performance measures are developed for each value and customized for the decisions.

Criteria/Performance Measures: Each value had at least one criterion that further refined the value into a measurable component. Each criterion had at least one performance measure that captured a specific scale used to measure or gauge the performance of each alternative. The criteria and the associated performance measures were applied as consistently as possible across all three decisions. However, the nuances of the decisions and the alternatives within them compelled the generation of slightly modified performance measures to capture appropriate comparisons within specific decisions. The nuances of each decision are captured in the technical memoranda summarizing each individual decision.

C

Decision-Maker Designation

Consultants: Explainers. Translators. Trusted advisors. Bring examples and proof. Provide data and analysis. Resources.

PWB Technical Team: Provide guidance, leadership, and support to decision process. Participate. Provide recommendations.

PWB Executive Committee: Provide input, perspective, and questions. Validate with Mike Stuhr. Make decisions.

Mike Stuhr: Provide validation of direction and decisions.

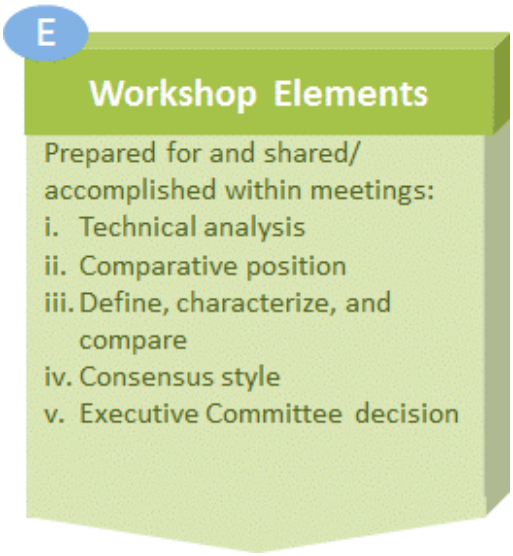
Decision-Maker Designation: A critical building block of the Decision Framework was clearly defining what roles the participants had in the process, and if those roles provide advice, recommendations, and/or decisions. This building block structured the conversation of specific roles, characterized the recommendation or decision authority of those roles, and determined how and where those decisions were made.

D

Decision Workshop Schedule

Feb 28	o Recognition of values o Agreement upon decision making framework
Mar 21	o Validation of information collection, analysis methodology, technical memo production o Comparative position determination
Apr 18	o Capacity conclusion
May 23	o Site conclusion
Jun 20	o Filtration conclusion

Workshop Schedule: Five workshops were planned for this Decision Framework. Each workshop delivered to the listed specific outcomes to maintain the schedule. (See Appendix A for workshop details.)

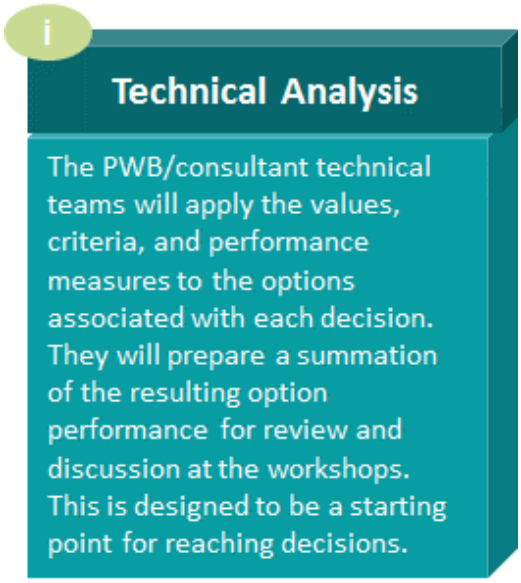


Workshop Elements: Five specific elements were prepared for and reviewed in the workshop setting designed to reach the conclusions associated with the three decisions. The workshops on April 18, May 23, and June 20 incorporated all of these elements. These elements were the culmination of the efforts by the technical teams. Each element is further detailed below.

3.3 Workshop Elements Details

There are five workshop elements, as introduced in the last building block of the Framework Components Details. These five elements are further detailed in these building blocks:

- Technical Analysis
- Comparative Position
- Define, Characterize, Compare
- Consensus Style
- Executive Committee Decision



Technical Analysis: The technical team, comprised of both PWB and consultant staff, evaluated and assessed the performance of the options against the values. The results of the technical analysis were relayed during the decision specific workshops.

Comparative Position: It is sometimes difficult to choose among a set of possible options. The likely differences in performance, plus the tradeoffs associated with values, may produce complexity in comparing results across the multiple options and reaching a conclusion and agreement. A suggested means to make the decision process less complex is to generate a position or option that serves as a point in which all other options are compared. This comparative position allows for the remaining options to be judged in performance as being equal to, worse than or better than that comparative position. This comparative position does not in any way limit the technical detail nor the differentiation of the alternatives. On the contrary, a comparative position could allow for more technical complexity in the process but produces the condition for the human participants in the process to tackle individual comparisons among criteria and values and then sum the results more effectively. The application of this comparative position was specific to each decision and was applied if it lent to reaching a conclusion and agreement more readily.

ii

Comparative Position

Each decision will have a comparative position. This comparative position serves as both the baseline from which other options are considered and value trade-offs are compared. A comparative position may be the minimum requirement within the decision and/or an option maximizing specific values.

iii

Define, Characterize, Compare

Each decision will have at least two touches – introduction at the March 21st workshop and detailed review and conclusion at a decision workshop. At the decision workshops, the technical teams will Define the options; Characterize factual advantages and disadvantages; and, Compare the options benefits against cost.

Define, Characterize, Compare: Each dedicated decision workshop followed a uniform format of defining the alternatives, characterizing each alternative, and then presenting the performance and comparison of the alternatives. This uniform format both assured all three decisions were equally considered and the flow of the information became familiar to the participants. This familiarity supported the digestion of information and the discussion and deliberation among the team.

Consensus Style: How the participants interacted and produced a conclusion and agreement was just as important as the collation and sharing of technical data. The entire Decision Framework and all building blocks took advantage of a consensus style of engagement. Both the culture of PWB and the nature of these decisions were reasons to have this sharing- and agreement-reaching environment. The only exception was the final agreement and decision by the Executive Committee. Although the Executive Committee members themselves looked to the technical team for guidance and advice, the technical team members were not consensus partners in the Executive Committee's ultimate decision.

iv

Consensus Style

All steps within this decision framework - validation of values; agreement to the comparative position; definition, characterization, and comparison of options; discussion in the meetings - will be conducted in the style of consensus. This includes the decisions reached by the Executive Committee.

v

Executive Committee Decision

Recommendations will be concluded by the technical team and the Executive Committee (Chris Wanner, Edward Campbell, Teresa Elliott, Gabriel Solmer) at the dedicated meetings. The Executive Committee will validate the conclusion with Mike Stuhr, and make a decision within 2 days of each workshop.

Executive Committee Decision: All decisions were made by the Executive Committee, which sought internal consensus. All decisions by the Executive Committee took place after the workshop sessions.

4.0 Values Hierarchy

Values represent the most important elements to the community and PWB. They are the guiding principles that must be considered when making decisions and were used to characterize, understand and communicate tradeoffs.

The PWB Filtration Team initiated the conversation about values by learning about the concerns of the public. PWB engaged Barney & Worth, Inc., to conduct a three-step process to identify community values specific to the Bull Run Filtration Project. Details of this community values process are captured in the Community Values Memorandum. Initial engagement of the public produced an impression of the leading community values in Tiers:

<u>Community Values Tier 1:</u>

Cost
Public health/water quality

<u>Community Values Tier 2:</u>

Resilience/reliability
Consistent quality
Environmental impacts
Equity
Expandability
Minimal treatment
Speed
Preparation for the future

The PWB Filtration Team reviewed these community values, cross-referenced against and supplemented with PWB values. PWB values considered included those captured in PWB's strategic plan:

- Customers: Keep the needs and desires of our customers in the forefront of our thoughts and actions.
- Service: Contribute responsively to the welfare of the community.
- Financial Health: Maintain fiscal integrity, undertake sound financing practices, and ensure auditable results.
- Employees: Recruit, maintain, motivate, and retain a highly qualified, diverse, and committed workforce; and provide a safe work environment.
- Partnership: Partner with our community, our customers, and regional water interests.
- Leadership: Focus on goals, results, and accountability while promoting human health and development.
- Responsiveness: React positively, cooperatively, and efficiently.
- Effectiveness: Make the most appropriate use of resources and infrastructure.
- Communication: Share information and knowledge openly.
- Flexibility: Adapt to new, different, and changing requirements.

- Equity: Ensure fair treatment and service to all.
- Stewardship: Protect the natural environment so its benefits are available to meet today's needs as well as those of future generations.

Through multiple iterations in workshop settings, the Filtration Team agreed upon eight values, shown in Table 1, to reflect the most important elements of PWB and the Community that must guide any decision. These were used to recognize tradeoffs among alternatives within each decision.

Table 1. Values

Values Hierarchy

Value	Public Health and Water Quality	Resiliency/ Reliability	Community Interests	Cost Benefit
Value Description	Provide drinking water that is safe and consistent	Facility maximizes likelihood of continued water provision, even after a fire or disaster	Integrate community interests in the decision-making process	Getting the most benefit for the dollar

Value	Meet Future Needs	Environmental Impacts	Integration	Implementation
Value Description	Maximizes ability to make adjustments in future	Minimize environmental impacts	Optimize operability & integration with PWB's systems & practices	Increases ability to implement and meet compliance schedule

Criteria are the next level within the hierarchy that refine the values into statements that lend themselves to measurable components. Performance scales are the measurable components associated with an individual criterion. The criteria were agreed upon by the Filtration Team and were applied consistently across all three of the decisions. Descriptions of the performance scales used in the decision are captured in the individual decision technical memoranda.

This final list of values and criteria is termed a Values Hierarchy (see Table 2) because the values serve as the top level of the structure and criteria and performance measures fit within that structure.

Table 2. Values Hierarchy

Values Hierarchy – Part A

Value	Public Health and Water Quality					Resiliency/Reliability			Community Interests			Cost Benefit	
Value Description	Provide drinking water that is safe and consistent					Facility maximizes likelihood of continued water provision, even after a fire or disaster			Integrate community interests in the decision-making process			Getting the most benefit for the dollar	
Criteria	Existing Micro-biological Regulations	Emerging Water Quality Regulations	Organics/ Inorganics Regulations	Consistent Water Quality	Chemical Impacts	Earthquake	Catastrophic WQ Event (forest fire, landslide)	Routine WQ Events (elevated turbidity, algae bloom)	Local Impacts	Consistency in Taste and Appearance	Perception of Safety	Cost of Construction	Operating Costs

Values Hierarchy – Part B

Value	Future Needs			Environmental Impacts			Integration					Implementation			
Value Description	Maximizes ability to make adjustments in future			Minimize environmental impacts			Optimize operability & integration with PWB's systems & practices					Increases ability to implement and meet compliance schedule			
Criteria	Capacity	Future Water Quality	Available Gravity Capacity	Electricity Usage	Residuals Produced	Construction and Operations Fuel Consumption	WTP Labor	Safety & Operations	Corrosion Control Integration	Other infrastructure Ramifications	Distribution System WQ	Ease of Construction	Implementation Complexity	Land Use Permits	On- and Off- site Ownership

All values must be part of the decision process, but the influence of those values must reflect the importance PWB places upon those values. Weighting reflects the relative importance the Filtration Team placed on the values and the criteria. In a workshop setting, the Filtration Team produced and agreed to a set of weights for the value hierarchy. The numbers associated with each value or criterion present the relative weight of that element (Table 3).

Table 3. Team-developed Weights

Value	Public Health and Water Quality	Resiliency/ Reliability	Integration	Cost Benefit	Implementation	Meet Future Needs	Community Interests	Environmental Impacts
Value Description	Provide drinking water that is safe and consistent	Facility maximizes likelihood of continued water provision, even after a fire or disaster	Optimize operability & integration with PWB's systems & practices	Getting the most benefit for the dollar	Increases ability to implement and meet compliance schedule	Maximizes ability to make adjustments in future	Integrate community interests in the decision making process	Minimize environmental impacts
Value Weight	25	15	12	12	10	10	9	7
Criteria per Values in rank order	Existing Micro-biological Regulations 6.2	Routine WQ Events (elevated turbidity, algae bloom) 6.3	Safety & Operations 3.6	Operating Costs 6.6	Implementation Complexity 3.1	Capacity 3.4	Consistency in Taste and Appearance 4.2	Residuals Produced 2.7
	Organics/ Inorganics Regulations 5.7	Catastrophic WQ Event (forest fire, landslide) 5.3	Distribution System WQ 2.3	Cost of Construction 5.4	Land Use Permits 2.4	Available Gravity Capacity 3.4	Chemical Concerns 2.9	Electricity Usage 2.3
	Emerging Water Quality Regulations 4.6	Earthquake 3.4	Corrosion Control Integration 2.2		On- and Off- site Ownership 2.2	Future Water Quality 3.2	Local Impacts 1.9	Construction and Operations Fuel Consumption 2.0
	Consistent Water Quality 4.5		Other infrastructure Ramifications 2.1		Ease of Construction 2.2			
	Chemical Impacts 4.1		WTP Labor 1.8					

The Filtration Team also agreed that carrying forward a weighting scheme that provided equal weights to the values would be appropriate. The comparison of results across multiple weighting schemes demonstrates the sensitivity of the results to the weights (Table 4).

Table 4. Equal Weights

Value	Public Health and Water Quality	Resiliency/ Reliability	Integration	Cost Benefit	Implementation	Meet Future Needs	Community Interests	Environmental Impacts
Value Description	Provide drinking water that is safe and consistent	Facility maximizes likelihood of continued water provision, even after a fire or disaster	Optimize operability & integration with PWB's systems & practices	Getting the most benefit for the dollar	Increases ability to implement and meet compliance schedule	Maximizes ability to make adjustments in future	Integrate community interests in the decision making process	Minimize environmental impacts
Value Weight	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Criteria per Values in rank order	Existing Micro-biological Regulations 2.5	Routine WQ Events (elevated turbidity, algae bloom) 4.2	Safety & Operations 2.5	Operating Costs 6.3	Implementation Complexity 3.1	Capacity 4.2	Consistency in Taste and Appearance 4.2	Residuals Produced 4.2
	Organics/ Inorganics Regulations 2.5	Catastrophic WQ Event (forest fire, landslide) 4.2	Distribution System WQ 2.5	Cost of Construction 5.3	Land Use Permits 3.1	Available Gravity Capacity 4.2	Chemical Concerns 4.2	Electricity Usage 4.2
	Emerging Water Quality Regulations 2.5	Earthquake 4.2	Corrosion Control Integration 2.5		On- and Off- site Ownership 3.1	Future Water Quality 4.2	Local Impacts 4.2	Construction and Operations Fuel Consumption 4.2
	Consistent Water Quality 2.5		Other infrastructure Ramifications 2.5		Ease of Construction 3.1			
	Chemical Impacts 2.5		WTP Labor 2.5					

A third weighting scheme was suggested by the Executive Committee. This scheme placed 40 percent of the weight on the "Public Health and Water Quality" and "Resiliency/Reliability" values and the remaining 60 percent equally distributed across the other six values (Table 5).

Table 5. 60/40 Weighting

Value	Public Health and Water Quality	Resiliency/ Reliability	Integration	Cost Benefit	Implementation	Meet Future Needs	Community Interests	Environmental Impacts
Value Description	Provide drinking water that is safe and consistent	Facility maximizes likelihood of continued water provision, even after a fire or disaster	Optimize operability & integration with PWB's systems & practices	Getting the most benefit for the dollar	Increases ability to implement and meet compliance schedule	Maximizes ability to make adjustments in future	Integrate community interests in the decision making process	Minimize environmental impacts
Value Weight	25	15	10	10	10	10	10	10
Criteria per Values in rank order	Existing Micro-biological Regulations 5.0	Routine WQ Events (elevated turbidity, algae bloom) 5.0	Safety & Operations 2.0	Operating Costs 5.0	Implementation Complexity 2.5	Capacity 3.3	Consistency in Taste and Appearance 3.3	Residuals Produced 3.3
	Organics/ Inorganics Regulations 5.0	Catastrophic WQ Event (forest fire, landslide) 5.0	Distribution System WQ 2.0	Cost of Construction 5.0	Land Use Permits 2.5	Available Gravity Capacity 3.3	Chemical Concerns 3.3	Electricity Usage 3.3
	Emerging Water Quality Regulations 5.0	Earthquake 5.0	Corrosion Control Integration 2.0		On- and Off- site Ownership 2.5	Future Water Quality 3.3	Local Impacts 3.3	Construction and Operations Fuel Consumption 3.3
	Consistent Water Quality 5.0		Other infrastructure Ramifications 2.0		Ease of Construction 2.5			
	Chemical Impacts 5.0		WTP Labor 2.0					

All three weighting schemes were carried forward and applied in the Decision Model.

5.0 Decision Model

The Decision Model incorporated the values, criteria, and performance evaluation of the viable alternatives into a structure allowing for comparative assessment of the alternatives. Throughout the evaluation and review, the team reminded itself that the Decision Model does not make the decision, the team does. This context assured that the Decision Model and the evaluation of alternatives was designed to inform the technical team and the Executive Committee, not make the decision for the team.

The Decision Model is a multi-criteria decision analysis methodology. Alternatives were rated in performance with each criterion under the values using a measurable scale. That performance rating was normalized across the spectrum of performance among the alternatives. That normalized

performance rating was then multiplied by the weight associated with that criterion. The summation across all criteria produces an overall score, referred to as a value score.

The series of graphics below further describe this evaluation process performed by the Decision Model using a hypothetical example – purchasing a car. More than one weighting scheme may be applied. Six criteria are part of this evaluation. In this example two weighting schemes are developed, one for the parents, one for the kids. Refer to Table 6. Each criterion receives a weight to reflect how the participants view the importance of that criterion. All criteria are considered as part of the evaluation, yet those with higher weight have more of an influence upon the resulting calculations of value. Weights may be displayed as a number or a percentage.

Table 6. Weighting Schemes – Example

	ENV1	SOC1	SOC2	SOC3	SOC 4	SOC 5
	Minimize air pollution and greenhouse gas emissions	Maximize exterior styling	Maximize safety	Maximize "fun" to drive	Maximize comfort in the interior	Maximize cargo capacity
Parents						
Weights	67	83	100	72	86	83
% of Total	13.6%	16.9%	20.4%	14.7%	17.5%	16.9%
Kids						
Weights	100	60	65	30	65	50
% of Total	27.0%	16.2%	17.6%	8.1%	17.6%	13.5%

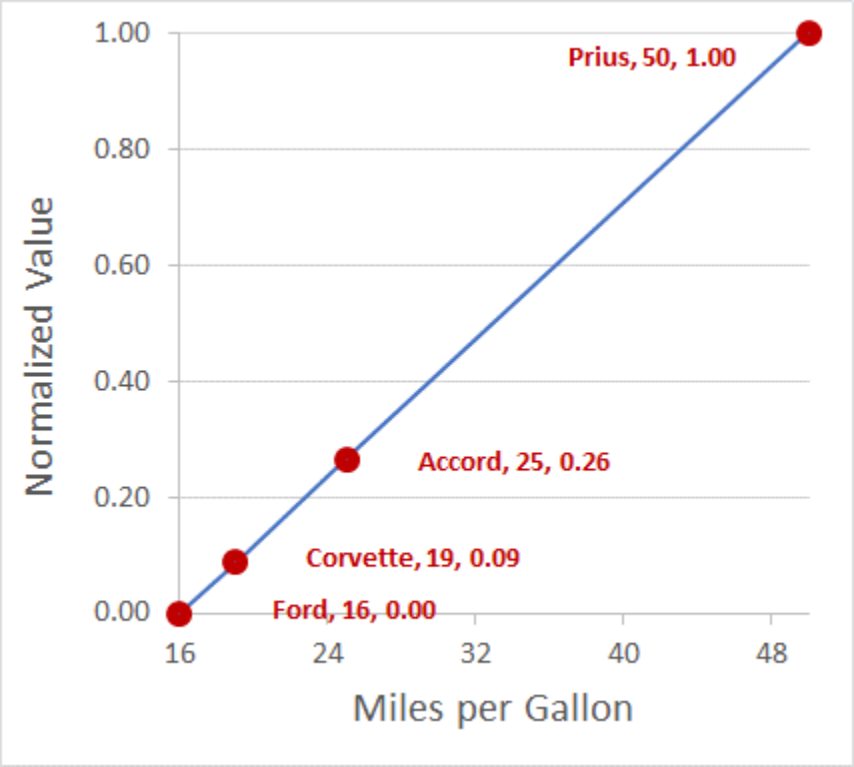
Each alternative is rated in its performance against the criteria. In this case, the alternatives are listed on the far-left column of Table 7. The performance scale is reflective of the characteristics of the criterion. For example, the ENV1 criterion used miles per gallon as its performance scale; whereas the SOC3 criterion uses a subjective scale of 1 to 3. The Decision Model is designed to account for either of these types of performance scales. Refer to Table 7.

Table 7. Performance Ratings – Example

	Environment - minimize the impact to the natural environment	Social - maximize social benefit					Financial
	ENV1	SOC1	SOC2	SOC3	SOC 4	SOC 5	FIN1
	Minimize air pollution and greenhouse gas emissions	Maximize exterior styling	Maximize safety	Maximize "fun" to drive	Maximize comfort in the interior	Maximize cargo capacity	Cost per mile
1. Corvette	19.0	3.0	1.0	3.0	2.0	22.0	$1.10
2. Honda Accord	25.0	1.0	2.0	1.0	3.0	45.0	$0.57
3. Toyota Prius	50.0	1.0	2.0	1.0	2.0	40.0	$0.49
4. Ford F150 Pickup	16.0	2.0	3.0	1.0	2.0	55.0	$0.72

The Decision Model then performs the calculation of multiplying the performance rating by the weight associated with the criterion. In order to produce this calculation, the model normalizes the performance scale, meaning it translates the performance ratings to a 0 to 1 scale. This normalization assigns a “0” to the worst performer in the range of performance and a “1” to the best performer. The remaining scores are then placed within the range of 0 to 1 to reflect the relative performance. As an example, the ENV1 criterion uses miles per gallon as its means of gauging the performance of the alternatives from an environmental perspective. The higher the miles per gallon the better the performance of the alternative. Since the Prius is the best performer at 50 MPG, that alternative receives a “1” in the normalized calculation. At the other end of the range, the Pickup with 16 MPG receives a “0” because it is the worst performer in that criterion. In the middle is the Corvette with a rating of 19 mpg and the Accord with a rating of 25. These two alternatives receive a normalized rating in relationship to where they fit within the range of performance across all the alternatives. Refer to Figure 2 for a graphical representation of the normalization.

Figure 2. Normalization – Example



Note that each point on the line is labeled with the name of the alternative (the car), the actual MPG performance rating of that car (i.e., 25 for the Accord), and the normalized value.

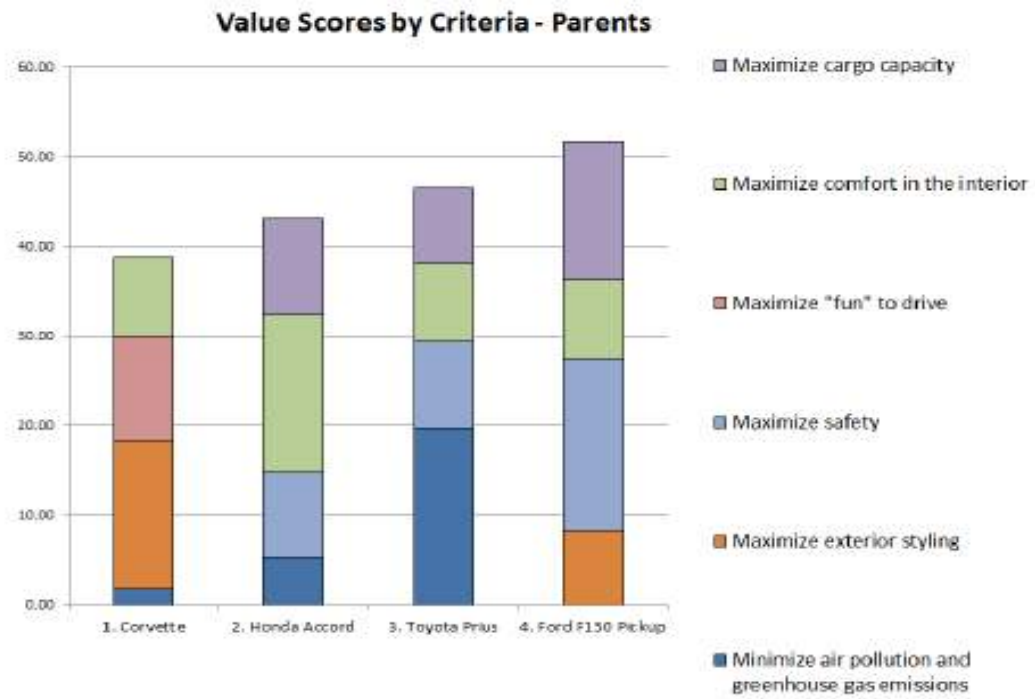
Multiplying the normalized performance of the Pickup at "0" times the weight assigned to that criterion of course produces a contribution of zero (bottom left hand corner of Table 8). Table 8 displays the calculation of the weight (using the parents' weight) times the normalized performance score in this car buying example.

Table 8. Results of Weight times Normalized Performance Rating – Example

Triple Bottom Line Goal	Environment - minimize the impact to the natural environment	Social - maximize social benefit				
	ENV1	SOC1	SOC2	SOC3	SOC 4	SOC 5
Criteria	Minimize air pollution and greenhouse gas emissions	Maximize exterior styling	Maximize safety	Maximize "fun" to drive	Maximize comfort in the interior	Maximize cargo capacity
Low Score	16.000	1.000	1.000	1.000	1.000	22.000
High Score	50.000	3.000	3.000	3.000	3.000	55.000
1. Corvette	1.20	16.90	0.00	14.66	8.76	0.00
2. Honda Accord	3.61	0.00	10.18	0.00	17.52	11.78
3. Toyota Prius	13.65	0.00	10.18	0.00	8.76	9.22
4. Ford F150 Pickup	0.00	8.45	20.37	0.00	8.76	16.90

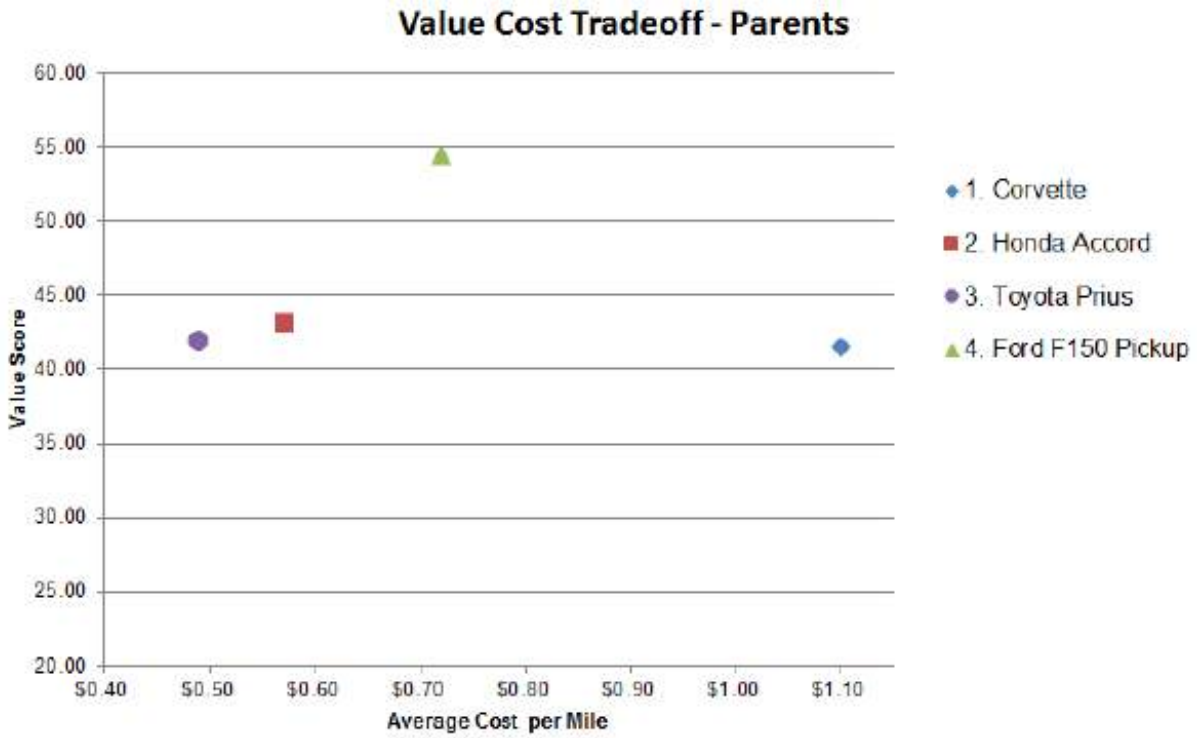
The summation of the criteria produces a value score. The next graphic, Figure 3, displays the results in a histogram. Each color of the bar represents the mathematical contribution of the criteria to the overall value score. The higher the bar the higher the contribution. The highest bar represents the highest overall performance relative to the criteria.

Figure 3. Contributions by Criteria – Example



Another view the Decision Model affords is the comparison of the value score against the cost of the alternative. The scatter plot shown in Figure 4 showcases the value score on the y-axis and the cost on the x-axis. The preferred location on the plot is up and to the left – highest value score with the lowest cost. Although the Pickup has the highest value score, it also has higher cost. The Prius and Accord offer lower value but also lower cost. This tradeoff is considered by the decision makers.

Figure 4. Cost versus Value Scatter Plot – Example



This example displays exactly how the Decision Model was applied to the three filtration decisions – capacity, site, and technology. The individual and separate technical memoranda associated with these three decisions capture the Decision Model results.

6.0 Workshops

Workshops were the primary means of engaging the Filtration Team and the Executive Committee and in reaching the decisions. Table 9 below summarizes the workshops and the objectives of each.

Table 9. Workshop Summary

Date	Meeting	Attendees	Objectives
Tues, January 30	Procurement Method Workshop	PWB Technical Team and Executive Committee	• Recognize the procurement alternatives • Conclude upon preferred procurement method
Wed, February 28	Decision Workshop	PWB Technical Team and Executive Committee	• Recognition of Decision Framework building blocks • Validation of Decision Framework participant's roles and authorities • Conclude value statements are exhaustive of Community and PWB values • Resolve criteria are reflective of values • Establish measures are applicable and provide differentiation of option performance
Wed, March 13	No Meeting; materials due for March Workshop		
Wed, March 21	Filtration Decision Workshop	PWB Technical Team and Executive Committee	• Recognize upcoming workshops content and expected outcomes • Review and accept values/criteria within the Values Hierarchy • Establish common understanding of technical elements of capacity, site and technology decisions • Review of and suggestions for capacity alternatives
Tues, March 27	Progress Meeting	Technical Team	• Produce weights for Values and Criteria • Guidance upon middle Capacity alternative • Provide alternatives evaluation matrix (utilizing agreed upon Values Hierarchy) for Technical Team to begin performance rating of Capacity alternatives • Review Cost curves for Capacity alternatives
Wed, April 11	No Meeting; materials due for April Workshop		
Wed, April 18	Capacity Decision	PWB Technical Team and Executive Committee	• Communication of groundwater policy • Review and reconciliation of Capacity alternatives evaluation (weighting, rating, and results) • Recommendation of preferred Capacity alternative • Review of on-line community survey results

Date	Meeting	Attendees	Objectives
Tues, April 24	Progress Meeting	Technical Team	• Review Site evaluation ratings • Site screening
Wed, May 16	No Meeting; materials due for May Workshop		
Wed, May 23	Siting Decision	PWB Technical Team and Executive Committee	• Review of Siting alternatives and filtering • Review and reconciliation of Siting alternatives evaluation (weighting, rating, and results) • Recommendation of preferred Siting alternative
Tues, May 29	Progress Meeting	Technical Team	• Review Technology evaluation ratings
Wed, June 13	No Meeting; materials due for June Workshop		
Wed, June 20	Technology Decision	PWB Technical Team and Executive Committee	• Review of Technology alternatives and filtering • Review and reconciliation of Technology alternatives performance ratings • Evaluation of value score results • Recommendation of preferred Technology alternative

Appendix A presents the agendas for the workshops, which focused on development and application of the Decision Framework, the Values Hierarchy, and the Decision Model.

Appendices

A. Workshop Agendas

Appendix A. Workshop Agendas

Portland Water Bureau – Filtration Decision Framework

PREPARED BY: Dan Speicher

MEETING DATE: February 28, 2018

LOCATION: Portland Water Bureau Office – 400 SW 6th; 1st floor Conference Room; 8:00 a.m. to 12:00 noon

INVITED ATTENDEES:

Dave Peters, PWB
Mike Saling, PWB
Michelle Cheek, PWB
Rich Seright, PWB
Kimberly Gupta, PWB
Yone Akagi, PWB
Terry Black, PWB
Chris Wanner, PWB
Edward Campbell, PWB
Tony Re, PWB
Gabriel Solmer, PWB
Jodie Inman, PWB
Christopher Bowker, PWB
Janet Senior, PWB
Jonathon Johnson, PWB
Jeana Ott, PWB
Scott Bradway, PWB
Pierre Kwan/HDR
Nicki Pozos/Barney & Worth
Libby Barg/Barney & Worth
Kelly Irving/Jacobs
Bob Chapman/Jacobs
Lee Odell/ Jacobs
Dawn Bierbaum/Jacobs
Dan Speicher/Jacobs

Objectives:

- Recognition of Decision Framework building blocks
- Validation of Decision Framework participant's roles and authorities
- Conclude value statements are exhaustive of Community and PWB values
- Resolve criteria are reflective of values
- Establish measures are applicable and provide differentiation of option performance

Agenda:

Timing	Subject	Description/Outcomes/Messages
8:00 – 8:15 **15 Minutes**	Opening	Welcome and Opening Remarks by Dave P Introduce all Safety Moment from Kelly Objectives of this session
8:15 – 8:50 **35 minutes**	Decision Framework Review	Review Decision Framework Building Blocks Note that participants will be asked to present building blocks and provide insights
8:50 – 9:10 **20 minutes**	Decision Framework Roles	Validate roles of participants: PWB technical team, PWB Executive Team, consultants, Mike Stuhr Consultant Staff: Provide technical expertise, support, and resources. PWB Technical Team: Provide guidance to decision process and technical evaluation, actively participate in decision process and workshops, and provide recommendations for conclusions in the workshops. PWB Executive Committee: Reach conclusion in workshop setting, validate conclusion with Mike Stuhr, and make decision within 48 hours of workshop. Mike Stuhr: Provide validation of direction and decisions.
9:10 – 9:20 **10 minutes**	Define Values Hierarchy	Review structure of value hierarchy – what it is, how it will be used, what are the components (values, criteria, performance scales) Questions we are to answer in review: *Are these values all-inclusive of the community and PWB values?* *Which criteria are applicable to which decision?* *Do the performance measures provide differentiation among the options?*

<table>
<tr><th>Timing</th><th>Subject</th><th>Description/Outcomes/Messages</th></tr>
<tr><td>9:20 – 10:10
50 minutes</td><td>Values Review</td><td>Review community values with Nicki/Libby, addition of operability with Lee
<u>Cost:</u> Gabriel, Chris B, Jeana
<u>Public Health and Water Quality:</u> Yone, Terry, Bob
<u>Resiliency/Reliability:</u> Tony, Michelle, Nicki
<u>Consistency:</u> Kim, Rich
<u>Meet Future Needs:</u> Ed, Dave, Kelly
<u>Environmental Impacts:</u> Janet, Jodie, Libby, Scott
<u>Chemical Use:</u> Mike, Pierre
<u>Operability:</u> Chris W, Jonathon, Lee
Question 1: Are there values that are not captured with these eight? If so, what are they?
Question 2: What, if anything, would you add or embellish with your assigned value? Broaden? Clarify? Scribe on a flip chart.</td></tr>
<tr><td>10:10 – 10:20
10 minutes</td><td>Break</td><td></td></tr>
<tr><td>10:20 – 11:10
50 minutes</td><td>Criteria Review</td><td>Criteria development review with Lee and Pierre
Are the criteria capturing the intent of the value (without being overwhelming)? Lee and Pierre panel are available for consultation
<table>
<tr><th>Value</th><th>Criteria</th><th>Owner</th></tr>
<tr><td rowspan="2">Cost</td><td>Capital</td><td>Gabriel</td></tr>
<tr><td>Lifecycle</td><td>Gabriel</td></tr>
<tr><td rowspan="2">Meet Future Needs</td><td>Capacity</td><td>Dave</td></tr>
<tr><td>Water Quality</td><td>Mike</td></tr>
<tr><td rowspan="4">Public Health and Water Quality</td><td>Microbiological</td><td>Kelly</td></tr>
<tr><td>Aesthetics</td><td>Jeana</td></tr>
<tr><td>Cl Residual</td><td>Bob</td></tr>
<tr><td>Chemicals</td><td>Yone</td></tr>
<tr><td>Consistency</td><td>Consistent WQ</td><td>Tony</td></tr>
<tr><td rowspan="5">Resiliency/ Reliability</td><td>Earthquake</td><td>Ed</td></tr>
<tr><td>Forest Fire</td><td>Libby</td></tr>
<tr><td>Turbidity Events</td><td>Michelle</td></tr>
<tr><td>Algal Blooms</td><td>Scott</td></tr>
<tr><td>Res. Turnover</td><td>Nicki</td></tr>
<tr><td rowspan="4">Environmental Impacts</td><td>Habitat</td><td>Jonathon</td></tr>
<tr><td>GHG</td><td>Janet</td></tr>
<tr><td>Residuals Produced</td><td>Jodie</td></tr>
<tr><td>Construction</td><td>Terry</td></tr>
<tr><td>Chemical Use</td><td>Minimal</td><td>Chris B</td></tr>
<tr><td rowspan="3">Operability</td><td>Impact on Ops</td><td>Kim</td></tr>
<tr><td>Impact on Maint</td><td>Chris W</td></tr>
<tr><td>Large WTP in last 20 yrs</td><td>Rich</td></tr>
</table></td></tr>
<tr><td>11:10 – 11:45
35 minutes</td><td>Performance Scales Review</td><td>Performance scales review by Lee and Pierre
Consider if performance measures reflect the criterion, is it understandable and measurable; summarize comments
In group setting, present comments to Lee/Pierre for improving performance scales</td></tr>
</table>

Timing	Subject	Description/Outcomes/Messages
11:45 – 11:55 **10 minutes**	Executive Committee Reactions	Provide reactions to compilation of the Values Hierarchy Executive Committee validation with Mike Stuhr and decision within 48 hours
11:55 – 12:00 **5 minutes**	Closure	Dave provide a summary and close the workshop

Portland Water Bureau – Filtration Decisions

PREPARED BY: Dan Speicher

MEETING DATE: March 21, 2018

LOCATION: Portland Water Bureau Office – 400 SW 6th; 1st floor Conference Room; 8:00 a.m. to 12:00 noon

INVITED ATTENDEES:

Dave Peters, PWB	Tony Re, PWB	Rich Stratton/HDR
Mike Saling, PWB	Gabriel Solmer, PWB	Phillipe Daniel/HDR
Michelle Cheek, PWB	Jodie Inman, PWB	Nicki Pozos/Barney & Worth
Rich Seright, PWB	Christopher Bowker, PWB	Libby Barg/Barney & Worth
Kimberly Gupta, PWB	Janet Senior, PWB	Kelly Irving/Jacobs
Yone Akagi, PWB	Jonathon Johnson, PWB	Bob Chapman/Jacobs
Terry Black, PWB	Jeana Ott, PWB	Lee Odell/ Jacobs
Chris Wanner, PWB	Scott Bradway, PWB	Kim Ervin/Jacobs
Teresa Elliott, PWB	Andy McCaskill/HDR	Dawn Bierbaum/Jacobs
Edward Campbell, PWB	Pierre Kwan/HDR	Dan Speicher/Jacobs

Objectives:

- Recognize upcoming workshops content and expected outcomes
- Review and accept values/criteria within the Values Hierarchy
- Establish common understanding of technical elements of capacity, site and technology decisions
- Review of and suggestions for capacity alternatives

Agenda:

Timing	Subject	Description/Outcomes/Messages
8:00 – 8:10 **10 Minutes**	Opening	Welcome and Opening Remarks by Dave P Safety Moment Objectives of this session
8:10 – 8:25 **15 minutes**	Workshop Schedule Review	Overview of workshops from March through June recognizing the flow of these workshops and the expected outcomes
8:25 – 8:45 **20 minutes**	Values Hierarchy Update	Review updated values and criteria from February workshop agreement upon the values, values definition, and criteria, and recognition of most applicable performance scales
8:45 – 10:00 **75 minutes**	Capacity Education and Alternatives	• Demand projections • Wholesale projections • Wellfield history • 3 Alternatives suggested
10:00 – 10:15 **15 minutes**	Break	
10:15 – 11:00 **45 minutes**	Site Education and possible Alternatives	• Six initial alternatives • Site characteristics • Site hydraulics • Alternative suggestions

Timing	Subject	Description/Outcomes/Messages
11:00 – 11:30 **30 minutes**	Technology Education and Alternatives	• Unit process functions • Alternatives • Large Greenfield Plants Constructed in the past 20-30 years
11:30 – 11:45 **15 minutes**	Executive Committee Reactions	Performance Scales for Capacity decision – suggested improvements
11:45 - 12:00 **15 minutes**	Next Steps and Closure	March 27th progress meeting – weighting and first draft of evaluation matrix Dave provide a summary and close the workshop

Portland Water Bureau – Filtration Decisions: Progress Meeting

PREPARED BY: Dan Speicher

MEETING DATE: March 27, 2018

LOCATION: Portland Water Bureau Office – 400 SW 6th; 1st floor Conference Room; 1:00 to 4:00 p.m.

INVITED ATTENDEES:

Dave Peters, PWB
Mike Saling, PWB
Michelle Cheek, PWB
Rich Seright, PWB
Kimberly Gupta, PWB
Yone Akagi, PWB
Terry Black, PWB
Jodie Inman, PWB
Christopher Bowker, PWB
Janet Senior, PWB
Jonathon Johnson, PWB
Jeana Ott, PWB
Andy McCaskill/HDR
Pierre Kwan/HDR
Phillippe Daniel/HDR
Nicki Pozos/Barney & Worth
Libby Barg/Barney & Worth
Kelly Irving/Jacobs
Bob Chapman/Jacobs
Lee Odell/ Jacobs
Kim Ervin/Jacobs
Dawn Bierbaum/Jacobs
Dan Speicher/Jacobs

Objectives:

- Produce weights for Values and Criteria
- Guidance upon middle Capacity alternative
- Provide alternatives evaluation matrix (utilizing agreed upon Values Hierarchy) for Technical Team to begin performance rating of Capacity alternatives
- Review Cost curves for Capacity alternatives

Agenda:

Timing	Subject	Description/Outcomes/Messages
1:00 – 1:05 **5 Minutes**	Opening	Welcome and Opening Remarks by Dave P Safety Moment Objectives of this session
1:05 – 2:30 **85 minutes**	Weighting	Weighting of the values and criteria Consider Cost/Benefit as part of the Values and as a value equal to all other Values
2:30 – 2:45 **15 minutes**	Percentile of Peak Day	Review of middle alternative options using demand profiles
2:45 – 3:40 **55 minutes**	Performance Review	Present Capacity performance matrix Review performance scales and initial application to Capacity Alternatives Validate level of detail required for performance evaluation of Capacity Alternatives (includes the review of cost curves) Recognize context for Capacity decision (i.e., the most influential criteria upon the decision)
3:40 – 3:55 **15 minutes**	Next Steps and Closure	Socializing of Weighting results April 18th Objectives: • Review On-line survey results/ impacts • Review and reconciliation of Capacity alternatives evaluation and selection of preferred capacity alternatives (if strong preference is obvious, the Capacity conclusion may be reached; if conclusion is not

Timing	Subject	Description/Outcomes/Messages
		evident because of inter-relation with Site decision, Capacity decision will be moved to May workshop); • Communication and sharing of information for site and technology alternatives; Summary of information collection, level of detail required, and packaging of material by April 11th for April 18th Capacity Decision Workshop (Question: more information on technology at April 18th Decision Workshop?)
3:55 – 4:00 **5 minutes**	Closure	Dave provide a summary and close the meeting

Portland Water Bureau – Capacity Decision

PREPARED BY: Dan Speicher

MEETING DATE: April 18, 2018

LOCATION: Portland Water Bureau Office – 400 SW 6th; 1st floor Conference Room; 8:00 a.m. to 12:00 noon

INVITED ATTENDEES:

Dave Peters, PWB	Edward Campbell, PWB	Pierre Kwan/HDR
Mike Saling, PWB	Tony Re, PWB	Phillipe Daniel/HDR
Michelle Cheek, PWB	Gabriel Solmer, PWB	Libby Barg/Barney & Worth
Rich Seright, PWB	Jodie Inman, PWB	Kelly Irving/Jacobs
Kimberly Gupta, PWB	Christopher Bowker, PWB	Bob Chapman/Jacobs
Yone Akagi, PWB	Janet Senior, PWB	Lee Odell/ Jacobs
Terry Black, PWB	Jonathon Johnson, PWB	Kim Ervin/Jacobs
Chris Wanner, PWB	Jeana Ott, PWB	Dawn Bierbaum/Jacobs
Teresa Elliott, PWB	Andy McCaskill/HDR	Dan Speicher/Jacobs

Objectives:

- Communication of groundwater policy
- Review and reconciliation of Capacity alternatives evaluation (weighting, rating, and results)
- Recommendation of preferred Capacity alternative
- Review of on-line community survey results

Agenda:

Timing	Subject	Description/Outcomes/Messages
8:00 – 8:10 **10 minutes**	Opening	Welcome and Opening Remarks by Dave P Safety Moment Objectives of this session
8:10 – 8:20 **10 minutes**	Ground Water Policy	Communication of groundwater policy
8:10 – 8:25 **15 minutes**	Evaluation Methodology	Weighting, performance rating, and calculating value scores process demonstrated with example
8:25 – 8:35 **10 minutes**	Weighting Scenarios	Three weighting scenarios
8:35 – 9:30 **55 minutes**	Performance Ratings	Review performance ratings of three alternatives
9:30 – 9:40 **10 minutes**	Break	
9:40 – 10:40 **60 minutes**	Evaluations Results	Total value scores, contributions by criteria, cost/value ratios
10:40 – 11:15 **35 minutes**	Recommendation	Preferred Capacity alternative
11:15 – 11:45 **30 minutes**	Online Survey	Current results of online community survey
11:45 - 12:00 **15 minutes**	Next Steps and Closure	Progress meeting – first draft of Site evaluation matrix Dave provide a summary and close the workshop

Portland Water Bureau – Siting Decision

PREPARED BY: Dan Speicher

MEETING DATE: May 23, 2018

LOCATION: Portland Water Bureau Office – 400 SW 6th; 400 Bldg, Rm 415, Floor 4, Chinook; 8:00 a.m. to 12:00 noon

INVITED ATTENDEES:

Dave Peters, PWB
Mike Saling, PWB
Michelle Cheek, PWB
Rich Seright, PWB
Kimberly Gupta, PWB
Yone Akagi, PWB
Terry Black, PWB
Chris Wanner, PWB
Teresa Elliott, PWB
Edward Campbell, PWB
Tony Re, PWB
Gabriel Solmer, PWB
Jodie Inman, PWB
Christopher Bowker, PWB
Janet Senior, PWB
Jonathon Johnson, PWB
Jeana Ott, PWB
Andy McCaskill/HDR
Pierre Kwan/HDR
Nicki Pozos/ Barney & Worth
Libby Barg/Barney & Worth
Kelly Irving/Jacobs
Brad Phelps/Jacobs
Dan Speicher/Jacobs

Objectives:

- Review of Siting alternatives and filtering
- Review and reconciliation of Siting alternatives evaluation (weighting, rating, and results)
- Recommendation of preferred Siting alternative

Agenda:

Timing	Subject	Description/Outcomes/Messages
8:00 – 8:10 **10 minutes**	Opening	Welcome and Opening Remarks by Dave P Caring Moment Objectives of this session
8:10 – 8:20 **10 minutes**	Filtering	Filtering from multiple to two alternatives - brief reminder
8:20 – 8:35 **15 minutes**	Evaluation Methodology	Weighting, performance rating, and calculating value scores process demonstrated with example Focus on the tradeoffs
8:35 – 9:30 **55 minutes**	Performance Ratings	Criteria considerations: Future Needs-Available Gravity Capacity, Implementation-Land Use Permits Review criteria performance ratings of two alternatives Discuss the influence and differentiation of the ratings
9:30 – 9:45 **15 minutes**	Model Improvements	Improve the Decision Model results to reflect the perspectives of the team
9:45 – 10:00 **15 minutes**	Break	Print out resulting value score graphs
10:00 – 11:00 **60 minutes**	Evaluations Results	Review total value scores, contributions by criteria, cost/value ratios
11:00 – 11:30 **30 minutes**	Recommendation from Tech Team	Preferred and/or recommended Siting alternative
11:30 – 11:45 **15 minutes**	Executive Committee Preference	Impressions from Executive Committee members

Timing	Subject	Description/Outcomes/Messages
11:45 - 12:00 **15 minutes**	Next Steps and Closure	Progress meeting – first draft of Technology evaluation matrix Dave P provide a summary and close the workshop

Portland Water Bureau – Technology Decision

PREPARED BY: Dan Speicher

MEETING DATE: June 20, 2018

LOCATION: Portland Water Bureau Office – 400 SW 6th; 400 Bldg, Rm 415, Floor 4, Chinook; 8:00 a.m. to 12:00 noon

INVITED ATTENDEES:

Dave Peters, PWB	Edward Campbell, PWB	Pierre Kwan/HDR
Mike Saling, PWB	Tony Re, PWB	Nicki Pozos/ Barney & Worth
Michelle Cheek, PWB	Gabriel Solmer, PWB	Libby Barg/Barney & Worth
Rich Seright, PWB	Jodie Inman, PWB	Kelly Irving/Jacobs
Kimberly Gupta, PWB	Christopher Bowker, PWB	Lee Odell/Jacobs
Yone Akagi, PWB	Janet Senior, PWB	Kim Ervin/Jacobs
Terry Black, PWB	Jonathon Johnson, PWB	Dan Speicher/Jacobs
Chris Wanner, PWB	Jeana Ott, PWB	Bob Chapman/Jacobs
Teresa Elliott, PWB	Andy McCaskill/HDR	Dawn Bierbaum/Jacobs

Objectives:

- Review of Technology alternatives and filtering
- Review and reconciliation of Technology alternatives performance ratings
- Evaluation of value score results
- Recommendation of preferred Technology alternative

Agenda:

Timing	Subject	Description/Outcomes/Messages
8:00 – 8:10 **10 minutes**	Opening	Welcome and Opening Remarks by Dave P Caring Moment Objectives of this session
8:10 – 8:40 **30 minutes**	Filtering of Alternatives	Filtering from three to two alternatives
8:40 – 9:30 **50 minutes**	Performance Ratings	Review each criterion and performance ratings of two alternatives Discuss the influence and differentiation of the ratings
9:30 – 9:45 **15 minutes**	Model Improvements	Improve the Decision Model to reflect the perspectives of the team
9:45 – 10:00 **15 minutes**	Break	Print out resulting value score graphs
10:00 – 11:00 **60 minutes**	Evaluations Results	Review total value scores, contributions by criteria, cost/value ratios
11:00 – 11:30 **30 minutes**	Recommendation from Tech Team	Preferred and/or recommended Technology alternative
11:30 – 11:45 **15 minutes**	Executive Committee Preference	Impressions from Executive Committee members
11:45 - 12:00 **15 minutes**	Next Steps and Closure	Technical Memo production Dave P provide a summary and close the workshop

Technical Memo

Date:	Tuesday, February 27, 2018
Project:	Bull Run Filtration Plant Project
To:	Portland Water Bureau
From:	HDR
Subject:	**Filtration Plant Project Alternative Delivery Methods - Final**

1.0 Introduction

The Portland Water Bureau (PWB) is moving forward with design, construction, and commissioning of an approximately $500 million Water Filtration Plant. In order to minimize project delivery risk and cost and schedule impacts, PWB is evaluating Alternative Delivery (AD) Methods as allowed under Oregon Revised Statute (ORS) 279C.335.

This Technical Memo describes three potential AD Methods available to deliver the Filtration Plant design, construction, and commissioning; discusses the advantages/disadvantages of each; and presents a comparison of the alternatives to assist in determining the most appropriate delivery method for the Filtration Plant project.

2.0 Starting Considerations

- All three AD methods will reduce project schedule compared with the standard design-bid-build (DBB) approach because they would eliminate the need to bring the design to 100% completion prior to the advertisement and bidding period required in DBB procurement. In addition, design and early construction activities can occur concurrently. In each case, contractor selection is done early in the design process.
- All three AD methods will require an exemption to competitive bidding under ORS 279C.335. However, none will limit competition and all have the potential to save costs through the shorter delivery schedule and collaborative working relationships they promote.
- The necessary commissioning activities can be included in each of the three AD methods.
- The base selection is CM/GC, unless one of the other two options proves superior.
- All three AD methods have been successfully used by public works agencies in Oregon and across the United States.

3.0 Alternative Delivery Approaches

The three AD options being considered are:

1. Construction Manager/General Contractor (CM/GC)
2. Fixed-Price Design-Build (FPDB)
3. Progressive Design-Build (PDB)

Each AD option discussed in the following sections describes the contractual arrangement(s) between Owner, Designer, and Construction Contractor, and specific attributes and applications of each option.

The figures in Attachment A provide a summary comparison of the three AD options, taking the Filtration Plant project characteristics and City's procurement processes into account.

3.1 Construction Manager/General Contractor

CM/GC combines the scope of work of a general contractor with that of a construction manager under a single contract with PWB. The contractual arrangement between PWB, the Designer, and Contractor for CM/GC is similar to that for DBB. Like DBB, PWB retains the Designer under a separate contract. At an early point in the design phase, PWB, using a competitive selection process, would select a CM/GC firm to provide construction management and general contracting services using a qualifications-based selection process, which may include cost considerations, similar in nature to the selection of the Designer. A CM/GC procurement process procedure can be found in ORS 279C.337. The CM/GC contract would include two phases: a pre-construction services phase during the design process followed by the construction services phase. The pre-construction services phase would provide:

1. constructability input into the design
2. construction subcontract packaging recommendations
3. development of a Guaranteed Maximum Price (GMP).

By joining the project team during design, the CM/GC can collaborate with PWB and the Designer on the design development and preparation of construction documents. As the design progresses, the CM/GC would initiate pricing the work and assembling a GMP. Once the design has progressed to a level suitable for construction estimating, the CM/GC submits the project GMP to PWB. After agreement is reached on a GMP, the construction phase can be authorized, and the CM/GC begins construction and eventual commissioning of the facility. Should PWB be unable to come to terms on the GMP, there remains an option to complete the design and publicly advertise the construction contract as a DBB.

During the construction services phase, the CM/GC procures subcontracts with trade contractors using multiple bid packages, typically on a low bid approach, to construct the project, and manages the construction process the same as under a DBB. In addition to management of the construction contract, the CM/GC may be allowed to self-perform portions of the trade work. Because the CM/GC has the flexibility to package subcontracted work during the pre-construction phase with PWB input, local and Disadvantaged/Minority-owned/Women-

owned/Emerging Small Business (D/M/W/ESB) participation can be maximized by focusing subcontractor procurement in those areas to the local market.

A major benefit of CM/GC is the collaboration that can result between PWB, the Designer, and the Contractor. The Contractor becomes, in effect, a member of the project delivery team during design, providing constructability and value-engineering input, thereby improving the quality of the design, potentially reducing the cost of construction, and affording the Contractor buy-in to the design documents. This model requires PWB to take an active role in managing the interface between the designer and CM/GC so that CM/GC input and design modification decisions are timely and the resulting schedule/cost impacts are fully analyzed. Because there is no contractual relationship between the Designer and CM/GC, PWB carries the risk associated with warranting the design documents to the Contractor.

3.2 Fixed Price Design-Build

In Fixed Price Design-Build (FPDB), PWB would enter into a contract with a single entity to perform both design and construction functions. This entity may be a single design/construction firm or separate design and construction firms working together under their own contractual arrangement.

The Design-Builder is responsible for providing design and construction of the project under one contract with PWB. This shifts design risks to the Design-Builder and typically reduces change orders, disputes, or claims. FPDB is normally procured using performance-based requirements rather than prescriptive (i.e., specifying the ultimate facility's performance characteristics rather than facility details). Consequently, this would require less PWB participation and input during design reviews and details than other AD methods.

Because the Designer and Contractor form a single entity, their interest in collaborating to improve constructability, usually enacts value engineering recommendations and an expedited schedule. In addition, subject to PWB authorization, the Design-Builder can initiate equipment pre-purchase and construction activities at the earliest opportunity and in parallel with design completion to shorten the schedule.

For FPDB, the price is submitted with the proposal and evaluated according to the established weighting criteria stated in the Request-for-Proposals (RFP), along with other qualitative-based selection criteria chosen by PWB. The relative weight of the price versus qualitative criteria would also be determined by PWB. The FPDB selection process provides the earliest cost certainty to PWB, as the fixed price is established before much of the design is complete. However, this procurement method requires early definition of project conditions, criteria, and requirements to be completed and included in the RFP, so there is a sufficient basis for an early price. As a result, this model includes the longest and most extensive procurement phase.

Because the Design-Builder is responsible for design work under a fixed-price agreement, a potential area of dispute can occur during design reviews, where PWB design comments or requests result in a change in the Design-Builder's cost or schedule, thereby potentially resulting in requests for cost/schedule impacts outside the price/schedule submitted with the proposal. Cost savings are realized through this model by promoting innovation from the

Design-Build proposers, provided the RFP requirements are not overly prescriptive and PWB maintains a hands off approach in design review.

Regarding procurement under FPDB, the RFP must include sufficiently developed design documents for the Design-Builder to provide an accurate price proposal and to further the design work as part of the proposal. A two-step process (Request for Qualifications, followed by an RFP issued to shortlisted firms) is typically required for this model because a significant amount of design work would be expected as part of the proposals (the basis of the price proposal). PWB should also consider the payment of a stipend to unsuccessful proposers, to partially offset the cost of proposal preparation. This would also allow PWB to utilize any design work submitted.

3.3 Progressive Design-Build

The contractual structure of PDB is similar to FPDB, in that design and construction responsibilities are procured under one contract. As with FPDB, a PDB contract may be with either a single entity to provide design and construction services or separate design and construction firms working together under their own contractual arrangement. However, the working relationships are more similar to CM/GC. In PDB, selection of the Design-Builder is based primarily on qualitative selection criteria, rather than a fixed price. Cost-based considerations such as design fee, overhead and markup rates, and others can be included during selection, but are not the primary criteria used. In contrast to FPDB, there may be little if any design work done prior to procurement, because price is determined as the design "progresses" after selection.

As in CM/GC, the contract would include two phases:

1. A pre-construction services phase to include basis of design, design development, construction estimating, and negotiation of the final construction price
2. Final design, construction, and commissioning.

In PDB, as the design and permitting are sufficiently defined, PWB would enter into a fixed price construction contract with the Design-Builder. Consequently, because there is no up-front fixed price, PDB affords PWB greater opportunity for involvement in the design process than FPDB; specifically, less upfront project definition prior to procurement. In addition, as in CM/GC, if PWB and the Design-Builder cannot come to terms on the construction price, PWB can retain the option of having the design brought to 100 percent completion, and then publicly bidding the work under a traditional DBB arrangement. Referred to as an "off ramp," the conditions of this option can be included in the original RFP, including the right of PWB to use any design work submitted for a subsequent procurement.

Like FPDB, PDB provides shifting of design risk to the Design-Builder. Under a single design and construction entity, the risk of potential change orders, disputes, or claims is minimized. If the Design-Builder consists of separate design and construction firms, it is likely that PWB's contract would be with the prime contractor and the designer would have a subcontractor arrangement with the prime.

4.0 Alternative Delivery Workshop

On January 30, 2018, an Alternative Delivery Workshop was held with HDR, Jacobs (CH2M), PWB and City of Portland procurement staff. The purpose of the workshop was to describe the contractual arrangements for the three AD methods, differentiate the AD methods by their specific characteristics, and compare each method with a list of criteria specific to the Filtration Plant project and PWB concerns (Figure 3).

The starting considerations for the workshop as discussed in Section 2.0 are summarized below:

- All three AD methods reduce project schedule compared with DBB
- None of the AD methods limit competition
- The necessary commissioning activities can be included in each of the three AD methods
- The base selection is CM/GC, unless one of the other two options proves superior.

4.1 Evaluation

As shown on Characteristics chart (Figure 2) under Best Applications, the bold items are key characteristics that differentiated each of the three methods. These key characteristics were then applied across the Comparison chart in Figure 3, which listed the primary PWB considerations under three main categories: Project-specific Attributes, PWB Culture, and Management and Reporting. The resulting workshop discussion revolved around the varied experience of the participants, including current City experience with PDB. Each of the listed considerations were then scored by a color bar:

Green – most advantageous

Yellow – neutral

Pink – least advantageous

Where differences between delivery methods were slight for a given criterion, the same color was used for both.

4.2 Workshop Summary

4.2.1 Project-Specific Attributes

PWB has extensive experience in CM/GC project delivery. There was higher confidence expressed in the ability to maintain cost and schedule control on the Filtration Plant project utilizing a CM/GC approach. There was some discussion regarding an interest in becoming proficient in PDB as well. However, there was concern expressed with difficulties experienced outside of PWB on other projects utilizing the PDB approach. The determination in the workshop was that there may be a good opportunity to add PDB to PWB's experience in alternative delivery, but the Filtration Plan project was not considered the right project to gain that experience.

4.2.2 Owner Culture

PWB prefers to maintain control of project decision-making, as well as engineering and operations input into the facility design. Consequently, FPDB was considered the least advantageous method under this category, while CM/GC and PDB provided higher levels of project control. In addition, one of the biggest drivers for PWB is maximizing D/M/W/ESB participation in both the design and construction contracts, which gave CM/GC a slight advantage over PDB. A collaborative working environment was also considered a plus, which is provided under both CM/GC and PDB.

4.2.3 Management & Reporting

Due to a dedicated project staffing level, Contract Administration was not considered an issue under any of the three delivery methods. This was true whether there were one or two contracts to manage, so was not a decision driver under this category. PWB suggested that a new consideration be included, Alternative Delivery experience, which would account for the PWB's familiarity with the type of alternative delivery. This consideration indicated that PWB had successful prior experience with CM/GC and was consequently more confident in its application for the Filtration Plant project than the other two delivery methods.

Figure 4 provides the evaluation results and indicates that CM/GC was the most advantageous method for delivery of the Filtration Plant program, as determined by PWB staff. The results of this workshop were then compared with the community values work currently ongoing, as indicated below.

4.3 Community Values Input

PWB, along with Barney & Worth, is soliciting stakeholder input on community values that will support project decision-making. Attachment B provides a preliminary memo describing the results of interviews completed to date that would relate values to the project delivery method. The relationship of the CM/GC project delivery method to the community values input as described in the memo is described below:

- Based on the top three values of cost, public health/water quality, and resilience, the CM/GC delivery method would support all three. PWB would procure both the designer and the CM/GC through qualifications-based processes and maintain direct contractual relationships with each. By managing both the designer and CM/GC in a collaborative working relationship during the pre-construction phase, PWB would maintain the ability to incorporate the necessary water quality and resiliency characteristics into the design, while bringing construction cost saving ideas from the CM/GC.
- With a high level of stakeholder interest in the decision-making process, the CM/GC delivery approach will allow PWB the maximum level of decision-making control compared with the other delivery options, as indicated under the Owner Culture category in Figure 4. By having the CM/GC participate in the design process, PWB can foster a collaborative working relationship between the designer and contractor while maintaining final authority over project decisions.

- The CM/GC delivery method will not in any way interfere with or alter PWB's open decision-making process. Design decisions, cost estimates, and schedule will be available to stakeholders as the project proceeds. With PWB managing each contract separately in a collaborative working relationship, PWB will have the most current information available for communication to stakeholders as well as the ability to foresee key decision points requiring stakeholder input.
- Economic development opportunities for disadvantaged communities will be enhanced under the CM/GC delivery method. One of the selection criteria included in the procurement documents for both the designer and CM/GC can be the plan for providing opportunities for small businesses, including consulting firms, construction companies, and suppliers. During the pre-construction phase, the CM/GC will have the flexibility to work with PWB and the designer to identify subcontracting work to be advertised specifically to the D/M/W/ESB community. In addition, it is typical during the construction phase of a CM/GC contract to identify additional opportunities for D/M/W/ESB firms that arise during the course of the construction work.

5.0 References

Oregon Legislature

2015 Oregon Revised Statutes, Chapter 279C — Public Contracting - Public Improvements and Related Contracts, 2017 Edition.

Design-Build Institute of America

2015 Design-Build Done Right™ Primer: Choosing a Project Delivery Method, Progressive Design-Build. April 2015

2017 Design-Build Done Right™ Primer: Progressive Design-Build, Design-Build Procured with a Progressive Design & Price. October 2017

Oregon State University

2002 Oregon Public Contracting Coalition Guide to CM/GC Contracting. Construction Engineering Management Program, Department of Civil, Construction, and Environmental Engineering, Oregon State University, Corvallis, Oregon. February 2002.

Appendices

A. Figures

B. Bull Run Filtration Memorandum Community Values Input on Alternative Delivery Approach

Appendix A. Figures

Figure 1. Alternative Delivery Method Processes

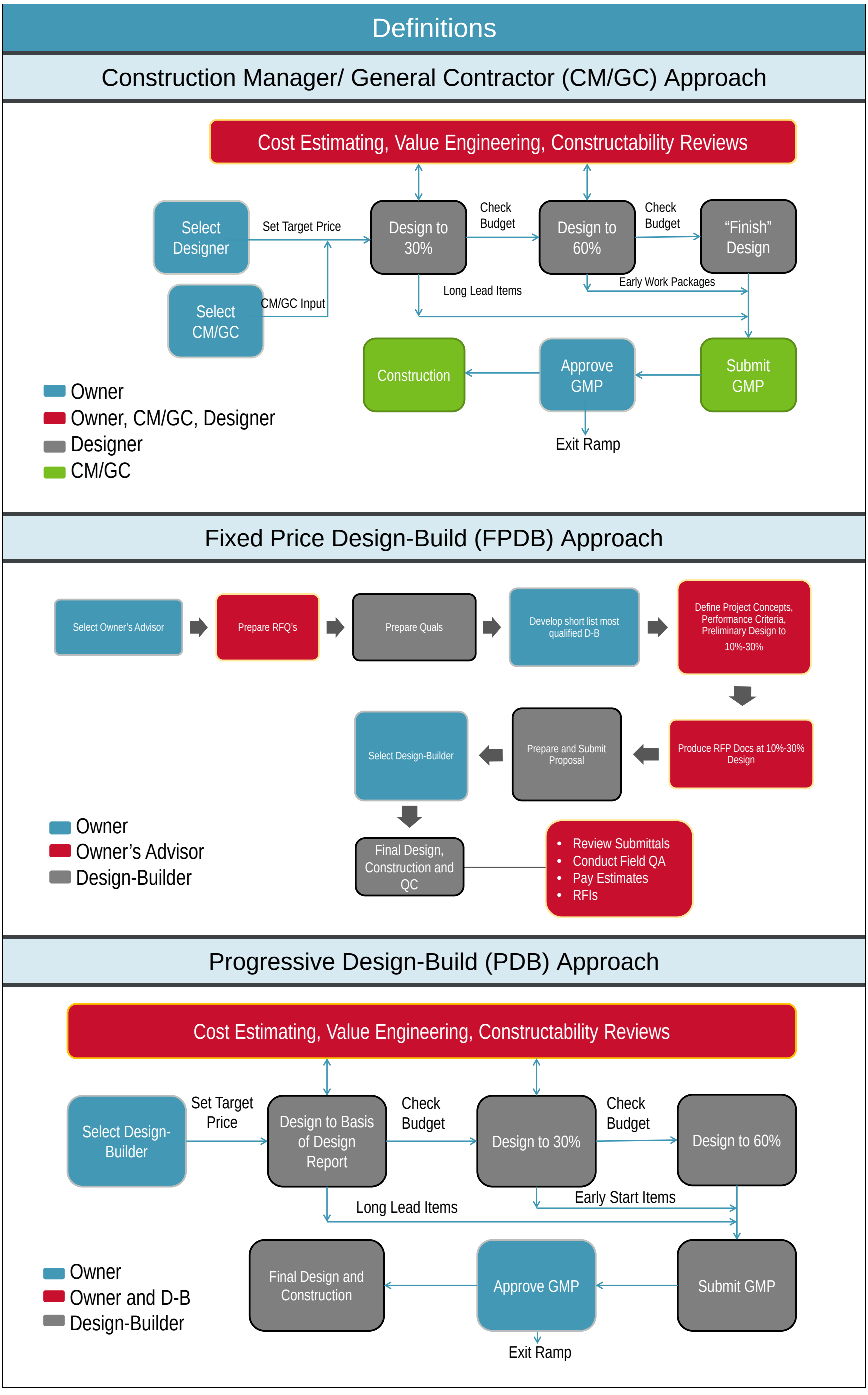


Figure 2. Characteristics of Different Alternative Delivery Approaches

Characteristics		
Construction Manager/ General Contractor (CM/GC)	Fixed Price Design-Build (FPDB)	Progressive Design-Build (PDB)
Advantages		
➢ Owner remains involved in design development (similar to DBB) ➢ Owner maintains the familiar relationship with the Designer ➢ Constructor input during design phase ➢ GMP Contract Model (accuracy and transparency) ➢ Competitively bid packages drives cost ➢ Can maximize local and D/M/W/ESB subcontractor participation ➢ Early equipment procurement	➢ Single Point of Accountability (Contractually and Functionally) ➢ Receive Comprehensive (undiluted) Performance Guarantee ➢ Fixed Price Early in Process ➢ Highest potential for schedule savings after procurement if minimal Owner design involvement	➢ Single Point of Accountability (Contractually) ➢ Qualifications-based selection ➢ Owner has specific preferences and desires high degree of involvement ➢ Promotes innovation during design with input from Design-Builder and Owner ➢ Maximum flexibility and control for the Owner ➢ Benefits of FPDB regarding single Design-Build entity with accuracy and transparency of CM/GC contract
Disadvantages		
➢ Split Design and Construction responsibilities ➢ Owner warrants Design to CM/GC ➢ Owner must manage two separate contracts and remain aware of schedule/cost impacts of design modifications requested by CM/GC ➢ Self-performing CM/GC may discourage competition for bid packages ➢ Agreement on GMP can be problematic, depending on amount of risk foreseen by CM/GC. ➢ Change management - whether unforeseen costs are “inside” or “outside” the GMP	➢ Owner involvement is limited once price is established (30% Design) ➢ Only performance is specified, normal design review process doesn’t apply ➢ Increased potential for change orders or claims on Owner-requested changes because price set so early ➢ RFP documents (Basis of Design and Preliminary Drawings) for FPDB procurement take time and cost $ to prepare ➢ Requires separate design contract to produce sufficient design documents ahead of RFP for accurate price proposal.	➢ Owner access to Designer may be through Contractor for a Contractor-led PDB team ➢ Construction pricing is established after Design-Builder selection ➢ Designer is potentially a sub to Contractor, which has potential of Owner conflicts
Best Applications		
➢ **Owner desires high degree of involvement and control** ➢ Owner desires more construction input into design ➢ Owner desires less construction risk (result of CM/GC design input and document buy-in) ➢ Project is complex or scope is uncertain ➢ **Maximum local and D/M/W/ESB construction contractor participation**	➢ Existing conditions, project scope and desired outcomes are well understood and defined ➢ **Owner does not need direct involvement in detailed design and construction (willing to “let go”)** ➢ Operational and aesthetic issues are well-defined ➢ Conventional, well-understood technology ➢ Owner has experience with alternative project delivery	➢ Owner has specific technology, aesthetic, and equipment preferences ➢ **Owner desires high degree of involvement during design and preconstruction activities** ➢ **Owner desires a single point of responsibility** ➢ Project is more complex and scope is uncertain

Bold items are key characteristics that differentiated each of the three methods

Figure 3. Comparison Chart Template Used in Workshop

Comparison				
Considerations		CM/GC	FPDB	PDB
Project-specific Attributes	➢ Technical complexity, ability to drive innovation			
	➢ Ability to control cost and schedule, impact to annual CIP cash flow			
	➢			
	➢			
Owner Culture	➢ Control of project-level decision-making, input into design, construction, and operation of facility			
	➢ Level of PWB contractual risk transfer			
	➢ Promote D/M/W/ESB participation throughout project term			
	➢ Opportunity for collaborative working environment			
Management and Reporting	➢ Contract administration (availability of PWB staff, design reviews, management of one contract vs. two)			
	➢ Ability to present accurate annual cost/schedule forecast to City Council			

Figure 4. Alternative Delivery Comparison Results from Workshop

Comparison (Results of Workshop)				
Considerations		CM/GC	FPDB	PDB
Project-specific Attributes	➢ Technical complexity, ability to drive innovation			
	➢ Ability to control cost and schedule, impact to annual CIP cash flow			
Owner Culture	➢ Control of project-level decision-making, input into design, construction, and operation of facility			
	➢ Level of PWB contractual risk transfer			
	➢ Promote D/M/W/ESB participation throughout project term			
	➢ Opportunity for collaborative working environment			
Management and Reporting	➢ Contract administration (availability of PWB staff, design reviews, management of one contract vs. two)			
	➢ Ability to present accurate annual cost/schedule forecast to City Council			
	➢ Alternative delivery experience			

Legend: Green – most advantageous
Yellow – neutral
Pink – least advantageous

Appendix B. Bull Run Filtration Memorandum Community Values Input on Alternative Delivery Approach

Portland Water Bureau
Bull Run Filtration
Community Values Input on Alternative Delivery Approach

INTRODUCTION

Barney & Worth is supporting the Portland Water Bureau in developing community values that will inform decision making on the Bull Run Filtration Project. This preliminary information from stakeholder interviews is provided to support the Alternative Delivery Approach decision on January 30, 2018 and ensure consideration of public values can be incorporated. This report reflects the advice, feelings, and attitudes of the initial fourteen stakeholders interviewed. It is not intended to provide a statistically valid profile of the community as a whole.

COMMUNITY VALUES

Key themes that emerged from the stakeholder interviews and are relevant to the Alternative Delivery Approach Decision are as follows:

1. **The top three values are cost, public health/water quality, and resilience.** Cost and public health/water quality were noted repeatedly throughout the stakeholder interviews. Indeed, many framed the treatment decisions as a cost-benefit evaluation – weighing public health/water quality benefits against the costs of those benefits. For those who know Portland's system well, resilience/reliability is their number one value. *"We are doing it for the sake of safety, but also need to consider cost - what is the balance."*

   What does this mean for the Delivery Approach? This value favors delivery approaches with the opportunity to lower project costs, but not if control over water quality or resiliency benefits is compromised.

2. **There is a high level of interest in the process being used to make decisions.** Many stakeholders acknowledged they don't have sufficient expertise to contribute to key decisions. However, they were still very interested in understanding the process being used to make decisions. *"I'd be curious to know the process that is being used to examine and deliberate and arrive at a decision."*

   What does this mean for the Delivery Approach? This value favors delivery approaches where Portland Water Bureau maintains a high level of control.

3. **Almost all stakeholders are asking for increased communication.** Stakeholders noted a past focus on neighborhood associations and coalitions, with greater opportunity to engage with industrial, business, and wholesale customers, as well as communities of color.

   What does this mean for the Delivery Approach? This value favors delivery approaches where there is a high level of decision transparency, allowing the basis of decisions to be clearly communicated with the public.

4. **Maximizing economic development opportunities for disadvantaged communities is a top social equity opportunity.** Filtration is a significant community investment and presents an opportunity for disadvantaged communities. "*People are seeking pathways and entries to living wage jobs and this would be an opportunity to do that. The water bureau has done some really strong work setting high workforce standards then exceeding them and I would expect to see that same sort of commitment to equity on these future projects.*"

   What does this mean for the Delivery Approach? This value favors delivery approaches where there is a greater level of control over subconsultant selection.

Technical Memorandum

Date:	September 11, 2018
Project:	Bull Run Filtration Project
To:	David Peters, PE and Michelle Cheek, PE – Portland Water Bureau
From:	Pierre Kwan, PE, Phillippe Daniel, PE, Aparna Garg – HDR; Dan Speicher – Jacobs
Reviewed by:	Rich Stratton, PE, Pete D'Adamo, PhD – HDR
Approved by:	Andy McCaskill, PE – HDR
Subject:	**Filtration Plant Capacity Alternatives**

1.0 Introduction

The Portland Water Bureau (PWB) is in the planning phase for the design and construction of a new filtration plant to treat their existing Bull Run surface water supply. This planning phase includes technical analysis to assist PWB in making four critical decisions: procurement method, filtration plant capacity, site suitability, and filtration technology. This technical memo (TM) documents the assumptions, analysis, and decisions made to determine the preliminary plant capacity.

The decision on plant capacity is framed by the values-based decision-making model, which includes specific criteria and performance scales. HDR has coordinated closely with PWB and their other consultants, Jacobs and Barney & Worth, to identify the criteria and performance scales that PWB staff used as part of the decision-making process in identifying the plant capacity. The performance scales applied to the capacity decision were considered independently of two major unknowns at this time: site location and filtration technology. The intent was to select the preferred plant capacity and then apply that decision to the subsequent site and filtration technology analyses.

The capacity decision includes considerations for future demands, level of service goals (both quantity and quality), costs (capital and operations and maintenance [O&M] for different filtration plant capacity and supplementary supply alternatives), and other factors. This TM presents the initial plant capacity alternatives, likelihood of need to rely on other PWB management strategies to satisfy peak demands, applicable decision model criteria related to capacity, and evaluation of each capacity alternative.

2.0 Demand Projections

A key part of the capacity evaluation is PWB's demand projections. These projections are described in Supply System Master Plan Technical Memo (SSMP TM) 3.1 – Projected Water Demand (dated February 28, 2017; Appendix A). Figures 1 through 3 are key projections from the 2017 TM used for this evaluation. PWB projected that future demands would be less than current demands once the Tualatin Valley Water District (TVWD) leaves the PWB system in 2026. The filtration treatment plant is required to be online by September 30, 2027, a year after the anticipated 2026 drop in demand.

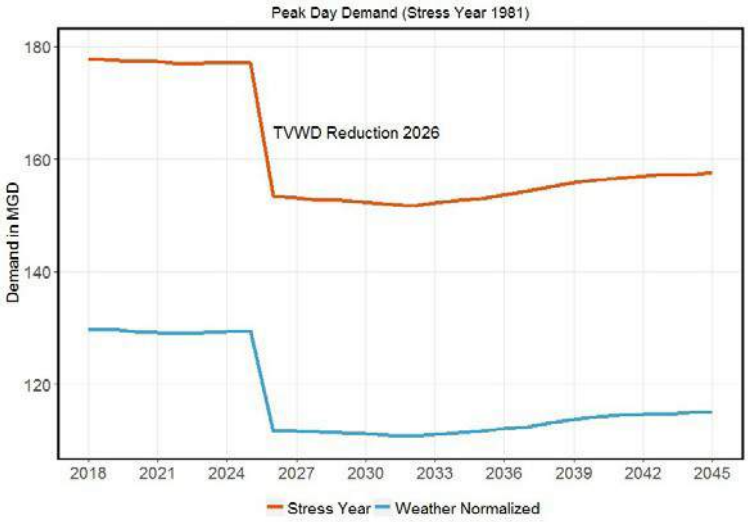


Figure 1. Projected Peak Day Demand
(Reference: SSMP TM 3.1 – Projected Water Demand Figure 5)

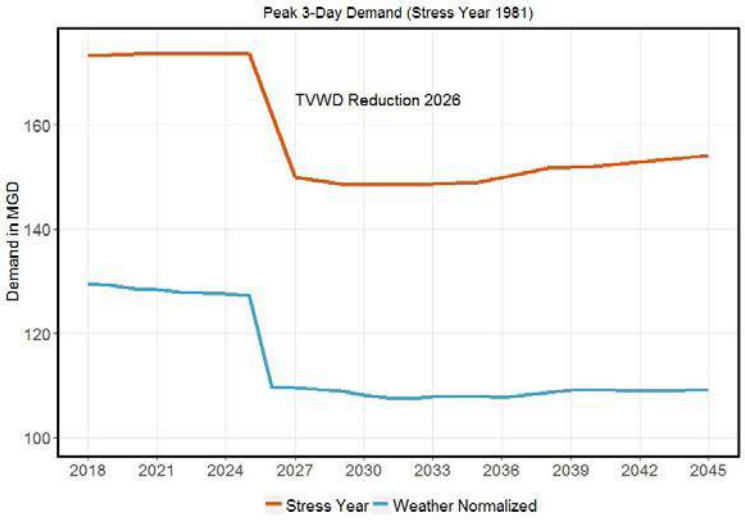


Figure 2. Projected Peak 3-day Demand
(Reference: SSMP TM 3.1 – Projected Water Demand Figure 6)

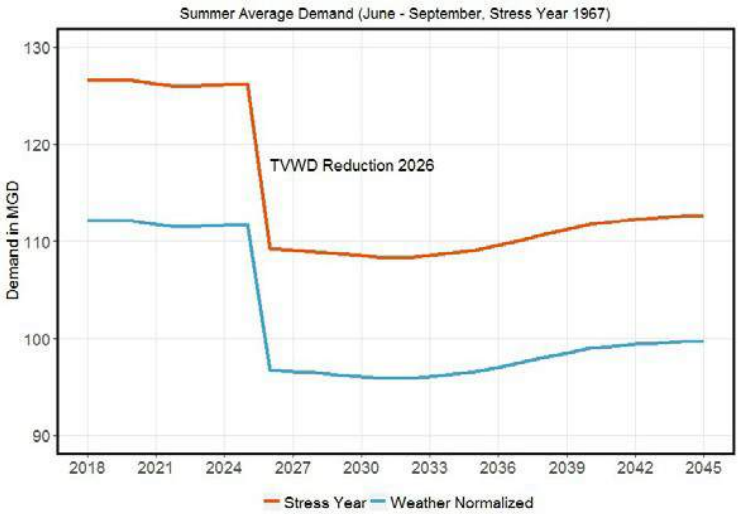


Figure 3. Projected Summer Average Demand
(Reference: SSMP TM 3.1 – Projected Water Demand Figure 3)

The key types of projected demand for this evaluation consist of:

- Peak day demand (PDD) – the highest projected demand in a single day.
- Peak 3-day demand (P3D) – the average of the highest demand over a 3-day period. This is another statistical projection used by PWB to account for the limitations involved in using in-town reservoir storage to understand and manage future peak demands.
- Summer average demand (SAD) – the overall average demand across a summer. By definition, half of the summer days will have demands higher than shown and the other half will have lower demands. This value is used for seasonal supply management.

In addition, the demand projections are described in two different ways:

- Weather normalized – projections based on average historical weather conditions. This method assumes that in the future, each day of the year has the same weather as the average weather of that day over the 1940 - 2015period.
- Stress year – projections are based on historical weather years that were the most stressful on the supply system. For this evaluation, the stress year corresponded to the conditions encountered in 1981 for the PDD and P3D and in 1967 for the SAD.

This demand information is used to help select and describe the capacity alternatives. A separate analysis was conducted by PWB to assess the likelihood of a demand as high as 160 million gallons per day (MGD) in 2045 given current understanding of the range of variability in weather conditions. The results of the analysis are shown in Figure 4. This figure shows the probability of a PDD of 120 MGD in 2045 as approximately 10th percentile, or for 100 rolls of the weather dice, the corresponding 2045 demand would be at least 120 MGD for 90 of those 100 rolls. Whereas 160 MGD PDD is slightly beyond the 100th percentile, meaning that in 0 of the 100 weather possibilities would 2045 demand exceed 160 MGD. Note that the values shown in this figure are close but do not precisely match the values shown in the prior figures due to the use of different datasets and analytical methodologies.

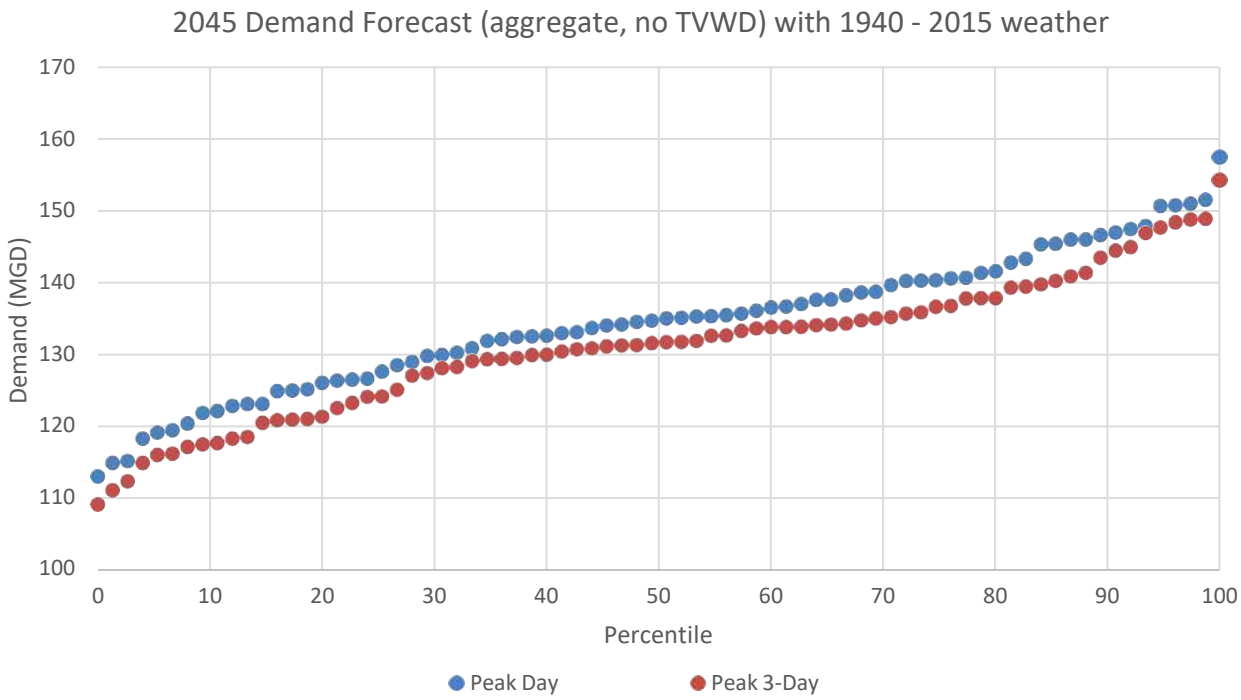


Figure 4. Estimated Probability of 2045 Demand as Influenced by Weather Variability

The future extent of the demand data currently available is limited by the population data available from Portland State University. Population data are not available for the period after 2045. The project team understands that the design life of the treatment plant will extend beyond 2045. The capacity assumption after that date is that additional capacity could be added at the sites being considered, and the layout of the plant can be designed to allow for capacity expansion of individual process components.

3.0 Alternative Management Strategies

Bull Run is the primary and preferred water supply to the PWB system and will remain the primary supply once the future filtration plant is constructed, although alternative management strategies may be used for managing the available water supply to meet water system demand. These strategies are described in this TM only in the context of their potential usage when demands exceed the future filtration capacity. Potential alternative management strategies include:

- Using groundwater pumped from PWB's Columbia South Shore Well Field (CSSWF);
- Drawing down in-town finished water reservoirs lower than current operational practices to meet demands;
- Curtailing water supply to wholesalers and asking them to switch to other water sources;
- Curtailing water supply to major commercial and industrial users and asking them to switch to other water sources, reduce usage, or stop usage altogether;
- Purchasing water from wholesalers that have available water supplies;
- Curtailment measures for residential customers and smaller commercial customers; and
- Stopping non-essential PWB water uses, such as flushing programs

Alternative management strategies, either used individually or in various combinations, could be implemented to allow PWB to meet water demands. PWB has issued the policy document "Characterization of Supplies for Selection of Filtration Capacity" (PWB, 2018; Appendix B) stating that "groundwater will continue to be used as it has been used in the past. Design of the filtration facility, and particularly pretreatment, will determine the degree to which turbidity is removed and is no longer a factor in future groundwater operation. PWB will not size the Bull Run filtration facility in such a manner that would require routine annual use of groundwater to meet average summer season demands." Regular water curtailment is not acceptable to customers and can cause lasting economic damage. There are also no wholesalers nearby that have the excess capacity and transmission capacity to supply a water system as large as PWB. As a result, PWB does not expect to use these management strategies to meet SAD in the future.

For purposes of the evaluations in this memo, the most likely alternative management strategy considered would be some combination of groundwater pumping and increased shorter-term reliance on in-town storage to meet PDD. Other strategies would also be considered in the future if available and if applicable to the situation. There is a cost associated with implementing each of the alternative management strategies. This cost was not calculated but simply noted as an additional cost for capacity alternatives that require the use of alternative management strategies.

4.0 Capacity Alternatives

Five capacity alternatives for the future filtration plant were initially identified by PWB and HDR (Table 1). The capacity for each alternative was established based on a combination of the physical constraints of the existing Bull Run supply system and the PWB demand projections previously summarized.

Table 1. Initial Capacity Alternatives

Capacity (MGD)	Description
200	Approximately equal to maximum Bull Run conduit capacity
160	Slightly higher than the projected 2045 PDD and P3D demands in a stress year
135-145	Covers 90% of 2045 PDD and P3D demands in stress year
115-120	Slightly higher than the projected 2045 PDD and P3D in a weather-normalized year
100	Slightly higher than the projected 2045 summer average demand in a weather-normalized year

The 200 MGD capacity was rejected from further consideration because it is 40 MGD higher than the projected PDD of 160 MGD in a stress year for 2045 (i.e., the highest demand day between 2027 and 2045). A 100 MGD capacity facility was also rejected because it would not meet system demand up to 50 percent of the time and alternative management strategies would be needed on a regular basis. This is inconsistent with PWB's groundwater policy.

The remaining alternatives (115-120 MGD, 135-145 MGD, and 160 MGD) were carried forward for evaluation using the decision model and criteria. The range of 115-120 MGD was reduced to 115 MGD to simplify the subsequent analysis. Similarly, the range of 135-145 MGD became 145 MGD.

5.0 Decision Model and Criteria

The three remaining alternatives were evaluated using the program's adopted decision model. The model consists of eight values, each having several criteria to evaluate each alternative.

Table 2 lists the values and criteria. While all of the values are applied to each alternative, not every criterion is applicable for the capacity decision. For example, the criteria "Existing microbiological regulations" is not applicable because the capacity of the future plant has no direct bearing on how well it would meet the regulations, whereas such regulations have a significant impact on the separate filtration technology decision. The table also lists the criteria specifically excluded from the capacity evaluation and the rationale.

Table 2. Decision Model and Criteria Used for Capacity Evaluation

Value	Criteria	Included/ Excluded	Rationale
Public Health and Water Quality	Existing microbiological regulations	Excluded	Compliance with regulations does not depend on facility capacity.
	Organics/inorganics regulations	Excluded	Compliance with regulations does not depend on facility capacity.
	Emerging water quality regulations	Excluded	Compliance with regulations does not depend on facility capacity.
	Consistent water quality	Included	Water quality can vary with use of alternative management strategies.
	Chemical impacts	Excluded	The water treatment chemicals dosages do not depend on facility capacity.
Resiliency/ Reliability	Earthquake	Included	A higher design capacity results in greater water production after a seismic event.
	Catastrophic water quality event	Included	Similar to the response to earthquakes, a higher design capacity results in greater drinking water production after a catastrophic water quality event.
	Routine water quality event	Excluded	This issue relates to the treatment decision, not capacity.
Community Interests	Local impacts	Included	The facility capacity dictates the size and extent of the construction required. This construction would impact the neighbors.
	Consistency in taste and appearance	Included	Water quality can vary with use of alternative management strategies.
	Chemical concerns	Excluded	Dosage does not depend on capacity but on treatment technology instead.
Cost Benefit	Cost of construction	Included	The extent of construction required is a direct function of the facility size.
	Operating cost	Included	The cost for operating the facility is directly dependent on its size.
	Total cost of delivered water	Included	The capacity of the future facility has impact on the construction costs.

Value	Criteria	Included/ Excluded	Rationale
Future Needs	Capacity	Included	The capacity of the future facility would decide whether alternative management strategies need to be used to meet peak demands.
	Future water quality	Included	The size of additional processes required for the future facility is an inverse function of its capacity.
	Available gravity capacity	Excluded	The gravity capacity available depends on the site and not capacity.
Environmental Impacts	Electricity usage	Included	The capacity of the future facility and the alternative management strategy used would decide the amount of electricity used.
	Residuals produced	Excluded	Initial estimates indicate there is no significant difference between the alternatives.
	Construction and operations fuel consumption	Included	This constitutes the number of truck trips and construction equipment used and is thus a direct function of how large the facility is.
Integration	WTP labor	Excluded	The labor required to operate and maintain the plant, for a given filtration technology, varies very little for the capacities being evaluated.
	Safety and operations	Included	The amount of chemicals that require handling and maintenance is a direct function of capacity.
	Corrosion control integration	Excluded	Corrosion control is related to water quality and not quantity.
	Other infrastructure ramifications	Included	The capacity of the future facility would decide the size of the other infrastructure required, such as pipes, basins, etc.
	Distribution system water quality	Included	Whether the future facility uses alternative management strategies such as groundwater is a direct function of its initial capacity.
Implementation	Implementation complexity	Included	The length of implementation schedule is a function of construction time, land acquisition, design and permitting and start-up time, and is therefore, a function of the facility capacity.
	Ease of construction	Included	Time taken to construct the facility is a direct function of its size.
	Land use permits	Excluded	There is no difference between permitting requirements for a larger plant versus a smaller one with respect to capacity, as opposed to the later site decision.
	On- and off-site ownership	Excluded	Ownership is related to siting instead of capacity.

6.0 Criteria Evaluation

A quantitative score was developed for each criterion used to evaluate the three capacity alternatives. This score was based on either a calculated value developed from various models, or a numerical score assigned to a qualitative description. For this scoring, a higher number means greater benefits and advantages whereas a lower number indicates substantial constraints and negative aspects. Criteria for which actual quantities are available have not been scored and the quantities have been used as such. Criteria that relate to Figure 4 have been scored from 0-100, based on a given alternative's probability of using an alternative management strategy to meet 2045 PDD and P3D. The alternative least likely to use an alternative management strategy was assigned a score of 100. Other criteria were scored on a scale of 1-10, 1 being assigned to the worst alternative and 10 to the best alternative. This section describes each applicable criterion, the scale used to develop the scoring, and the basis for the scoring. Table 3 summarizes the scoring.

Table 3. Evaluation Criteria and Valuation

Value	Public Health and Water Quality					Resiliency/Reliability			Community Interests			Cost Benefit		
Value Description	Provide drinking water that is safe and consistent					Facility maximizes likelihood of continued water provision, even after a fire or disaster			Integrate community interests in the decision-making process			Getting the most benefit for the dollar		
Criteria	Existing Micro- biological Regulations	Organics/ Inorganics Regulations	Emerging Water Quality Regulations	Consistent Water Quality	Chemical Impacts	Earthquake	Catastrophic WQ Event (forest fire, landslide)	Routine WQ Events (elevated turbidity, algae bloom)	Local Impacts	Consistency in Taste and Appearance	Chemical Concerns	Cost of Construction	Operating Costs	Total Cost of Delivered Water
Performance Scale	Ability to meet existing regulations	Ability to meet existing regulations	Ability to meet existing regulations	Use of Alternative Management Strategies	Chemical Selection	Ability to Maintain Supply	Half the Capacity	Treated Water Quality	Neighbors Impacted	Qualitative	Dosage	Capital Cost[1]	Operating Costs[1]	Lifecycle Cost
160 MGD	N/A	N/A	N/A	100 points	N/A	48 MGD	80 MGD	N/A	123,000 truck trips during const.	100 points	N/A	$226,500,000	$11,500,000	5 points
145 MGD	N/A	N/A	N/A	84 points	N/A	44 MGD	73 MGD	N/A	116,000 truck trips during const.	84 points	N/A	$209,000,000 + cost for alternative management strategies	$11,000,000 + cost for alternative management strategies	10 points
115 MGD	N/A	N/A	N/A	3 points	N/A	35 MGD	58 MGD	N/A	97,000 truck trips during const.	3 points	N/A	$177,000,000 + cost for alternative management strategies	$9,000,000 + cost for alternative management strategies	1 point

Value	Future Needs			Environmental Impacts			Integration					Implementation			
Value Description	Maximizes ability to make adjustments in future			Minimize environmental impacts			Optimize operability & integration with PWB's systems and practices					Increases ability to implement and meet compliance schedule			
Criteria	Capacity	Future Water Quality	Available Gravity Capacity	Electricity Usage	Residuals Produced	Construction and Operations Fuel Consumption	WTP Labor	Safety & Operations	Corrosion Control Integration	Other infrastructure Ramifications	Distribution System WQ	Ease of Construction	Implementation Complexity	Land Use Permits	On- and Off-site Ownership
Performance Scale	Time to Next Expansion	Bull Run Water Quality	MGD	MWh/year	Volume produced	# Truck Trips + Operations Fuel Consumption	Required FTEs	Amount of Chemicals	Switching Sources/Use of Management Strategies	Redundancy	Use of Alternative Management Strategies	Risk to Schedule	Risk to Schedule	Risk to Schedule	Ownership
160 MGD	10 points	1 point	N/A	5 points	3,628 cy/year	276,000 Gal (Const. Fuel consumption)	N/A	8,200 dry tons/year	N/A	1 point	100 points	1 point	1 point	N/A	N/A
145 MGD	7 points	4 points	N/A	10 points	3,628 cy/year	261,000 Gal (Const. Fuel consumption)	N/A	7,800 dry tons/yr	N/A	4 points	84 points	4 points	2 points	N/A	N/A
115 MGD	1 points	10 points	N/A	1 point	3,628 cy/year	218,000 Gal (Const. Fuel consumption)	N/A	6,900 dry tons/yr	N/A	10 points	3 points	10 points	10 points	N/A	N/A

1-Capital and operating cost are for a typical granular media filtration water treatment plant and do not specifically represent data or cost of a facility for the Bull Run supply. The cost information is solely for comparative purposes.

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6.1 Consistent Water Quality

Performance Scale: As noted earlier, PWB will need to implement alternative management strategies whenever PWB system demands exceed the Bull Run filtration plant capacity. Some of these alternative management strategies may cause the distribution system water quality to change significantly. For example, groundwater from the CSSWF has different pH, alkalinity, and total dissolved solids than the Bull Run supply. Therefore, the scale for this criterion is based on the likelihood that an alternative management strategy is used to meet 2045 PDD.

Basis for Valuation: The scoring is based on the probability of a capacity alternative to use alternative management strategies to meet 2045 PDD (Figure 4). The scoring is as follows:

- 160 MGD: 100 points, because there is a 1 in 100 chance of using an alternative management strategy to meet the projected 2045 PDD
- 145 MGD: 84 points, because there is a 16 in 100 chance of using an alternative management strategy in 2045
- 115 MGD: 3 points, because there is a 97 in 100 chance of using an alternative management strategy in 2045

6.2 Earthquake

Performance Scale: The ability to quickly restore some measure of drinking water production is crucial after an earthquake. Per the 2013 Oregon Resilience Plan prepared by the Oregon Seismic Safety Policy Advisory Commission, a drinking water utility should restore some level of plant production in the weeks and months following a major earthquake. Specifically, the Plan's Table 8.19 (Water and Wastewater Sector: [Willamette] Valley Zone) indicates that the desired water treatment plant availability (capacity) within 0 to 24 hours after an earthquake is 20-30 percent of the full normal capacity. A larger capacity plant would therefore have the benefit of providing greater immediate supply availability after an earthquake than a smaller capacity one. This does not consider overall system seismic vulnerability, but only focuses on the treatment facility.

Basis for Valuation: The criterion valuation is based on 30 percent of the normal rated plant capacity, which is the desired capacity within 24 hours immediately following an earthquake.

- 160 MGD: 48 MGD
- 145 MGD: 44 MGD
- 115 MGD: 35 MGD

6.3 Catastrophic Water Quality Event

Performance Scale: A catastrophic water quality event, such as large fire or landslide in the watershed, will hinder the ability for a filtration plant, regardless of filtration technology, to produce water that continues to meet all regulatory requirements. In such an event, PWB would implement management strategies and operate the plant at a lower capacity to provide longer coagulation times, greater settling times, lower filter loading rates, higher chlorine disinfection times, and/or other similar adjustments so that the adversely impacted Bull Run supply could

still be used to some extent. Such adjustments would occur for a facility with any type of filtration technology and not specific to a single technology.

Basis for Valuation: The criterion valuation assumes the available filtration plant capacity after a catastrophic event is effectively halved to continue Bull Run treatment.

- 160 MGD: 80 MGD
- 145 MGD: 73 MGD
- 115 MGD: 58 MGD

6.4 Local Impacts

Performance Scale: Local impacts are defined as truck trips during construction. The primary impacts to neighbors are anticipated to be related to noise, traffic, and road dust from these truck trips. Truck trips related to ongoing operations were not included as this is not a significant differentiator between different size facilities. A facility requiring more truck trips scored lower than a facility requiring less truck trips.

Basis for Valuation: During construction, a larger capacity filtration plant would have more truck trips than a smaller one as the facility is larger in physical size. The number of construction truck trips is based on the conceptual design modeling for a direct filtration granular media plant. The modeling results are summarized in the document Cost Curves for Granular Media Filtration TM in Appendix C. A different type of treatment process and/or site-specific requirements may cause the values to vary significantly, however the ratios between the alternatives would be similar.

- 160 MGD: 123,000 truck trips during construction
- 145 MGD: 116,000 truck trips during construction
- 115 MGD: 97,000 truck trips during construction

6.5 Consistency in Taste and Appearance

Performance Scale: When an alternative management strategy is used, such as CSSWF groundwater, or purchasing outside water supplies, the taste and appearance of drinking water can change from the Bull Run water. For instance, CSSWF groundwater has higher total dissolved solids and alkalinity than water supplied from Bull Run. Switching between these sources can change taste and appearance characteristics. A facility that is less likely to require the use of an alternative management strategy is less likely to change taste and appearance and scored higher than a facility that is more likely to require the use of groundwater. Therefore, a larger capacity filtration plant is the best alternative as it would be least dependent on a management strategy.

Basis for Valuation: The scoring is based on the probability of a capacity alternative to use an alternative management strategy to meet PDD demand in 2045 (Figure 4). The scoring is as follows:

- 160 MGD: 100 points, because there is a 1 in 100 chance of this alternative using groundwater to meet the 2045 PDD

- 145 MGD: 84 points, because there is a 16 in 100 chance of this alternative using groundwater to meet the 2045 PDD
- 115 MGD: 3 points, because there is a 97 in 100 chance of this alternative using groundwater to meet the 2045 PDD

6.6 Cost of Construction

Performance Scale: The cost of construction takes into consideration the infrastructure that needs to be built and also the alternative management strategies that might need to be used for a given facility size to meet the peak demands.

Basis for Valuation: A larger facility would require more infrastructure to be built but would also be less dependent on alternative management strategies to meet the PDD. A smaller facility, though, would require less infrastructure, would also be more likely to use an alternative management strategy to meet PDD.

- 160 MGD: $226,500,000
- 145 MGD: $209,000,000 + cost of alternative management strategy
- 115 MGD: $177,000,000 + cost of alternative management strategy

6.7 Operation Cost

Performance Scale: The operation cost directly relates to the operational requirements of the facility and also the alternative management strategies that might need to be used for a given facility size to meet the peak demands.

Basis for Valuation: A larger facility would require more infrastructure but would also be less dependent on alternative management strategies to meet the PDD. A smaller facility, though, would require less infrastructure, would also be more likely to use an alternative management strategy to meet PDD.

- 160 MGD: $11,500,000
- 145 MGD: $11,000,000 + cost of alternative management strategy
- 115 MGD: $9,000,000 + cost of alternative management strategy

6.8 Cost of Delivered Water

Performance Scale: The total cost of delivered water includes the cost of drinking water delivered from the Bull Run Filtration Plant and the cost of water delivered through alternative management strategies.

Basis for Valuation: The scoring is based on the total delivered water cost. Ten points are assigned to the alternative which is least expensive and 1 point is assigned to the alternative that is most expensive. The following values are assigned to each capacity alternative based on the aforementioned scale:

- 160 MGD: 5 points, because Bull Run water has the highest estimated cost but incurs management strategy costs very infrequently or not at all.
- 145 MGD: 10 points, because the estimated delivered Bull Run water is 10 percent lower than the 160 MGD alternative while alternative management strategy costs are

incurred less often. This means that the delivered water cost, which includes Bull Run water cost and alternative management strategy cost, is the lowest.

- 115 MGD: 1 point because while the estimated Bull Run water is the lowest cost, this alternative will incur alternative management strategy costs most frequently. This means that the delivered water cost is the highest.

6.9 Capacity

Performance Scale: The capacity scale is based on number of occurrences when the initial filtration plant firm capacity is exceeded through 2045 (the extent of the planning horizon) and alternative management strategies are needed to meet demands.

Basis for Valuation: The scoring is based on the ability of the plant to meet needs of both 2045 weather normalized average PDD and 2045 stress year PDD using Bull Run filtration alone. Ten points are assigned to the alternative that can meet these demands and 1 point to the alternative that cannot meet the demands. Values between 1 and 10 are interpolated linearly based on plant capacity between the 2045 weather normalized PDD and 2045 stress year PDD. The following values are assigned to each capacity alternative based on the aforementioned scale:

- 160 MGD: 10 points, because capacity meets normalized and stress year PDD
- 145 MGD: 7 points, because capacity covers 90% of 2045 PDD and P3D demands in a stress year
- 115 MGD: 1 point, because capacity is just above the 2045 weather normalized PDD and far less than the 2045 stress year PDD

6.10 Future Water Quality

Performance Scale: This criterion is based on the space needed to add additional treatment processes to address future water quality changes; either changes to the untreated Bull Run supply or changes to drinking water requirements for the Bull Run filtration plant.

Basis for Valuation: The scoring is based on the size of additional processes needed for the filtration plant irrespective of a filtration technology. Ten points are assigned to the alternative that would require smaller sized additional processes and 1 point to the alternative that would require larger sized additional processes. The following values are assigned to each capacity alternative based on the aforementioned scale:

- 160 MGD: 1 point for being the largest capacity, which implies that it would need largest sized additional processes among the three alternatives
- 145 MGD: 4 points on linear scaling between 160 MGD and 115 MGD
- 115 MGD: 10 points for being the smallest capacity, which implies that it would need the smallest-sized additional processes among all three alternatives

6.11 Electricity Usage

Performance Scale: Similar to the total cost of the delivered water criterion, PWB water supply electricity usage includes the Bull Run Filtration Plant and the water delivered through

alternative management strategies, such as water from wholesalers or pumping CSSWF groundwater. The estimated electricity usage is based on the conceptual design modeling for a direct filtration granular media plant summarized in Appendix C. Site- specific constraints and changes to the filtration technology will cause electricity usage to change, although the ratios between alternatives would be similar. As with the total cost of delivered water, electrical usage for water associated with an alternative management strategy is harder to define as the electricity depends on pumping costs from the CSSWF.

Basis for Valuation: The scoring is based on the estimated combined electricity usage for Bull Run Filtration Plant and the alternative management strategy. Ten points are assigned to the alternative that would consume least amount of electricity and 1 point to the alternative that would consume the most amount of electricity. The following values are assigned to each capacity alternative based on the aforementioned scale:

- 160 MGD: 5 points, because Bull Run Filtration Plant has the highest estimated electricity usage but would require electricity for alternative management strategy usage very infrequently
- 145 MGD: 10 points, because the estimated electricity usage is 10 percent lower than the 160 MGD alternative while alternative management strategy costs are still infrequent
- 115 MGD: 1 point, because while the Bull Run Filtration Plant has the lowest estimated electricity usage, this alternative would incur more frequent electricity usage associated with alternative management strategies

6.12 Construction and Operations Fuel Consumption

Performance Scale: A larger capacity filtration plant would have more truck trips and construction equipment usage than a smaller one as there are more facilities to build and/or facility is larger in physical size. As a result, a larger plant would use more fuel during construction. The estimated construction fuel consumption is based on the conceptual design modeling for a direct filtration granular media plant summarized in Appendix C.

The conceptual design modeling also calculated fuel consumption once the filtration plant becomes operational. This value was not used because the difference between the largest and smallest plant in the number of truck trips during operations is relatively small as compared to the difference in the number of truck trips during construction.

Basis for Valuation: This criterion uses the following values for each alternative:

- 160 MGD: 276,000 gallons of fuel consumed during construction
- 145 MGD: 261,000 gallons of fuel consumed during construction
- 115 MGD: 218,000 gallons of fuel consumed during construction

6.13 Safety & Operations

Performance Scale: Safety and operations are based on the volume of chemicals stored and used in a given treatment facility. The annual volumes of chemicals are based on the conceptual design modeling for a direct filtration granular media plant. The modeling results are

summarized in Appendix C. Increased quantities are assumed to result in more handling and maintenance and increase the risk of accidents.

Basis for Valuation: This criterion uses the following values for each alternative:

- 160 MGD: 8,200 dry tons/year
- 145 MGD: 7,800 dry tons/year
- 115 MGD: 6,900 dry tons/year

6.14 Other Infrastructure Ramifications

Performance Scale: A filtration plant has multiple impacts to other infrastructure. A larger capacity filtration plant will require larger capacity (larger diameter) pipelines between the plant site and the existing transmission conduits, larger overflow basins, and other larger hydraulic structures. In addition, a larger capacity plant would mean a larger paved area and result in increased stormwater runoff to manage. Hence, the largest facility would have the lowest score for this criterion.

Basis for Valuation: The scoring is based on the infrastructure requirements for a given alternative. Ten points are assigned to the alternative that would require smaller infrastructure and 1 point to the alternative requiring larger infrastructure. The following values are assigned to each capacity alternative based on the aforementioned scale:

- 160 MGD: 1 point for being the largest capacity, which implies that it would require largest infrastructure among all three alternatives
- 145 MGD: 4 points linearly scaled between 160 MGD and 115 MGD
- 115 MGD: 10 points for being the smallest capacity which implies that it would require smallest infrastructure among all three alternative

6.15 Distribution System Water Quality

Performance Scale: As with the criterion Consistent Water Quality, use of alternative management strategies may cause the distribution system water quality to change. For example, the CSSWF groundwater and water purchased from adjacent wholesalers to meet PWB demands have different pH, alkalinity, and total dissolved solids values than the Bull Run supply.

Basis for Valuation: The scoring is based on the likelihood that an alternative management strategy is used in 2045 PDD per Figure 4. The scoring is as follows:

- 160 MGD: 100 points, because there is a 1 in 100 chance of using an alternative management strategy to meet the PDD
- 145 MGD: 84 points, because there is a 16 in 100 chance of using an alternative management strategy to meet the PDD
- 115 MGD: 3 points, because there is a 97 in 100 chance of using an alternative management strategy to meet the PDD

6.16 Ease of Construction

Performance Scale: Ease of construction takes into consideration the effect of facility size on the length of construction schedules. With all other factors being equal (site, filtration technology, monthly cash flow), a larger capacity filtration plant will take longer to construct than a smaller capacity plant and may make the site more congested.

Basis for Valuation: The scoring is based on the amount of time needed to construct a filtration plant, regardless of the filtration technology. 10 points are assigned to the alternative that requires least amount of time to construct and 1 point is assigned to the alternative requiring most amount of time to construct. The following values are assigned to each capacity alternative based on the aforementioned scale:

- 160 MGD: 1 point for being the largest capacity, i.e., most time needed
- 145 MGD: 4 points linearly scaled between 160 MGD and 115 MGD
- 115 MGD: 10 points for being the smallest capacity, i.e., least time needed

6.17 Implementation Complexity

Performance Scale: Implementation complexity takes into consideration the effect of facility size on the length of construction schedules and start-up time for the facility. Larger sized facility would require more equipment and systems to be tested, started, and placed into service and would likely push the start-up date. For example, Appendix C indicates that a 115 MGD direct filtration media plant would have 16 gravity filters, a 145 MGD plant would have 20 filters, and a 160 MGD plant would have 22 filters. Conversely, a 115 MGD plant would have two rapid mix trains while the 145 and 160 MGD plants would have three trains–a small change. Finally, the backwash pump station has the same capacity regardless of plant capacity. Therefore, implementation complexity increases with capacity but the overall change is not linear.

Basis for Valuation: While the implementation complexity may not be a true discriminator, for the sake of this evaluation, the following 0 to 10 point scoring is assigned for 160 and 115 MGD:

- 160 MGD: 1 point for being the largest capacity and therefore highest relative complexity
- 115 MGD: 10 points for being the smallest capacity and least relative complexity

Given the non-linear differences for complexity, the following scoring is assigned for 145 MGD:

- 145 MGD: 2 points (nearly the same as a 160 MGD plant)

7.0 Evaluation

The PWB Filtration Team, including all representatives of the Executive Team, met on April 18, 2018, to review the performance of the capacity alternatives and reach a conclusion upon the preferred capacity alternative. This decision modeling process was used to support the Filtration Team and the Executive Committee in reaching conclusions. The decision model incorporates the values, criteria, and performance scales of the three viable capacity alternatives. Throughout the evaluation and review, the team reminded itself that the decision model alone does not make the decision. This context assured that the decision model and the evaluation of alternatives was designed to inform the technical team and the Executive Committee, not make

the decision for PWB.

Three weighting scenarios were carried through the process to reflect the different perspectives of the PWB team members. The three weighting scenarios were:

1. Team Weighted (TW) – The PWB Filtration Team weights produced on March 27, 2018.
2. Equal Weights (EQ) – Equal weights among the eight values.
3. Split (SP) – A 60/40 split weighting where 40 percent of the weight remained with Public Health Water Quality (25 percent) and Reliability (15 percent) as identified in the team weighted scenario, and the remaining 60 percent was distributed equally among the other six values.

These weighting scenarios were carried through the evaluation process to demonstrate weighting sensitivity. The summary of these weights and their associated impacts on scoring are shown in Table 4.

Table 4: Weighting Scenarios

ID#	Evaluation Criteria	TW	EQ	SP
1	**Public Health and Water Quality**	25	12.5	25
2	**Resiliency/Reliability**	15	12.5	15
2.1	Earthquake: 30% Availability	5.9	6.25	7.5
2.2	Catastrophic WQ event: Maintain half capacity	9.1	6.25	7.5
3	**Community Interests**	9	12.5	10
3.1	Local Impacts: Truck trips	1.9	4.17	3.33
3.2	Consistency in Taste and Appearance: Percentile availability	4.2	4.17	3.33
4	**Cost Benefit**	12	12.5	10
4.1	Cost of Construction: Capital $	5.4	6.25	5
4.2	Operating Cost: Operating $	6.6	6.25	5
5	**Future Needs**	10	12.5	10
5.1	Capacity: Expansion potential 1-10	5.2	6.25	5
5.2	Future Water Quality: Bull Run water quality 1-10	4.8	6.25	5
6	**Environmental Impacts**	7	12.5	10
6.1	Electrical Usage: Megawatts per year	2.3	4.17	3.33
6.2	Residuals Produced: Cubic years/year	2.7	4.17	3.33
6.3	Construction and Operations Fuel Consumption: Construction + opertions fuel consumption	2	4.17	3.33
7	**Integration**	12	12.5	10
7.1	Safety and Operations: Chemical dry tons/year	5.3	4.17	3.33
7.2	Other Infrastructure Ramifications: Redundancy 1-10	3.2	4.17	3.33
7.3	Distribution System WQ: Percentile Availability	3.5	4.17	3.33
8	**Implementation**	10	12.5	10
8.1	Ease of Construction: Risk to schedule 1-10	4.2	6.25	5
8.2	Implementation Complexity: Risk to schedule 1-10	5.8	6.25	5

The performance ratings of the alternatives found in Table 3, and the weighting of the values and criteria found in Table 4 are the inputs for the evaluation of the site alternatives. The normalized performance rating multiplied by the weight and added across values and criteria produces a value score. Table 5 demonstrates this calculation.

Columns N and O in Table 5 list the values and criteria and their associated weights. In the calculation in Table 5, the weights that are showcased are those associated with the Team weighting scheme (TW) in Table 4. Column B of Table 5 displays the weight percentage of each value/criterion. This weight percentage is the number that is carried through the evaluation calculation. Columns E and F and G summarize the performance ratings of each capacity alternative. These are the same numbers that are presented in Table 3 and further characterized in Section 6. Columns C and D reflect the minimum and maximum performance ratings among the alternatives. Columns H, I, and J are the normalized performance ratings of the three alternatives. Normalization (calculating performance in a 0 to 1 scale) is done for all performance scales to allow for common application in the evaluation. Regardless of the scale used to demonstrate performance of the alternatives (i.e., performance scale of site acres for Community Interests/Local Impacts), normalization produces a 0 for the worst performer and a 1 for the best performer within each value/criterion. Columns I and J are the calculated values scores for each value/criterion. This is the multiplication of the weight (Column B) times the Normalized Rating (Column G or H) times 100 (the 100 is just to make the result a more manageable number). The calculations within each cell of Columns I and J reflect the contribution of value the respective alternative receives from the specific value/criteria. The summation of these contributions down Column K or L or M produces the total value score for each capacity alternative. These total values scores demonstrate, relatively, how well the alternatives perform against the values and criteria. The higher the number, the better the relative performance.

Table 5. Value Score Calculations

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Weight %	Raw Ratings					Normalized Ratings			Value Scores (weight times normalized rating times 100)				
Value/ Criteria No.	TW	Minimum	Maximum	160 MGD	145 MGD	115 MGD	160 MGD	145 MGD	115 MGD	160 MGD	145 MGD	115 MGD	Value/Criterion	Assigned Weight (TW)
1	25.0%	3	100	100	84	3	1.00	0.84	0.00	25.0	20.9	0.0	**Public Health and Water Quality/**Consistent WQ	25
2.1	5.9%	35	48	48	44	35	1.00	0.69	0.00	5.9	4.1	0.0	**Resiliency/Reliability/**Earthquake	5.9
2.2	9.1%	58	80	80	73	58	1.00	0.68	0.00	9.1	6.2	0.0	**Resiliency/Reliability/**Catastrophic WQ Event	9.1
3.1	2.8%	123000	97000	123000	116000	97000	0.00	0.27	1.00	0.0	0.8	2.8	**Community Interests /**Local Impacts	1.9
3.2	6.2%	3	100	100	84	3	1.00	0.84	0.00	6.2	5.2	0.0	**Community Interests/**Consistency in Taste Appearance	4.2
4.1	5.4%	226.5	177	226.5	209	177	0.00	0.35	1.00	0.0	1.9	5.4	**Cost Benefit/**Cost of Construction	5.4
4.2	6.6%	11.5	9	11.5	11	9	0.00	0.20	1.00	0.0	1.3	6.6	**Cost Benefit/**Operating Costs	6.6
5.1	5.2%	1	10	10	7	1	1.00	0.67	0.00	5.2	3.5	0.0	**Future Needs/**Capacity	5.2
5.2	4.8%	1	10	1	4	10	0.00	0.33	1.00	0.0	1.6	4.8	**Future Needs/**Future WQ	4.8
6.1	2.3%	1	10	5	10	1	0.44	1.00	0.00	1.0	2.3	0.0	**Environmental Impacts/**Electrical Usage	2.3
6.2	2.7%	3628	3628	3628	3628	3628	0.00	0.00	0.00	0.0	0.0	0.0	**Environmental Impacts/**Residuals Produces	2.7
6.3	2.0%	276000	218000	276000	261000	218000	0.00	0.26	1.00	0.0	0.5	2.0	**Environmental Impacts/**Fuel Consumption	2
7.1	5.3%	8200	6900	8200	7800	6900	0.00	0.31	1.00	0.0	1.6	5.3	**Integration/**Safety and Operations	5.3
7.2	3.2%	1	10	1	4	10	0.00	0.33	1.00	0.0	1.1	3.2	**Integration/**Infrastructure Ramifications	3.2
7.3	3.5%	3	100	100	84	3	1.00	0.84	0.00	3.5	2.9	0.0	**Integration/**Distribution System WQ	3.5
8.1	4.2%	1	10	1	4	10	0.00	0.33	1.00	0.0	1.4	4.2	**Implementation/**Ease of Construction	4.2
8.2	5.8%	1	10	1	2	10	0.00	0.11	1.00	0.0	0.6	5.8	**Implementation/**Implementation Complexity	5.8
									lue Scores (sum of all values/criteria value scores):	55.9	55.9	40.1		

Figures 5 through 7 demonstrate the performance of the three capacity alternatives within the three different weighting scenarios. The numbers below each stacked bar present the summation of the value score. Each color of the stacked bar represents the contribution the alternative received from each value. Each value has criteria that are used to gauge the performance of the alternatives. The size of the colored bar is determined by multiplying the performance score the alternative received (Table 3) by the weight of the specific criterion (Table 4). The results of the criteria scores are then added to produce the total contribution per value. The higher the total score, the better the collective performance of the alternative against the values.

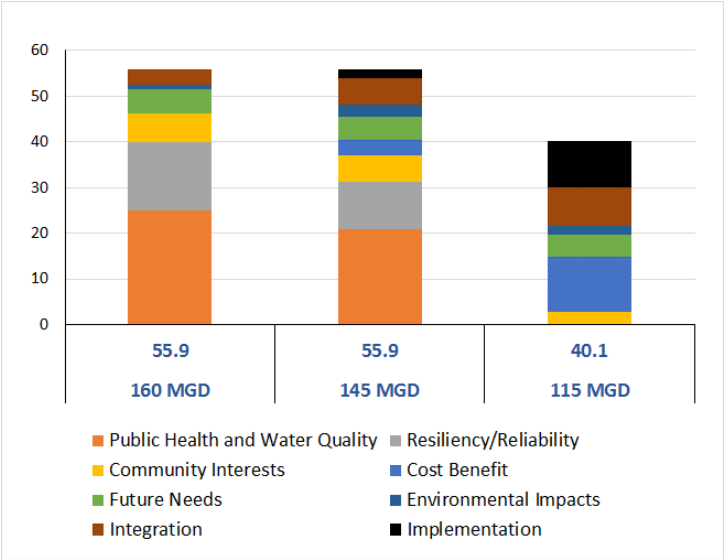


Figure 5. Team Weighting Value Scores

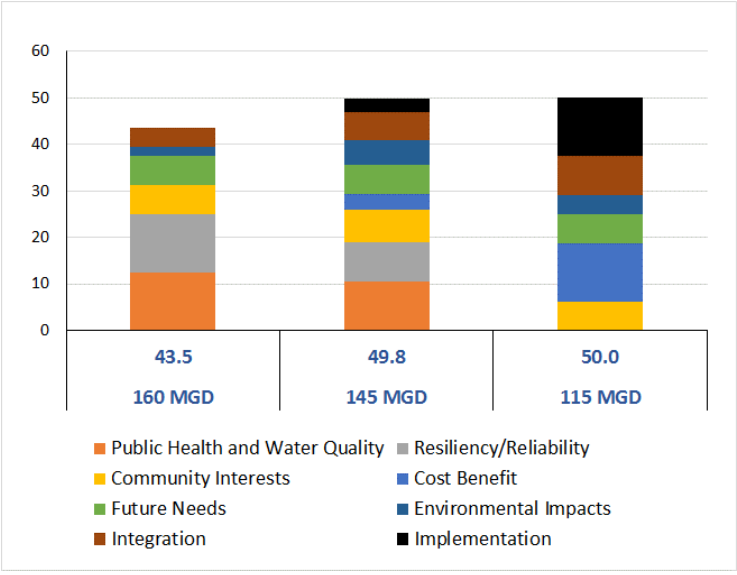


Figure 6. Equal Weighting Value Scores

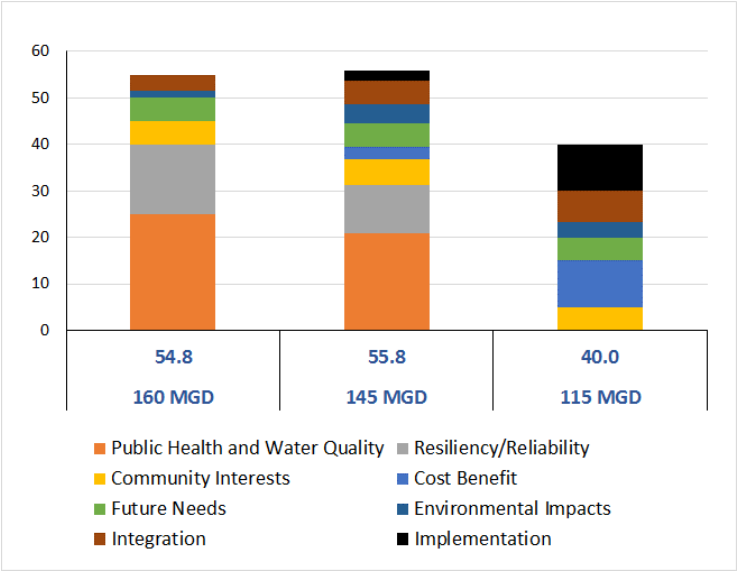
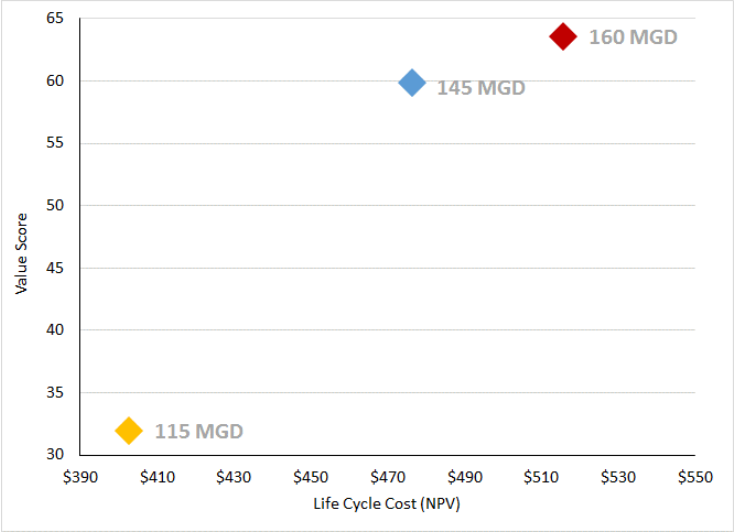


Figure 7. 60/40 Split Weighting Value Scores

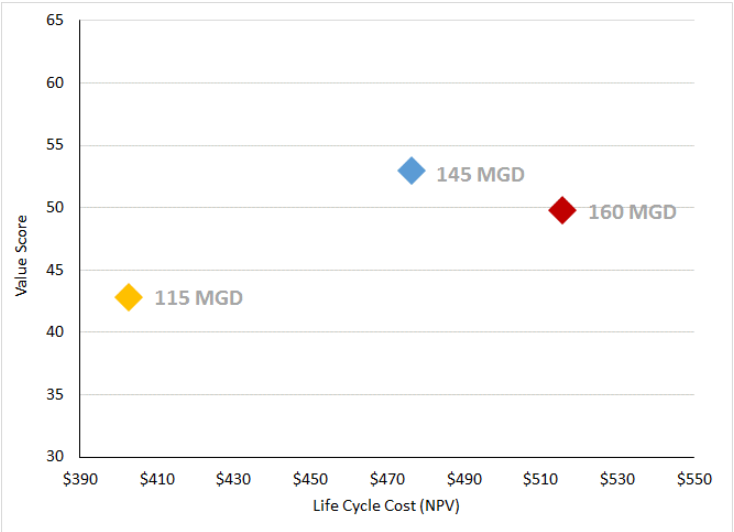
Another means to evaluate the performance of the alternatives is to contrast the total lifecycle cost of the alternatives against their total decision score. To avoid double counting of the cost element, the Cost Benefit value is removed from the calculation of the decision score. The resulting total value score is then graphically plotted against the lifecycle cost (see Figures 8 through 10). The total lifecycle cost is based upon the addition of cost of construction plus the operating costs over a 25-year period.

This comparison also allows for a calculation of the investment required per unit of value. The table associated with the scatter plot presents the total cost ($M) to gain a unit of value. The table also demonstrates the additional lifecycle cost and resulting additional value in the movement to more valued alternatives. The same three weighting scenarios are evaluated.



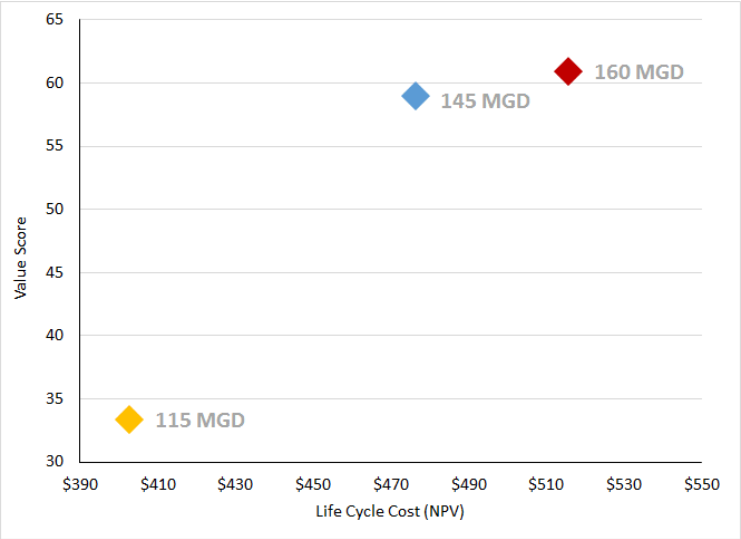
	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
160 MGD	63.5	$ 515.80	$ 8.12	3.7	$ 39.50	10.61
145 MGD	59.8	$ 476.30	$ 7.96	27.9	$ 73.50	2.64
115 MGD	31.9	$ 402.80	$ 12.61	-----	----	----

Figure 8. Team Weighting Scatter Plot



	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
160 MGD	49.7	$ 515.80	$ 10.37	-3.2	$ 39.50	-12.20
145 MGD	53.0	$ 476.30	$ 8.99	10.1	$ 73.50	7.27
115 MGD	42.9	$ 402.80	$ 9.40	-----	----	----

Figure 9. Equal Weighting Scatter Plot



	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
160 MGD	60.9	$ 515.80	$ 8.47	2.0	$ 39.50	20.05
145 MGD	58.9	$ 476.30	$ 8.08	25.6	$ 73.50	2.87
115 MGD	33.3	$ 402.80	$ 12.08	-----	----	----

Figure 10. 60/40 Split Weighting Scatter Plot

Further discussion on April 18, 2018, persuaded the team to reconsider the influence of some of the criteria. The intent was not to manipulate the scores, but to consider the importance and influence of specific criteria. Note, again, that the decision model is not designed or intended to produce the answer. Rather, the decision model is designed to incorporate values, structure meaningful performance comparisons, and demonstrate tradeoffs, and support conversation among the technical team and the Executive Committee. Based upon the technical team's deliberations, a conclusion was reached that four criteria do not lend to differentiation among the alternatives:

a. Ease of construction

b. Implementation complexity

c. Future water quality

The Team agreed to review the evaluation with removal of these three criteria across the three weighting scenarios. The resultant scoring from this revision is shown on the following figures.

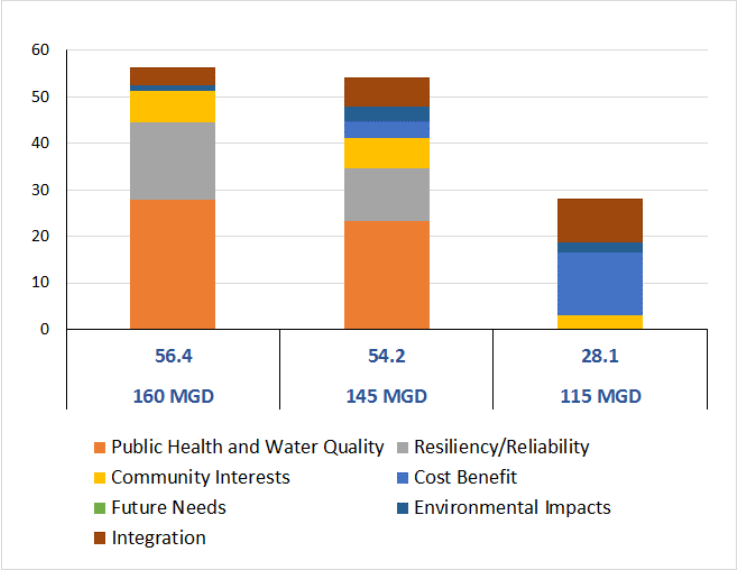


Figure 11. Updated Team Weighting Value Scores

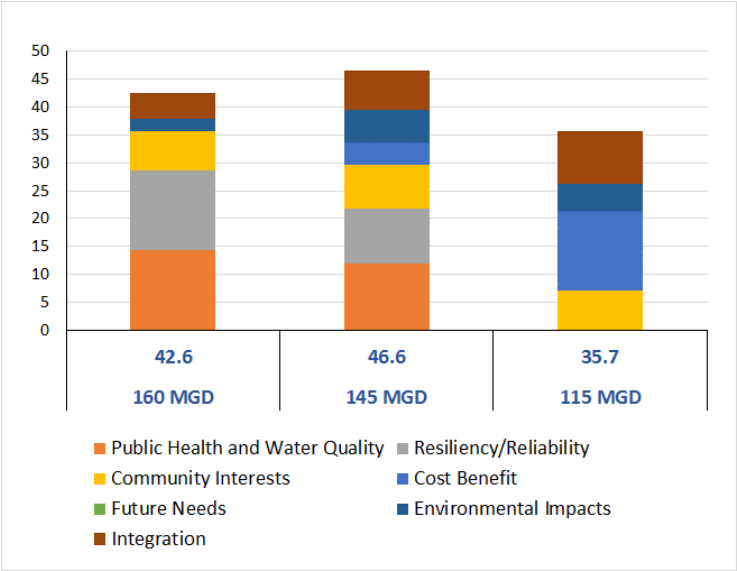


Figure 12. Updated Equal Weighting Value Scores

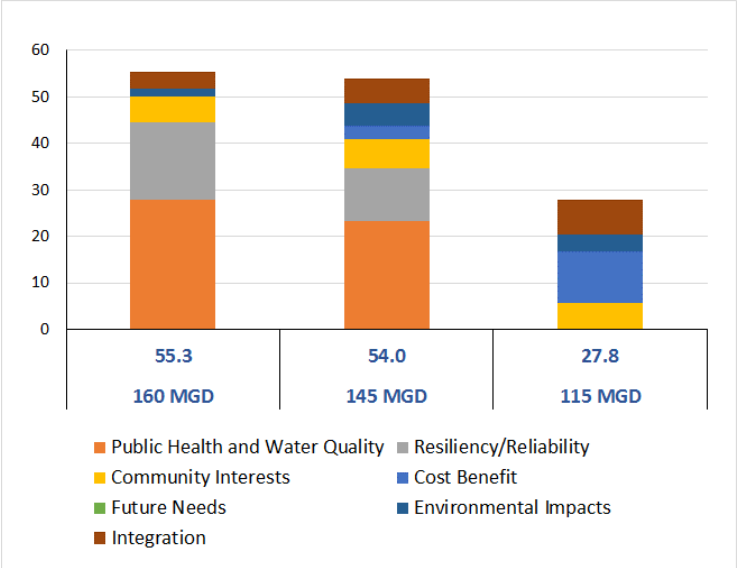
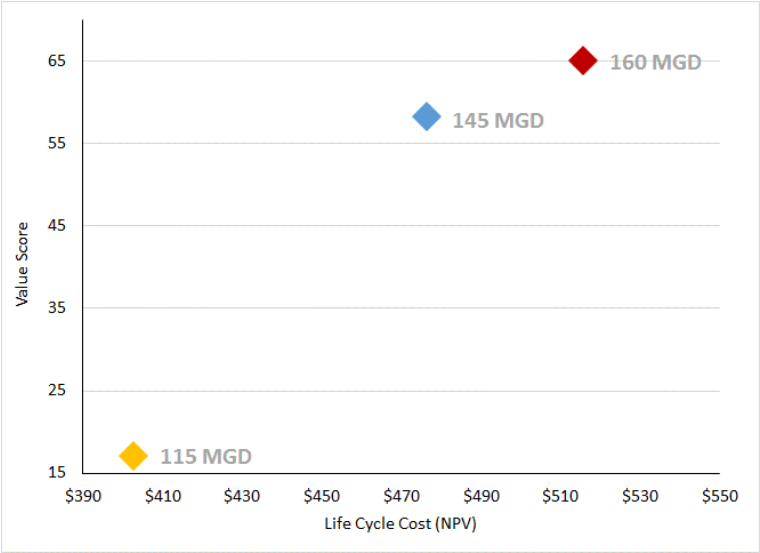
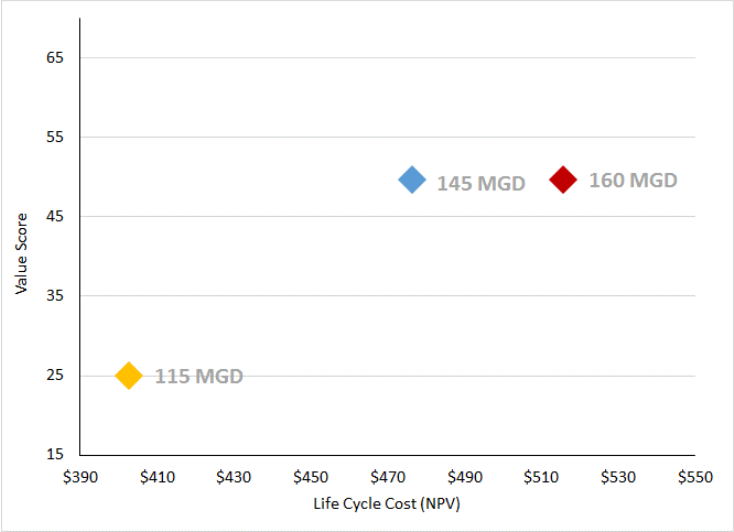


Figure 13. Updated 60/40 Split Weighting Value Scores



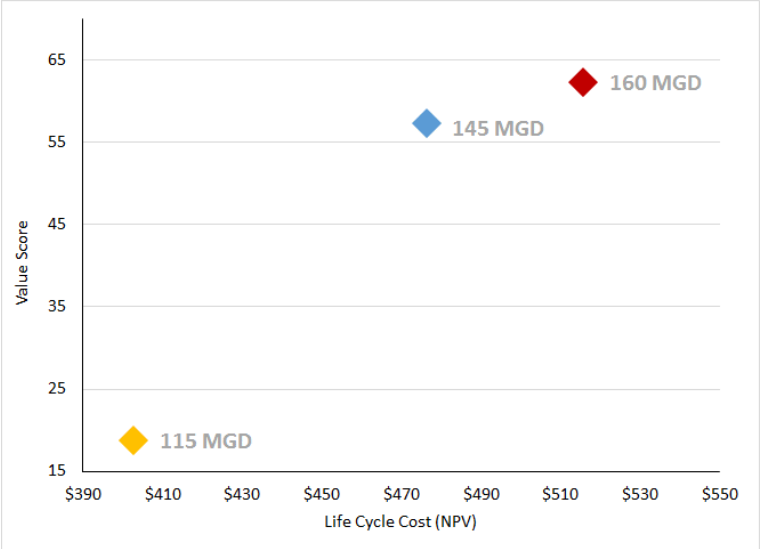
	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
160 MGD	65.0	$ 515.80	$ 7.93	6.6	$ 39.50	5.94
145 MGD	58.4	$ 476.30	$ 8.16	41.3	$ 73.50	1.78
115 MGD	17.1	$ 402.80	$ 23.62	-----	----	----

Figure 14. Updated Team Weighting Scatter Plot



	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
160 MGD	49.7	$ 515.80	$ 10.38	-0.1	$ 39.50	-546.07
145 MGD	49.8	$ 476.30	$ 9.57	24.8	$ 73.50	2.97
115 MGD	25.0	$ 402.80	$ 16.11	-----	----	----

Figure 15. Updated Equal Weighting Scatter Plot



	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
160 MGD	62.3	$ 515.80	$ 8.28	5.0	$ 39.50	7.91
145 MGD	57.3	$ 476.30	$ 8.32	38.5	$ 73.50	1.91
115 MGD	18.8	$ 402.80	$ 21.48	-----	----	----

Figure 16. Updated 60/40 Split Scatter Plot

It was decided by the Filtration Team to use this new cut of the performance data, eliminating ease of construction, implementation complexity, and future water quality from the analysis.

8.0 Recommendation

The potential plant capacities discussed in this memorandum: 115, 145, and 160 MGD were chosen after taking into consideration the projected PDD in a stress year for 2045 and their ability to consistently meet projected PWB water system demands.

The PWB Filtration Team, with concurrence from the Executive Team, used the results of the decision model to first remove the 115 MGD alternative from further consideration. This alternative provided the fewest overall benefits to the PWB in most of the evaluation scenarios that the team considered and discussed, as well as having the highest cost per unit value for all reviewed scenarios.

The same decision models indicated the scoring between the 145 MGD and 160 MGD alternatives were very similar. After another analysis of the criteria, with and without scoring, the Filtration Team and the Executive Committee merged the two alternatives into a single conclusion. The decision is to proceed forward with a desired capacity of 160 MGD, with the understanding that the capacity ultimately constructed may be somewhat smaller as a result of subsequent decisions about siting and filtration technology as well as later design choices. However, the lowest installed capacity that the PWB will accept is 145 MGD. This refined decision of a desired capacity and hard lower limit provides adequate direction at this early phase of the project and reflect PWB's current understanding of projected peak day demand, while providing flexibility during treatment plant design in the coming years ahead.

Appendices

A. Projected Water Demand

B. Characterization of Supplies for Selection of Filtration Capacity

C. Cost Curves for Granular Media

Appendix A. Projected Water Demand

Technical Memo 3.1
Projected Water Demand

To: Stakeholders

From: Jodie Inman, Janet Senior, Hossein Parandvash

CC: File

Date: February 28, 2017

Re: Projected Water Demand

1.0 Purpose

The purpose of this Tech Memo is to document projected aggregate water demand for the PWB service area through the Supply System Master Plan (SSMP) 20-yr planning window. Aggregate demand is the combined demand of both PWB retail and wholesale customers. This information is essential for developing scenarios as part of Task 9.

2.0 Background

The 2000 Supply, Transmission, and Storage Analysis (STSA) evaluated and developed demand projections as part of the 2001 Infrastructure Master Plan (IMP) process. The STSA used demand data from the 1996 Regional Water Supply Plan (RWSP). Per the 1996 RWSP, the demand forecast was based on estimated "status quo" forecast of sales per customer class and application of conservation and price increase adjustments. Peak day demands were projected based on historical ratios of peak day to average day. Table 2-1 summarizes the projected demands for the "Existing Customers" (defined as the City of Portland and existing wholesale customers) from Appendix G of the STSA.

Table 2-1 2000 STSA Demand Projections

Metric	Projected Demand, Million Gallons per Day (MGD)			
	2000	2010	2020	2050
SAD – Summer average daily demand	157	167	182	246
PDD – Peak day demand	234	253	284	382

When compared to actual demand data from 1996-2016, PWB demands have seen a significant decrease compared to the 2001 IMP and 2000 STSA projections. Figure 1 demonstrates the trend of reduction in actual demand from 1996-2016. Aggregate demand is comparable to "Existing Customers" from the STSA. Table 2-2 quantifies the percent difference from projected demand in the STSA to actual demand, 1996-2016.

Figure 1 – Actual Aggregate Demand (1996-2016)

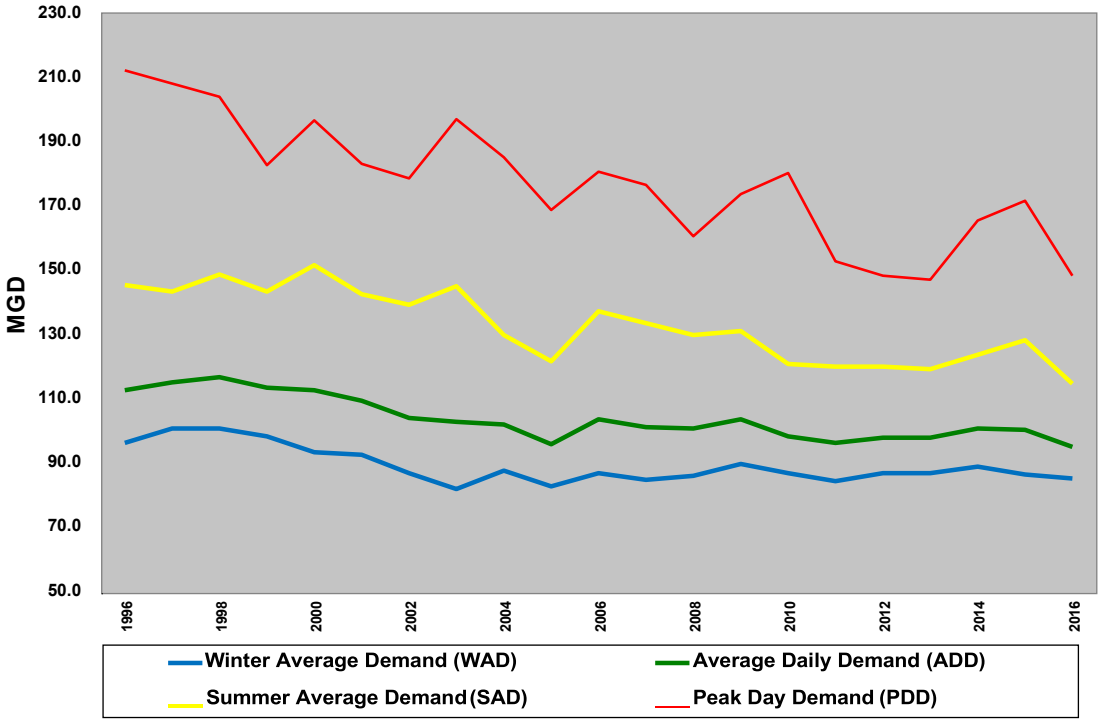


Table 2-2 2000 STSA Projection vs. Actual Demand Comparison

Metric	2000 Projected	2000 Actual	Difference	2010 Projected	2010 Actual	Difference
SAD	157	152	-4%	167	121	-27%
PDD	234	197	-16%	253	181	-28%

* Demands in MGD.

These declines occurred despite a 23% increase in population (770,910 to 951,518) and the addition of the City of Sandy as a wholesale customer (Sandy began drawing water from PWB in 2014). Factors influencing this change in demand include lower per capita use in the retail service area, the 2008-2010 economic recession, conservation, changes in land use patterns, and wholesale customer decisions, among others.

These significant differences between projected and actual demands challenged the relevancy of the planning performed as part of the 2001 IMP. New demand projections are needed for the SSMP to better inform supply decisions such as capacity, timing, and sizing of infrastructure.

3.0 Key Metrics For New Demand Projections

Five key metrics were identified to focus this memo on demand data most relevant to water system operation and infrastructure planning. These metrics are:

1. ADD - Average daily demand
2. SAD – Summer average demand (average daily demand during the peak season, June through September)
3. WAD – Winter average demand (average daily demand during the off-peak season, October through May)
4. PDD - Peak day demand
5. P3D - Peak 3-day demand

Average daily demand (ADD) is a useful measure for the amount of water to be provided in emergency conditions or if various key components of the water system are out of service. Summer average demand (SAD) is important for evaluating the adequacy of existing supply sources to meet summer demands and sizing new sources of supply if needed. Winter average demand (WAD) is useful for estimating the largest amount of water that might be needed from the wellfield, typically during a turbidity event. Peak demands (both peak day and peak 3-day) are important for sizing treatment and transmission systems to provide water during high heat weather, and to avoid short-term curtailment.

These demand metrics were reviewed against historical weather years to determine which demand weather year was the most stressful on the supply system for that metric. These years, known as "stress years", provide indicators for the water supply needed to provide for similar stressful weather years in the future. A "stress year" was not applied to WAD as there would likely not be significant variation from the average. See Appendix Section 4.1 for additional description of weather stress years. The stress years were defined, using the historical weather data from 1960 through 2015, as:

Metric	Historical Stress Weather Year
ADD - Average daily demand	1967
SAD – Summer average demand	1967
PDD - Peak day demand	1981
P3D - Peak 3-day demand	1981

Demands fluctuate from day to day based on the calendar date and whether or not a particular day falls on a weekend or particular holidays (water demand has historically been lower on weekends and some holidays than during the week). Daily demand also changes due to daily weather fluctuations. Since long-term daily weather forecasts are not available, two approaches are considered to reflect the effect of daily weather on future demand. One approach is to project demand under average historical weather conditions. This is similar to assuming that in the future, each day of the year has the same weather as the average weather of that day over the 1960-2015 period. The demand projections under this approach are the "weather normalized" demands. The other approach is to assume that the daily weather

conditions of a particular historical "stress year" are repeated in the future. In this approach, the weather conditions of the "stress years" are used to reflect the effect of daily weather on the demand projections. These two approaches provide a comparison of projected demands based on average weather to demands based on a stress year.

4.0 Demand Model Factors

PWB used an econometric model[1], developed internally, to establish and estimate the relationship between water demand and socio-economic, demographic, weather, and other factors that affect aggregate demand by all customer classes served by PWB in the retail and wholesale areas. PWB considered the following factors known to affect water demand for the update to the aggregate demand model approach from previous iterations:

- Weather
- Population
- Land use
- Wholesale customer contracts and behavior
- Water conservation policies, programs and behaviors
- Price of water (revenue per million gallons from sales of retail and wholesale water is used as a proxy for price)
- Climate change

These factors are not fixed or static for the term of the SSMP. The degree to which they will change over the planning horizon can only be estimated based on information currently available. The methodologies, major assumptions, and data sources for these estimates are described in the Appendix. To represent these unknowns in the demand model results, PWB defined each factor, generally described as follows:

Weather: Weather is represented in the analysis both as the stress years described in Section 3.0, and as weather normalized (average) conditions for comparison.

Population and land use: Population in the Portland service area is projected to continue to increase. Population densities will increase as more land area is used for multi-family residential uses versus single family residential uses. These changes are already evident in the retail service area, for example, the Pearl District and close-in Northeast and Southeast Portland. Population for the aggregate service area is estimated at 952,521 for 2018 and rises

[1] An Econometric model uses application of statistical and mathematical theories in economics for establishing relationships between the variable of consideration and other variables that are known to affect it, called "explanatory variables". The model is used for testing hypotheses and forecasting future trends.

to 1,029,403 in 2025. When TVWD reduces demand on the system in 2026, population served declines to 905,123. By 2045, population served recovers to 1,035,326.

Wholesale customers: Aggregate demand incorporated the "most likely" wholesale demand described in Tech Memo 3.2. The most significant change being TVWD reducing wholesale purchases from PWB in 2026 (PWB supply to TVWD Wolf Creek offline - supply to Metzger remaining). Other considerations not part of the "most likely" scenario described in Tech Memo 3.2 may be considered later in the SSMP process, as part of scenario analysis.

Water conservation: Two water conservation scenarios were modeled, one that assumed a continuation of current trends and another that assumed more aggressive programs and technological change. The demands shown in Figures 2-6 incorporate the current trend scenario, which includes plumbing code changes since 1992; technology improvements in appliances, indoor fixtures and irrigation; and customer education and incentive programs. Results from the more aggressive conservation scenario may be considered later in the SSMP process, as part of scenario analysis.

Price: Price can affect customer water use behaviors and decisions to install water saving appliances and fixtures. The demand estimates incorporate a pattern of anticipated price increases over the planning horizon, starting at 7% and plateauing later at 3%. The price increase projections reduce demand in the later years as a result of the compounding effect of rate increases.

Climate change: The Pacific Northwest is expected to experience warmer conditions in the future, which is likely to affect water use especially during the summer season. PWB used five global climate models (GCM) downscaled to the Portland area to estimate the effect on future air temperatures and precipitation, which are key variables in the aggregate demand model. Of the five models evaluated, PWB selected the GCM with the largest effect on demand for the purposes of the demand estimate in this memo (similar to the stress year assumption used for weather). Climate change is projected to increase demands, with more impact on peak metrics such as PDD, P3D and SAD, and less impact on average metrics such as ADD and WAD (see appendix for percentage changes for each metric). Results from the other GCMs can be considered later in the SSMP process, as part of scenario analysis.

5.0 Aggregate Demand Model Results

Model results are presented for the five key metrics, comparing weather normalized conditions with the stress year weather. Changes in wholesale customer usage plays a significant role in reducing demand[2]. Reduction by TVWD in 2026 is clearly evident, with the largest overall effect on anticipated future demand. The change in usage patterns by Rockwood and Gresham

[2] The guaranteed purchase quantity for wholesale customers may differ from actual demand. When making capacity and sizing decisions, need to account for and make sure can meet the guaranteed purchase quantity for all wholesale customers.

to address population growth with alternative (non-PWB) supplies also acts to maintain, vs increase, demand for those customers. In addition, continuing conservation, changes in land use, as well as anticipated price increases, have a negative impact on demands.

Population and climate change increase demand. However, these are not enough to counteract the factors causing reduced demand discussed above. When all factors are combined, the modeled projections of demand gently decline to 2026, with a steep drop in 2026, followed by a relatively flat curve with some increase from 2030-2040, and then a leveling off or gentle decline again after 2040. Overall, future demands are expected to be less than historical demand, and significantly lower than previous projections.

Figure 2 – Average Daily Demand (ADD)

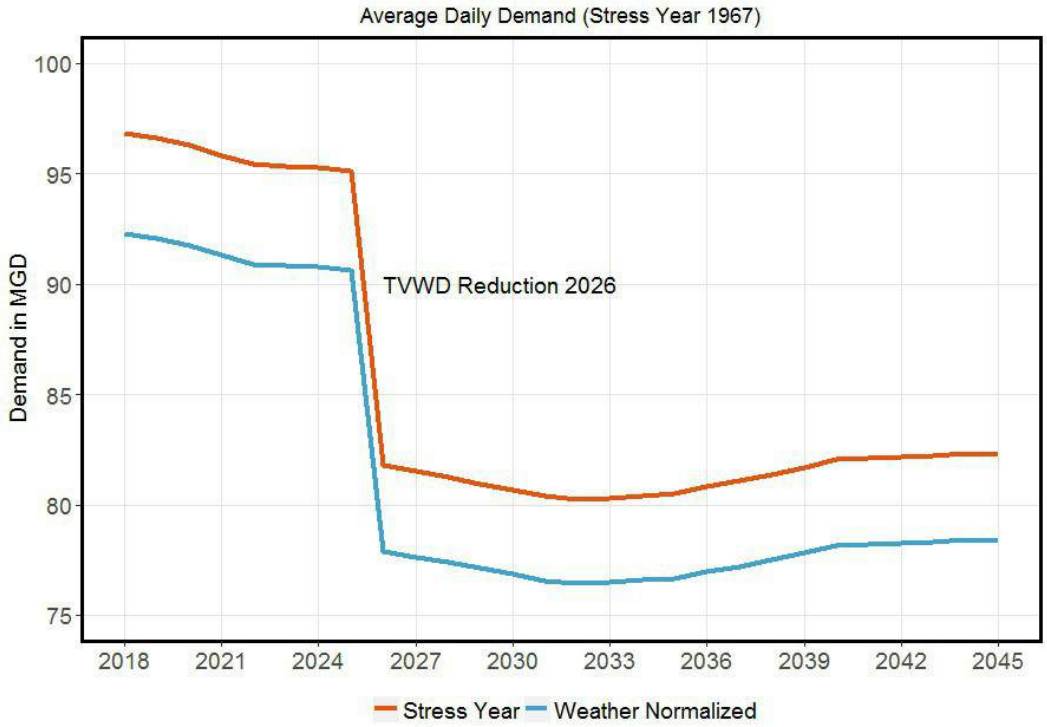


Figure 3 – Summer Average Demand (SAD)

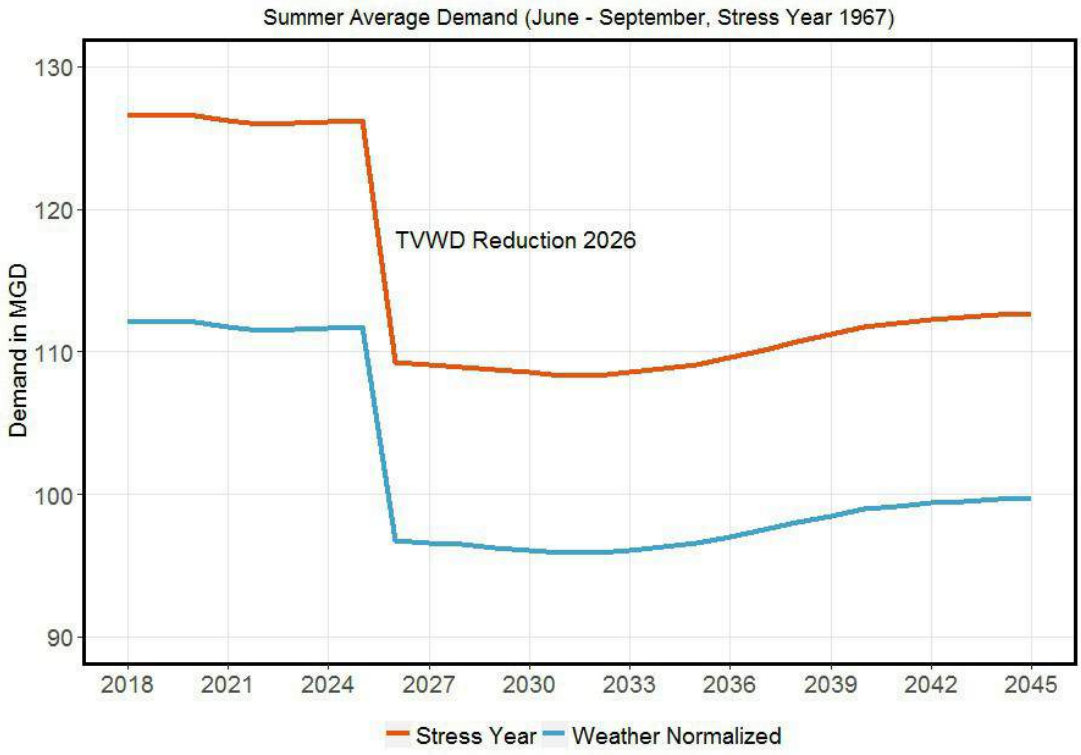


Figure 4 – Winter Average Daily Demand (WAD)

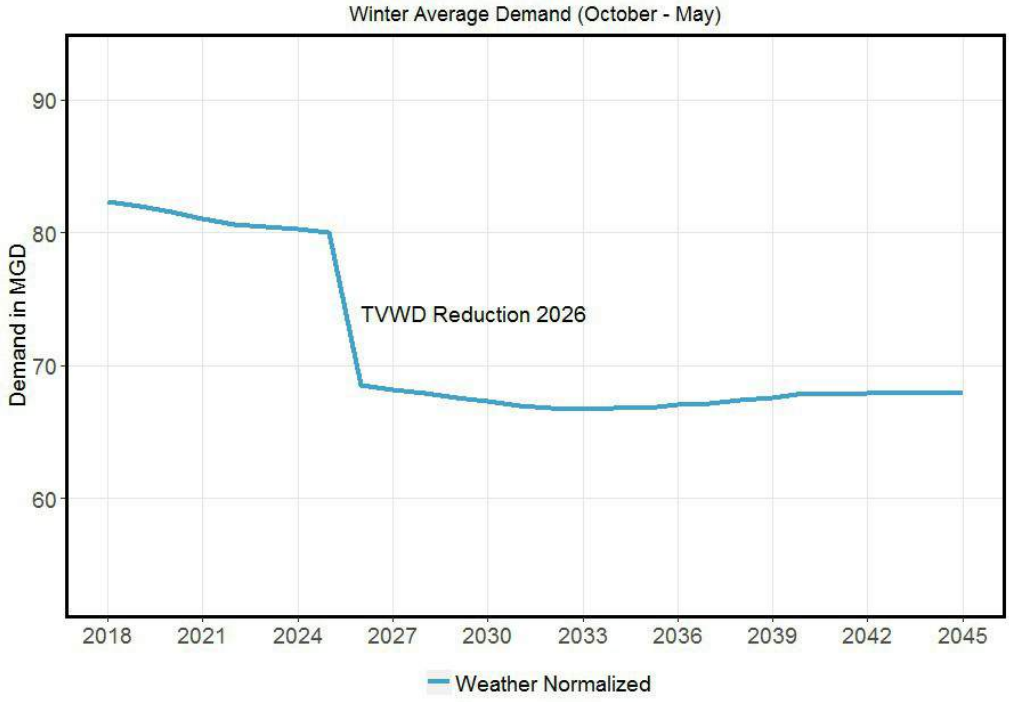


Figure 5 – Peak Day Demand (PDD)

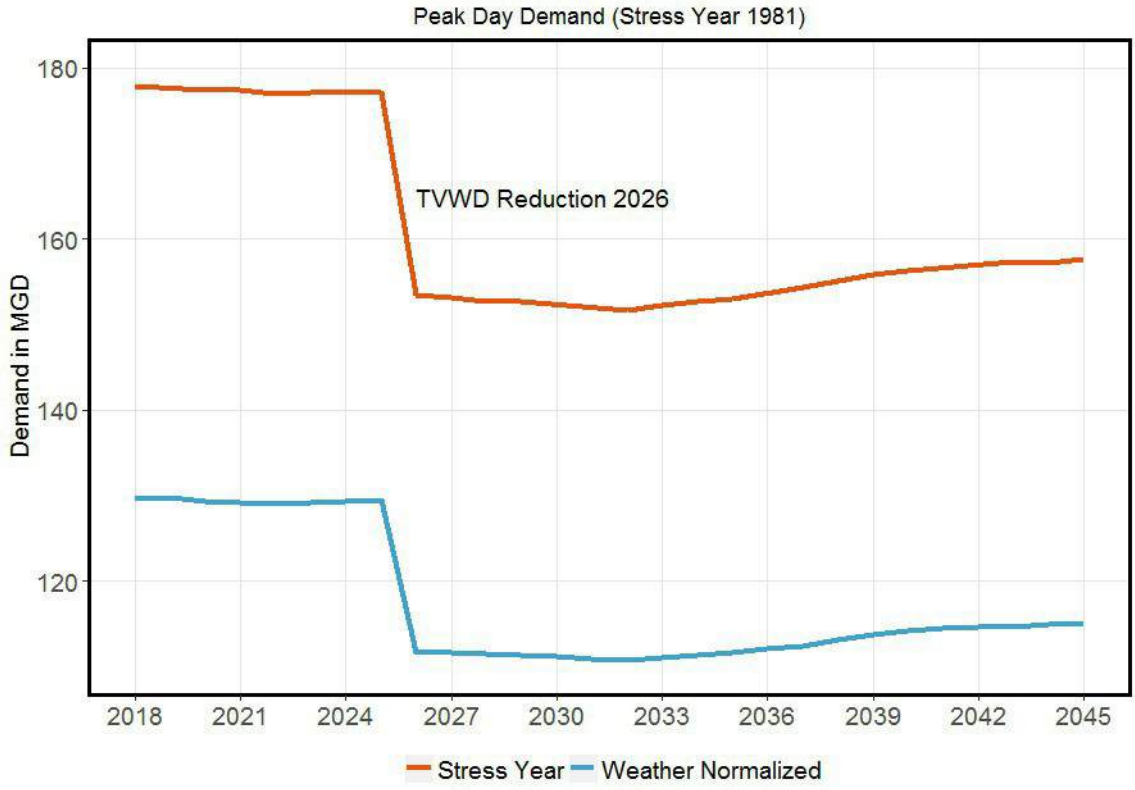
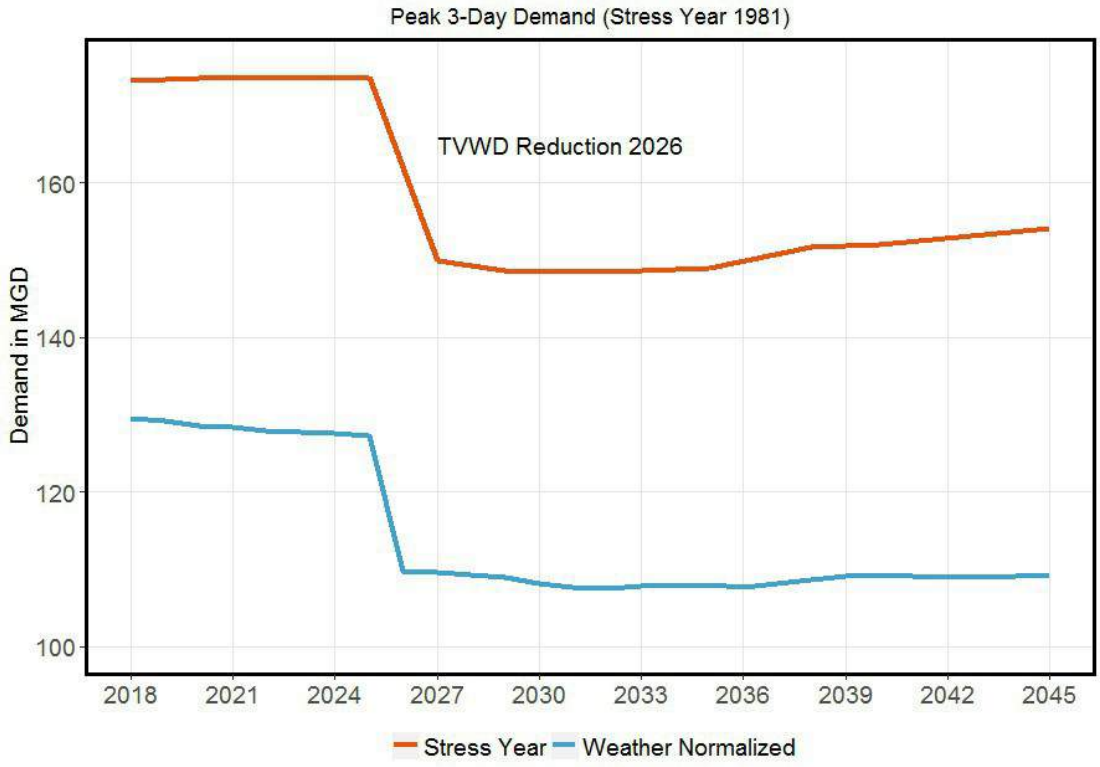


Figure 6 – Peak 3-Day Demand



Conclusion

As indicated in Figure 1, aggregate demand has been declining over the last 20 years. Each of the demand indicators show declines from the 1990s, despite an increase in population from approx. 770,000 to approx. 950,000. When future stress year demand projections are compared with projections from the 2000 STSA, the reduction in the overall demand is even more significant, with reduction of more than 50% in the out years, see Table6-1.

Table 6-1 Comparison of 2000 STSA Demand Projections vs 2017 Demand Projection

Metric	2020 Old	2020 New	Difference	2050 Old	2045 New	Difference
SAD	182	127	-30%	246	113	-54%
PDD	284	177	-38%	382	158	-59%

* Demands in MGD.

Factors that increase demand include population, and to a lesser degree climate change. Factors that decrease demand include wholesale customer decisions, densifying land use, conservation, retail customer behavior, and water prices. Of these dampening factors, wholesale customer decisions have the largest effect – namely the reduction in TVWD demand in 2026 creating steep declines for each demand indicator. After 2026, the net effect of these factors results in relatively flat trend forward from 2027 through 2045.

Overall, demand is projected to be lower in 2045 than today. Summer average demand is expected to decline from approx. 120 mgd in 2010 (actual) to approximately 110 mgd in 2045 (modeled, stress year weather). Average peak day demand is expected to decline from approx. 180 mgd in 2010 (actual) to approximately 155 mgd in 2045 (modeled, stress year weather). These declines in demand occur despite an increase in population served[3] from approx. 945,000 in 2010 (actual) to a modeled estimate of approx. 1,000,000 in 2045.

This new pattern in service area water demand, especially in contrast to projected demand from the STSA modeling work in 2000, will impact the timing, sizing and need for new supply infrastructure.

[3] Population served includes PWB retail service area as well as proportionate population of wholesale customers. For instance, not all of the population of the TVWD service area are included, as some are served by alternative TVWD supplies.

APPENDIX

Demand Model Methodology

Parandvash, Hossein, 2/2017

1.0 Structure and Content of the Demand Model

A regression model was used to estimate the relationship between daily aggregate demand and its major drivers like weather, population, and price. The estimated model along with population forecasts, price projections, and assumptions about future values of other variables were used to forecast daily aggregate demand for water for the 2018-2045period.

Various studies, Hannan (1963), Jorgenson (1964 and 1967), and Harvey and Shephard (1993) show that time series data can be decomposed into trend, seasonal, and irregular components. Chesnutt and McSpadden (1995) show that part of the daily water demand variations can also be decomposed into variables that describe weather effect.

A structural time series model is adopted to represent the demand for water by all customer classes. The general specification of the demand model is represented by **(1)**.

$$D = f(S, W, Pop, Pr, I, LT) \qquad \textbf{(1)}$$

where D is daily demand by all customers in the service area, S and W represent seasonal and weather variables respectively, Pop represents the population served, Pr is the proxy for price of water, I represent indicator or dummy variables depicting weekends, holidays, conservation, and some data anomalies, and LT represent long-term trend variables. These variables are explained in more detail in the sections below.

1.1.Seasonal variables

There is a distinct bell-shaped seasonal pattern in daily demand for water in the Portland area. Demand during the winter months is very flat, it starts increasing mid-spring, peaks in June-September period, and declines mid-fall. Granger and Watson (1984) suggest the use of a series of 11 dummy variables to represent 11 months of the year to depict seasonal variations. In this approach the 12th month dummy is dropped to avoid singularity.

Hannan (1963), Jorgenson (1964 and 1967), Harvey and Shepard, (1993), and Dziegielewski and Opitz (2000) also recommend use of Fourier series terms as a continuous function of time to express these seasonal patterns. We consider this approach in this study. For daily demand data these variables can be constructed as

$$SS_{it} = \sin\left(\frac{2\pi it}{DIY}\right) \text{ and } SC_{it} = \cos\left(\frac{2\pi it}{DIY}\right) \qquad \textbf{(1)}$$

where i is the number of cycles within each year, t is the day of the year, and DIY is the number of days in the year, i.e., 365 days for regular and 366 for leap years. For instance,

SS_1 and SC_1 (t subscript is dropped to avoid clutter) complete one full Sine and Cosine cycle and SS_2 and SC_2 complete two full cycles within a year.

1.2. Weather variables

Weather is an important driving factor in daily demand. Daily air temperature and precipitation determine the level of water use, especially during the peak season. Weather is obviously governed by a seasonal pattern, which is reflected in demand as well. Using air temperature and precipitation directly as explanatory variables would entangle the seasonal demand pattern with the daily effect of weather on demand.

To resolve such a problem, seasonal variations are removed from both daily air temperature and precipitation by auxiliary regression equations. Natural logarithm of the maximum daily temperature and daily precipitation are used as the dependent variables and the harmonic variables as the explanatory variables in the auxiliary regression models. The predictions of the auxiliary regression models depict the historical daily conditional means of air temperature and precipitation and the residuals show daily deviations from their respective conditional means. Daily precipitation, DP, is scaled to avoid taking the natural log of zero. Equations represented in **(3)** show how the seasonally adjusted contemporaneous daily precipitation values are generated.

$$
\begin{aligned}
P &= \ln(DP+1) \\
P_t &= \hat{\alpha} + \sum_{i=1}^{6} \hat{\beta}_i SS_i + \sum_{j=1}^{6} \hat{\gamma}_j SC_j + e_t \\
Pdl(0)_t &= P_t - \left(\hat{\alpha} + \sum_{i=1}^{6} \hat{\beta}_i SS_i + \sum_{j=1}^{6} \hat{\gamma}_j SC_j \right)
\end{aligned}
\qquad \textbf{(2)}
$$

Similarly, the seasonally adjusted contemporaneous maximum daily temperatures are generated according to **(4)**.

$$
\begin{aligned}
T &= \ln(MT) \\
T_t &= \hat{\alpha} + \sum_{i=1}^{6} \hat{\beta}_i SS_i + \sum_{j=1}^{6} \hat{\gamma}_j SC_j + \varepsilon_t \\
Tdl(0)_t &= T_t - \left(\hat{\alpha} + \sum_{i=1}^{6} \hat{\beta}_i SS_i + \sum_{j=1}^{6} \hat{\gamma}_j SC_j \right)
\end{aligned}
\qquad \textbf{(3)}
$$

where MT is the maximum daily temperature and $Pdl(0)_t$ and $Tdl(0)_t$ represent contemporaneous deviations from the conditional means, respectively.

Various lags of mean adjusted precipitation and temperature variables are used as explanatory variables in the demand model. These variables are also multiplied by low frequency harmonics and used as interaction variables to allow the model to have flexible coefficients for weather variables throughout the year. This allows the demand model to correctly reflect the effect of changes in precipitation and temperature on demand when they matter, that is, more impact during the peak season and less in winter. In addition, the number of consecutive days without precipitation adjusted for conditional mean is included to reflect the impact of dry spells on demand. This variable is also multiplied by low frequency harmonics, used as interaction variables, to allow for flexible coefficients.

1.3.Indicator variables

There are variations in daily demand, which are not associated with seasonal, weather, economic, or demographic factors. For instance, depending on the customer composition of the service area, demand might drop or rise on weekends and holidays. Usually, one would see a drop in weekend demand when water consumption by nonresidential customer classes comprise a considerable part of the overall demand. This is due to the fact that most public and private work places, schools, and institutions are closed on weekends and holidays and therefore do not use as much water as they do during weekdays.

These variations are represented by indicator or dummy variables in the demand model. Weekend dummy variable takes the value of one (1) for Saturday and Sunday and zero (0) for the rest of the week. Weekend variable is also interacted with the low frequency harmonics to allow seasonal flexibility for the coefficients. Holidays are represented by a series of dummy variables that take the value of one (1) on the days of observance and zero (0) otherwise. Short-term data anomalies as a result of meter malfunction with known periods of occurrences are also handled by a set of daily or monthly dummy variables.

1.4.Demographic, economic, and trend variables

Total demand for water is affected by a variety of demographic and economic factors. Overall, factors that could cause a downward trend in total demand are increases in water and sewer rates, 1992 plumbing fixture code changes for new homes, change in the conservation attitude of customers, impact of conservation programs, changes in land-use, and slowdown in the economy. Positive growth in population, the economy, and income could cause increases in total demand over time. Population and a proxy for the price of water are used to represent demographic and economic factors that could contribute to long-term trend.

Other factors that affect long-term trend are depicted by low frequency harmonics. These variables are generated in a fashion similar to the seasonal variables; however, their phase of oscillation occurs over the period of the data used in the demand model for estimation of the coefficients. The variables are generated as

$$LTS_{it} = \sin\left(\frac{2\pi it}{DD}\right) \text{ and } LTC_{it} = \cos\left(\frac{2\pi it}{DD}\right) \qquad \textbf{(4)}$$

where *i* is the number of cycles within the data period, *t* is the day number in the data period,

and *DD* is the total number of days in the data used in the demand model.

1.5.Functional form

A linear functional form is used to explain the variations in daily demand in terms of the explanatory variables discussed above. Equation **(6)** shows the compact representation of the functional form.

$$\ln(D) = \alpha + \beta S + \gamma W + \delta \ln(Pop) + \varepsilon \ln(Pr) + \theta I + \omega LT + u \qquad \textbf{(6)}$$

where D is daily demand in millions of gallons. S and W are Seasonal and Weather variables as explained in the above. Pop and Pr are population served and price respectively. I are indicator variables representing various factors that affect demand such as weekends, holidays, etc. LT are the long-term trend variables that explain effect of factors such as land-use, conservation, and changes in the demand attitude that are not captured by the implicit variables in the model. a , b, g, d, e, q, and w are the unknown coefficient vectors to be estimated and u is the error term with Gaussian properties.

2.0 THE DATA

Daily production data at Headworks are available from the Supervisory Control and Data Acquisition (SCADA) systems. Production data measure the amount of water supplied to all retail customer classes and wholesale customers plus the unbilled and unaccounted-for water in millions of gallons per day. The daily production data are available since 1960. Data for the 1980-2015 period were used for the estimation of the demand model. The accuracy of the production data is more reliable for this period and the trend in demand is more in line with the changes in demand as a result of conservation and land-use.

The historical population for the retail service area and the service areas of the wholesale customers have been provided by the Population Research Center (PRC) at Portland State University. The population numbers for the wholesale service areas have been adjusted for the water that the wholesale customers obtain from sources other than the PWB.

Since aggregate demand covers all retail and wholesale customers, there are no single rates or rate structures that can be used in the demand model. Instead, annual revenue per million gallons, adjusted for inflation, is used as a proxy for price. The coefficient of the price variable measures the price elasticity of demand, which is the degree of response to price changes by all customers.

Total daily precipitation and maximum daily temperature, measured at the Portland Airport weather station, are available since 1940, by Oregon Climate Service. The weather data are used to generate the explanatory weather variables, which are used in the demand model.

3.0 REGRESSION RESULTS

Results of the regression model estimation are presented in Table 1, where the explanatory variables are defined as:

S(i) and C(i) are seasonal variable of different sine and cosine frequencies,

D_WKND is the dummy variable for weekends,

D_NYD, D_MEMD, D_JUL4, D_LBD, D_VETD, D_TG, and D_XMAS are dummy variables for New Year, Memorial, Independence, Labor, Veterans, Thanksgiving, and Christmas days respectively,

NPD is the number of consecutive days without rain,

P_DL(i) are daily precipitation variables with different lags,

T_DL(i) are maximum daily temperature variables with different lags,

Pop is the retail and wholesale population served by PWB sources.

Pr is the annual revenue per million gallons.

D_ECii are annual dummy variables representing changes in demand that could be attributed to the economy, land-use, or other factors that impact demand that are not presented by specific variables.

D_CONS92 is a dummy variable representing the 1992 building code changes of water fixtures.

D_Y92(Jul, Aug, Sep) are dummy variables depicting the reduction in demand as a results 1992 mandatory curtailment.

D_WIN07 is a dummy variable representing the data anomaly in winter of 2007.

C(i)_jj12 and S(i)_jj12 are the long-term cyclical trend sine and cosine wave variables over the 1993-2012 period for PWB retail and 1983-2012 period for Wolf Creek depicting impact of the economy, rates, conservation, land use, etc.,

C is the constant term, and

AR(i) are the error correction terms for autocorrelation.

The model shows a strong relationship between daily demand and the explanatory variables. The adjusted R^2 is 0.89, which is rather high for daily demand data. Initial run of the model demonstrated autocorrelation among the error terms. First order AR was added for error correction. The AR term is significant and the Durbin-Watson statistics shows that the autocorrelation problem is resolved. Moreover, all coefficients have proper signs.

Table 1. Aggregate demand regression model.

Dependent Variable: Daily Aggregate Demand														
Variable	**Coeff.**	**Std. Error**	**t-Statistic**	**Prob.**	**Variable**	**Coeff.**	**Std. Error**	**t-Statistic**	**Prob.**	**Variable**	**Coeff.**	**Std. Error**	**t-Statistic**	**Prob.**
S1	-0.0990	0.0021	-47.7712	0.0000	T_DL3*C1	-0.0587	0.0112	-5.2226	0.0000	P_DL4*S2	-0.0137	0.0078	-1.7524	0.0797
C1	-0.1998	0.0020	-100.1644	0.0000	T_DL4	0.0340	0.0082	4.1515	0.0000	P_DL5	-0.0322	0.0047	-6.8875	0.0000
S2	0.0871	0.0019	46.1455	0.0000	T_DL4*C1	-0.0567	0.0113	-5.0178	0.0000	P_DL5*C1	0.0365	0.0064	5.7326	0.0000
C2	0.0562	0.0019	29.7888	0.0000	T_DL4*C2	-0.0243	0.0112	-2.1613	0.0307	P_DL6	-0.0303	0.0049	-6.1529	0.0000
S3	-0.0264	0.0019	-14.2137	0.0000	T_DL6	0.0284	0.0079	3.6010	0.0003	P_DL6*C1	0.0341	0.0067	5.1053	0.0000
S4	0.0058	0.0019	3.0550	0.0023	T_DL6*C1	-0.0551	0.0103	-5.3258	0.0000	P_DL6*C2	-0.0032	0.0061	-0.5131	0.6079
C5	0.0063	0.0018	3.4354	0.0006	T_DL6*S1	-0.0349	0.0113	-3.0787	0.0021	LOG(POP)	1.0385	0.0637	16.2975	0.0000
C6	-0.0078	0.0019	-4.2340	0.0000	T_DL6*C2	-0.0076	0.0109	-0.6907	0.4898	LOG(Pr)	-0.1812	0.0568	-3.1885	0.0014
D_WKND	-0.0312	0.0016	-19.4976	0.0000	P_DL0	-0.0380	0.0059	-6.4700	0.0000	D_CONS92	-0.0532	0.0104	-5.0908	0.0000
D_WKND*C1	0.0043	0.0023	1.9001	0.0574	P_DL0*C1	0.0425	0.0077	5.5046	0.0000	D_Y92JUL	-0.2611	0.0187	-13.9538	0.0000
D_WKND*S1	0.0019	0.0023	0.8255	0.4091	P_DL0*S1	0.0290	0.0082	3.5449	0.0004	D_Y92AUG	-0.3143	0.0432	-7.2720	0.0000
D_NYD	-0.0150	0.0133	-1.1308	0.2582	P_DL0*C2	-0.0183	0.0071	-2.5685	0.0102	D_Y92SEP	-0.1924	0.0362	-5.3129	0.0000
D_MEMD	0.0009	0.0113	0.0832	0.9337	P_DL0*S2	-0.0209	0.0075	-2.8021	0.0051	D_WIN07	-0.1112	0.0181	-6.1321	0.0000
D_JUL4	-0.0381	0.0112	-3.3969	0.0007	P_DL1	-0.0623	0.0056	-11.1573	0.0000	D_EC01	-0.0604	0.0137	-4.4129	0.0000
D_LBD	0.0182	0.0128	1.4236	0.1546	P_DL1*C1	0.1014	0.0074	13.6217	0.0000	D_EC02	-0.0591	0.0160	-3.6952	0.0002
D_VETD	0.0200	0.0178	1.1192	0.2631	P_DL1*S1	0.0568	0.0081	7.0160	0.0000	D_EC03	-0.0618	0.0197	-3.1419	0.0017
D_TG	-0.0314	0.0097	-3.2538	0.0011	P_DL1*C2	-0.0328	0.0073	-4.4872	0.0000	D_EC04	-0.0605	0.0220	-2.7494	0.0060
D_XMAS	-0.0383	0.0082	-4.6884	0.0000	P_DL1*S2	-0.0433	0.0074	-5.8825	0.0000	D_EC05	-0.0585	0.0236	-2.4795	0.0132
NPD_R	0.0025	0.0004	6.3859	0.0000	P_DL2	-0.0464	0.0064	-7.2999	0.0000	D_EC06	-0.1212	0.0236	-5.1425	0.0000
NPD_R*C1	-0.0005	0.0004	-1.0848	0.2780	P_DL2*C1	0.0842	0.0086	9.7675	0.0000	D_EC07	-0.1264	0.0313	-4.0429	0.0001
NPD_R*S1	0.0011	0.0004	2.5144	0.0119	P_DL2*S1	0.0443	0.0087	5.0665	0.0000	D_EC08	-0.1755	0.0345	-5.0807	0.0000
T_DL0	0.2033	0.0082	24.8048	0.0000	P_DL2*C2	-0.0303	0.0076	-3.9741	0.0001	D_EC09	-0.1660	0.0444	-3.7413	0.0002
T_DL0*C1	-0.2733	0.0108	-25.3476	0.0000	P_DL2*S2	-0.0386	0.0083	-4.6627	0.0000	D_EC10	-0.2127	0.0494	-4.3048	0.0000
T_DL0*S1	-0.0566	0.0120	-4.7258	0.0000	P_DL3	-0.0406	0.0059	-6.8404	0.0000	D_EC11	-0.2480	0.0549	-4.5186	0.0000
T_DL0*C2	0.0616	0.0106	5.8119	0.0000	P_DL3*C1	0.0620	0.0073	8.4601	0.0000	D_EC12	-0.2474	0.0590	-4.1945	0.0000
T_DL0*S2	0.0408	0.0109	3.7325	0.0002	P_DL3*S1	0.0321	0.0089	3.6153	0.0003	D_EC13	-0.2709	0.0586	-4.6239	0.0000
T_DL1	0.1172	0.0082	14.3770	0.0000	P_DL3*C2	-0.0109	0.0072	-1.5072	0.1318	D_EC14	-0.2725	0.0615	-4.4314	0.0000
T_DL1*C1	-0.1636	0.0107	-15.3511	0.0000	P_DL3*S2	-0.0265	0.0084	-3.1549	0.0016	D_EC15	-0.3123	0.0647	-4.8248	0.0000
T_DL1*S1	-0.0710	0.0121	-5.8815	0.0000	P_DL4	-0.0395	0.0060	-6.5692	0.0000	C1_8015	0.0397	0.0114	3.4673	0.0005
T_DL1*S2	0.0261	0.0106	2.4600	0.0139	P_DL4*C1	0.0580	0.0077	7.4892	0.0000	S1_8015	0.0678	0.0076	8.9408	0.0000
T_DL2	0.0590	0.0082	7.1883	0.0000	P_DL4*S1	0.0349	0.0079	4.4072	0.0000	C	-8.0572	0.9152	-8.8035	0.0000
T_DL2*C1	-0.0889	0.0113	-7.8333	0.0000	P_DL4*C2	-0.0190	0.0068	-2.7887	0.0053	AR(1)	0.4611	0.0048	95.5649	0.0000
R-squared				0.8885	Mean dependent var				4.6748					
										Independent variables = 94				
										Seasonal = 7				
										Weather = 52				
										Weekend and holidays = 10				
										Economy and trend = 17				
Prob(F-statistic)				0.0000										

The population coefficient is 1.03, which indicates that a 1% increase in population results in a little bit more than 1% increase in daily demand for water. Long-term trend, conservation, and economy variables capture the impact of conservation, land-use, and other factors that result in the downward trend in demand. Coefficient of price has the negative sign and estimates a price elasticity of 0.18 that indicates 1.8% drop in demand as a result of a 10% increase in price. The dummy variable representing weekends, along with its interactions with the harmonics, show percent drop in demand that is higher during the peak season. Holiday dummy variables for New Year, Independence, Thanksgiving, and Christmas Days are all negative and statistically significant. Dummy variables for the Memorial, Labor, and Veterans Days are positive but statistically notsignificant.

Coefficients of the seasonal variables are all significant and depict the seasonal variations in the daily demand. The weather variables, although all significant, have different levels of influence on demand. In general, model results indicate that temperature has a higher effect on daily demand than precipitation. As expected, the weather variables that are interacted with the harmonics make the effect of unseasonable rain and temperature less pronounced.

3.1.Decomposition of the effects

One of the features of the model is that the variations in demand can be decomposed into the effects of different variables. For instance, the linear combination of all seasonal variables, as estimated by the demand equation, shows the seasonal variations in demand. By adding the linear combination of the weather variables to that of seasonal, the peaking behavior can be demonstrated. The antilog of the linear combination of all variables except for the weather variables, gives us the weather-normalized demand with seasonal variation. For simulation purposes also, weather effect from any weather year can be added to the weather normalized demand of any specific year. This would make it possible to simulate demand for a specific year with a historical sample of weather effects and explore demand under the best and worst case weather conditions.

4.0 FORECASTING

In order to use the demand model as a forecasting tool, data on the future values of the explanatory variables are required. The seasonal and weekend variables are predetermined. Some of the indicator variables like conservation can be judgmentally determined as to what value they should take in the future. One can also decide about the effect of the long-term cyclical trend variables. However, the model needs future values of population and price for weather-normalized demand forecasts. Effect of any ongoing or future conservation and land-use need to be determined ex-post and outside of the demand model. For this the Residential End Use demand model, discussed in the "Conservation and land-use impact" section 4.4 below is used, which only applies to the retail service area demand.

The forecast horizon for the Supply System Master Plan (SSMP) is 20 years, but these demand projections cover the period 2018-2045. The population forecasts provided by PRC are used to

project future demand. The wholesale populations are adjusted for seasonal offloads and the assumptions regarding the future wholesale contracts (see Tech Memo 3.2). Annual rates of increase in price, provided by Finance group, are used to project price over the forecast horizon. The projected annual rates of increase in price proxy (revenue per millions of gallons sold to retail and wholesale customers adjusted for inflation) are: 7% over 2017-2021, 5% over 2022-2031, and 3% over 2031-2045.

4.1. Demand under historical weather

In order to identify the years that weather driven demand causes stress on the supply system, aggregate demand under historical weather patterns are simulated. The weather variables of the demand model estimate the variation in demand on each day of the historical weather years during the 1940-2015 period. The daily weather effects are applied to the 2017 weather-normalized demand forecasts to simulate demand under 1940-2015 weather conditions. Various demand metrics such as peak day and peak 3-day, peak season average day, annual average day, and average day off-season demands are computed to determine which demand weather years are the most stressful on the supply system. The simulations show that 1981 peak day and peak 3-day demand and 1967 peak season average day and annual average day demand are the most stressful on the system.

4.2. Forecast Evaluation

The usual statistics that result from running the regression equation normally report the fit of the model and how significant the coefficients of the explanatory variables are. However, to evaluate the quality of forecast we need to compute different types of statistics. The one that is used in this study is Mean Absolute Percentage Error (MAPE) of the forecast. The advantage of this statistic is that it is scale-indifferent and easy to explain. It is defined as

$$MAPE = \frac{1}{N} \sum_{t=1}^{N} \left| \frac{\hat{D}_t - D_t}{D_t} \right|$$

where $\hat{D}$ and D are Forecast and Actual demands respectively and $t = 1,...., N$ is the forecast period.

MAPE for daily forecast over the 1980-2015 period is 6.3%. The accuracy is increased when MAPE is computed for monthly and annual average demand. Over the same period, MAPE computed for monthly and annual average are 3.5% and 1.2% respectively. Daily variations in demand are mainly determined by the weather, therefore, any daily demand behavior that is not weather related adds to the inaccuracy of the forecast. For instance, some wholesale customers start filling their reservoirs in advance when they predict hot days ahead. These types of reservoir operations lower the sensitivity of demand and the demand model to daily weather variations.

4.3.Climate impact

PWB used five global climate models (GCMs) downscaled by the University of Idaho (UI) for the Portland area as input data for the demand model. These five models were rated highly by UI for representing weather conditions in the Pacific Northwest. These models were used to recreate 30 years of historical air temperatures and precipitation, and to estimate 30 years of future air temperature and precipitation. The data set from each GCM was used to generate demand projections specific to that GCM.

The demand model coefficients along with climate predictions of 5 GCMs were used to estimate the long-term climate impact on demand over 1950-2005 and 2016-2045 periods. First, the auxiliary regression equations were used to establish the conditional mean for temperature, precipitation, and number of consecutive days without precipitation. The simulated historical climate, as projected by each GCM, was used for the 1950-2005 period. Then, the same set of weather variables was generated based on the simulated historical climate projections and their conditional means. Next, weather coefficients were applied to weather variables to estimate the daily weather effect on demand based on the simulated historical climate projections. In the next step, simulated future climate projections were used to generate the same set of weather variables for the 2016-2045 period. However, these variables are in terms of deviations from the conditional means established for the simulated historical projections. Applying the weather coefficients to these variables estimates the weather effect under the changed climate projections relative to the simulated historical projections for each GCM. Climate projections of each GCM for the two periods are applied to 2017 weather-normalized demand forecasts. Then, averages of the various demand metrics were computed for the two periods. The differences between the two sets of demand metrics over the 1950-2005 and 2016-2045 periods measure the long-term change in demand due to climate change according to each GCM over the two periods. Comparing the demand metrics allows us to choose the GCMs that lead to demand conditions that put the most stress on the supply system.

The percent difference between the historical period and the future period was then used to estimate the effect of climate change on demand for each GCM and each metric. Of the five GCMs, the GCM with the largest effect on the metric was used to define the percent change for that metric for the results presented in this memo. Calculated percent changes were as follows for aggregate demand (retail and wholesale) are shown in Table 2.

Table 2. Calculated GCM percent changes for aggregate demand.

	HadGEM2-ES	GFDL-ESM2M	CanESM2	CSIRO-Mk3-6-0	CNRMCM5	Maximum Effect
ADD	2.80%	2.07%	2.83%	2.17%	1.76%	2.83%
SAD	5.70%	4.66%	6.17%	4.87%	3.68%	6.17%
WAD	0.79%	0.23%	0.51%	0.25%	0.39%	0.79%

	HadGEM2-ES	GFDL-ESM2M	CanESM2	CSIRO-Mk3-6-0	CNRMCM5	Maximum Effect
PDD	3.16%	5.30%	5.13%	3.94%	1.51%	5.30%
P3D	3.67%	5.04%	5.07%	4.08%	1.85%	5.07%

Climate change is anticipated to have an increasing effect on air temperature and precipitation over time. The rate and pattern of change during the SSMP planning horizon is not yet known, and year to year variability is still expected to occur. As a simplifying assumption, PWB applied the percent change as follows: the effect at year one, 2018, was defined as zero and the effect at 2045 was defined as 100 percent of the calculated percent difference. The effect is then gradually increased, in a linear progression, from 0 to 100 percent. So, if the percent change for peak season daily demand (historical compared to future) was 6 percent, then the climate effect on demand in 2018 was zero and in 2045 was 6 percent.

It is important to note that this procedure assumes that no aggressive adaptation action to reduce water use in response to climate change (in addition to current water efficiency trends) occurs over time. In that respect, the climate impact projections on demand could represent an over-estimate of demand response under each GCM projection. It is not known, however, if actual changes in air temperature and precipitation will be similar to, less than, or maybe even greater than the GCMs selected for thisanalysis.

4.4.Conservation and land-use impact

Downward trend in demand could be attributed to passive and programmatic conservation, changes in land-use and increases in price of water and sewer. The impact of price of water is estimated in the demand model directly and is reflected in the demand forecasts. The impact of conservation and land-use, however, are not directly estimated in the demand model, and therefore not projected into the future.

A residential end-use model was developed recently by Aquacraft based on the Water Research Foundation study 4309b, Residential End Use of Water, Version 2 (2016). The model can be used to forecast single and multifamily residential demand. It has parameters on water savings of various water fixtures and appliances and customer behaviors that are used in the embedded mathematical equations to adjust demand. The parameters of the model are based on the national survey and the estimated mathematical equations are based on the national data collected for the study. The parameters were developed for both single and multifamily residential customers. The model can be used to forecast residential demand under various conservation scenarios. PWB has purchased the model for the purpose of estimating future water savings that come as a result of passive and programmatic conservation and changes in land-use.

Aquacraft used the available information from PWB and augmented itwith information from Tacoma, which was part of the WRF study, in order to fit the model for PWB's demand forecasting purposes. Tacoma was deemed to be the closest surrogate for the PWB service area among the utilities that participated in the WRF 4309bstudy.

Historical PWB billing data are used to calibrate the parameters of the model. The calibration process is to change the parameters so that the model can generate single and multifamily demand levels that are close to the actual. The calibrated parameters are used to initialize the model for demand forecast. The residential end use demand model allows changes to the parameters over the forecast horizon based on assumptions made about the future changes in technology, land-use, and conservation behavior of the customers. The difference between the baseline forecasts with no changes in the initial parameters and the forecasts with parameters changed based on conservation assumptions, estimates the future savings by the residential classes in the PWB retail service area. Moreover, baseline demand forecasts with no new multifamily development compared with the demand forecasts that incorporate new multifamily development forecasts by the PRC, estimates the impact of changes in land-use on demand.

Two conservation scenarios based on the best guesstimates and conjectures by the Water Efficiency group were considered. Scenario 1 is in line with the recent trends in demand and mainly shows the continued impact of passive conservation and 1992 building code changes. Scenario 2 assumes more aggressive water efficiency programs, more inclination to save water on the part of customers, and smaller and more water efficient landscapes. The estimated savings from changes in land-use, pertaining to retail service area new multifamily development, and conservation Scenarios 1 and 2, are used to adjust the aggregate demand forecasts projected by the econometric demand model.

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Appendix B. Characterization of Supplies for Selection of Filtration Capacity

To: Executive Committee

From: Christopher Bowker

CC: Yone Akagi, Terry Black, Michelle Cheek, Kimberly Gupta, Jodie Inman, Jonathan Johnson, David Peters, Tony Re, Mike Saling, Janet Senior, Rich Seright

Date: April 9, 2018

Re: Characterization of Supplies for Selection of Filtration Capacity

EXISTING SUPPLY USES

The purpose of this memo is to characterize the anticipated role of groundwater in the future as filtration of the Bull Run is implemented. The Bull Run is the primary source of water for the City of Portland (City). The Watershed Program programmatic service level (PSL) 1 identifies the Bull Run as a primary source and states that the Bull Run watershed is expected to provide 95% or more of the City's annual water supply. When additional supply has been needed, the Columbia South Shore Well Field (CSSWF) has been used as a secondary supply to meet those demands. The groundwater supply is used under the following conditions.

- Summer supply augmentation – Groundwater is used to augment the Bull Run supply when the Bull Run water supply is insufficient to meet the combined drinking water and regulated fish flow demands of the summer season. Between 1985 and 2016, groundwater has been used fifteen times for supply augmentation, most notably in 1987 (5.3 BG) and 2015 (5.8 BG).

- Turbidity – Groundwater is used to blend with or replace, the Bull Run supply when turbidity levels increase in the Bull Run supply beyond levels allowed by regulations. Between 1985 and 2016, groundwater has been used ten times due to turbidity - eight times as a replacement and two times to blend with the Bull Run supply.

- Augmentation during maintenance or repairs on the Bull Run supply – Groundwater can be used during times when the Bull Run supply system is either down or operating at limited capacity due to maintenance (planned or unplanned). This includes events such as July 2014 when one of the conduits had to be shut down for emergency repairs during a high demand period.

- System readiness – Since 2008, Operations has completed annual maintenance runs of the groundwater system. The purpose of the maintenance runs is to exercise wells, booster pumps, and the treatment system, as well as to maintain operator training. This approach increases system readiness by identifying equipment problems and repairing

them prior to an unplanned need or emergency. Routine maintenance runs also enhance staff training and readiness.

- Emergency – Groundwater will also serve as a backup supply during catastrophic events that affect Bull Run such as severe or extended drought, fire in the watershed, flood, landslide, volcanic activity, or earthquake. Groundwater has been used once in this capacity in 1995 when a landslide damaged the conduits and required the Bull Run supply to be shut down. The Eagle Creek fire and elevated *Cryptosporidium* levels are additional examples of events that could require shutdown of the Bull Run supply, either due to danger to staff operating Headworks or due to water quality impacts in the water supply drainage.

Future Supply Uses

After meeting with the Executive Committee and after discussing the subject further at the Filtration Education Workshop, it is the team's understanding that groundwater will continue to be used as it has been used in the past. The Bull Run will continue to be the primary source of water for the City. Groundwater will continue to be used as a supplemental source for the situations described above.

With the addition of filtration, the Bull Run supply will be managed and designed to meet at least average summer season demands in the future. Filtration is expected to reduce Bull Run system shutdowns due to turbidity. Design of the filtration facility, and particularly pretreatment, will determine the degree to which turbidity is no longer a factor in future groundwater operation. Otherwise, groundwater will continue to be used as it has been in the past. The Bureau will not size the Bull Run filtration facility in such a manner that would require routine annual use of groundwater to meet average summer season demands.

Specific decisions regarding usage of groundwater to augment summer supply would continue to be made as part of implementing the Summer Supply Plan, which provides a comprehensive strategy for augmenting PWB's baseline water resources, if needed, during the peak demand season.

Appendix C. Cost Curves for Granular Media Filtration

Draft: Cost Curves for Granular Media Filtration

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PREPARED BY:	Lee Odell Enoch Nicholson
DATE:	April 11, 2018
PROJECT NUMBER:	699275.01.03
REVIEWED BY:	Bob Chapman
APPROVED BY:	Kelly Irving

Summary Information

Cost estimates and evaluation criteria metrics are presented in Table 1 for granular media direct filtration for water treatment plant (WTP) capacities of 115, 145, and 160 million gallons per day (mgd).

Values provided are for a typical granular media direct filtration WTP and do not represent data or cost of a facility for the Bull Run Supply. The information in this technical memorandum is solely for comparative purposes. Any resemblance to actual conditions is simply coincidental. They do not include soft costs such as engineering, construction management, permitting etc.

Table 1. Granular Media Direct Filtration Costs and Measures for Water Treatment Plant

	Capacity		
Item	**115 mgd**	**145 mgd**	**160 mgd**
Construction cost	$215,600,000	$253,940,000	$275,720,000
Annual operations and maintenance	$9,827,000	$11,664,000	$12,598,000
25-year life-cycle cost	$402,823,000	$476,259,000	$515,847,000
Cost per CCF delivered*	$0.44	$0.52	$0.56
Electrical usage (megawatt-hours per year)	10,024	12,370	13,677
Residuals (cubic yards per year)	3,628	3,628	3,628
Truck trips during construction	97,133	115,976	122,806
Truck trips per year	682	741	781
Fuel consumption (gallons during construction)	218,276	260,620	275,969
Fuel consumption (gallons per year)	3,831	4,163	4,388
Chemicals (dry tons per year)	6,946	7,808	8,238

*CCF is hundred cubic feet. Includes construction costs and annual operations and maintenance costs.

Introduction

The cost estimating guidance presented in this technical memorandum (TM) was developed by an Excel-based conceptual parametric estimating system (CPES). This guidance supports development of a Class 5 cost estimate, as defined by the Association for the Advancement of Cost Engineering International (see Attachment A for more information). Class 5 cost estimate is provided with very little project definition (0-2%) and is used for concept screening. Refer to the attachment for more information on costs estimate classes.

Granular media filtration was selected for the type of WTP since that is the most common treatment technology used in large WTPs in North America.

Table 2 presents the capital cost elements included in this guide and estimating steps. Guidance is provided thereafter for each cost element presented in Table 2. The overall process flow diagram is shown in Figure 1.

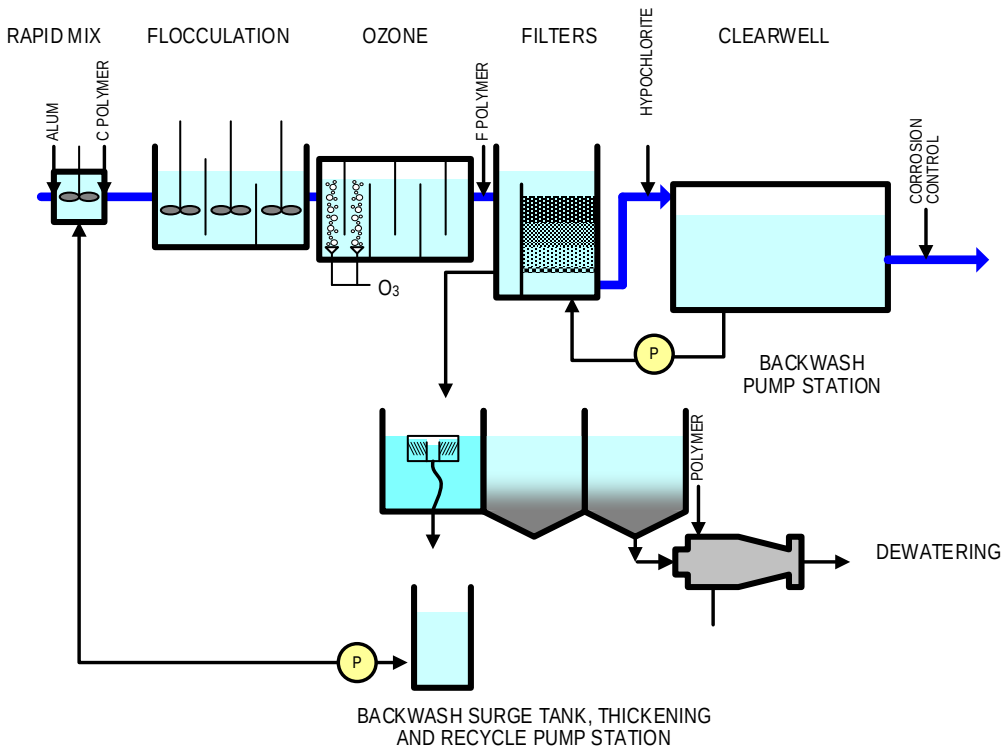


Figure 1. Direct Granular Media Filtration Process Flow Diagram

Figures 2 through 10 (provided at the end of this TM) show granular media filtration construction cost curves, annual O&M cost curves, energy use curves, annual residual production cost curves, number of truck trips during construction, number of truck trips annually, fuel consumption during construction, annual fuel consumption, and annual chemical usage, respectively.

Table 2. Capital Cost Elements for Granular Media Direct Granular Media Filtration Plant Capacity Comparison

	Capacity		
Project Element	**115 mgd**	**145 mgd**	**160 mgd**
Rapid mix, type, No. trains	Turbine, 3	Turbine, 4	Turbine, 4
Flocculation, type, HRT, No. trains	HPW, 30, 6	HPW, 30, 6	HPW, 30, 8
Coagulant, type, average dose (mg/L)	Alum, 5	Alum, 5	Alum, 5
Coagulant aid polymer, type, average dose (mg/L)	Liquid, 0.75	Liquid, 0.75	Liquid, 0.75
Filter aid polymer type, average dose (mg/L)	Liquid, 0.1	Liquid, 0.1	Liquid, 0.1
Ozone generation capacity (lb/day)	2,880	3,630	4,005
Ozone contactors, No.	2	3	4
Media filter type	Sand/Anthracite	Sand/Anthracite	Sand/Anthracite
Media filter size (square feet)/No.	950/16	932/20	926/22
Media filter depth (sand/anthracite in inches)	12/60	12/60	12/60
Disinfection type, average dose (mg/L)	OSHG, 3	OSHG, 3	OSHG, 3
Clear well volume (MG)	11.6	14.5	16.0
Backwash pump station capacity (mgd)	34	34	33
Corrosion control chemicals, average dose (mg/L)	NaOH, 10	NaOH, 10	NaOH, 10
Surge basin volume (MG)	6.4	9.2	11.6
Sludge thickener (MG)	0.65	0.82	0.90
Sludge holding (MG)	0.4	0.5	0.6
Dewatering	Centrifuge	Centrifuge	Centrifuge
Does not include:			
Conveyance to site	Not included	Not included	Not included
Raw water pumping	Not included	Not included	Not included
Finished water pumping	Not included	Not included	Not included
Operations facilities	Not included	Not included	Not included
Overflow basins or containment	Not included	Not included	Not included

Alum = aluminum sulfate; HRT = hydraulic residence time; HPW = horizontal paddle wheel; lb/day = pounds per day; MG = million gallons; mg/L = milligrams per liter; mgd = million gallons per day; NaOH = sodium hydroxide; OSHG = onsite sodium hypochlorite generation.

Table 3 presents the site-wide allowances included within the water infrastructure component construction cost curves developed from CPES for WTPs, as these facilities include additional supporting infrastructure to enable the group of unit processes to perform in a secure environment. These allowances are based on actual constructed projects and experience for the cost of site grading, roadways, site secondary power distribution, site instrumentation and control signal transmission, and yard piping to interconnect the unit processes as a percentage of the total facility unit process component construction cost.

Table 3. Site-wide Allowances for Water Treatment Plant

Project Component	Allowance
Site grading, roadways, stormwater management	5%
Site electrical distribution (less primary & standby power provisions)	4%
Site yard piping	7.5%
Site I&C/SCADA network	5%
Total site-wide allowance	21.5%

I&C = instrumentation and control; SCADA = supervisory control and data acquisition.

Contractor Allowances

Construction contractor allowances include contractor overhead, markup, mobilization, bonds, and insurance. Table 4 presents the percentage of costs related to each of these additional construction costs. These allowances are based on CH2M Constructors, Inc., experience for traditional design-bid-build delivery projects. Certainly, these allowances will vary by project type and market conditions at the time of bidding. For this guide and resulting conceptual cost estimating tool, the total of 15 percent is a reasonable assumption.

Table 4. Construction Contractor Allowances

Allowance & Governing Subtotal	Cost Percentage
Overhead/general conditions allowance applied to project component cost subtotal	14%
Profit	5%
Mobilization/bonds/insurance allowance applied to project component subtotal	3.5%
Total contractor allowance	22.5%

Project Contingency

A 40 percent contingency is applied to the sum of the project component costs and contractor allowances to account for incomplete definition and design.

The following items are not assumed nor explicitly accounted for in the project component costs at this stage of conceptual cost estimating:

- Rock excavation
- Tunneling or boring
- Pile foundations
- Seismic foundations
- Shoring
- Soil contamination
- Dewatering conditions
- Environmental mitigation
- Weather impacts
- Depth of structures
- Local building code restrictions
- Coatings or finishes
- Building or architectural preferences

- Client material preferences
- Client equipment preferences
- Existing utilities interference
- System-wide I&C automation integration
- Primary electrical power source transmission and transformation
- Access and maintenance roadways

Construction Truck Trips and Fuel Consumption

The construction truck volumes were assumed to be 10 cubic yards for construction and residuals hauling. Average distance was estimated at 20 miles per trip. Fuel consumption was estimated at 8.9 miles per gallon.

Annual O&M Cost Estimate Preparation

Annual O&M cost includes the following elements:

- Labor
- Chemicals
- Power
- Residuals disposal

Chemicals, power, and ultimate residuals disposal are based on user input of both average annual day and maximum day design flow capacity, so the chemical usage, residuals production, and total connected horsepower, which are each sized for maximum day, can be proportionally reduced to represent average annual usage. Labor, as well as repair and maintenance materials, are considered fixed costs unrelated to flow rate.

Labor

Table 5 presents the assumed base staffing requirements and hourly rates for WTP based on a wide range of staffing philosophies across water utilities world-wide.

Table 5. Project Component Staffing Requirements and Rates

Project Component Staffing	Staffing Rates
One superintendent 8 hours per day, 5 days per week	$50/hour
Two operators onsite always	$30/hour
Two maintenance workers 8 hours per day, 7 days per week	$30/hour
One clerical worker 8 hours per day, 5 days per week	$20/hour
One lab worker 8 hours per day, 5 days per week	$20/hour

Chemicals

Table 6 presents the chemicals, average annual dose assumptions, and chemical unit costs associated with each WTP type, resulting in a total chemical cost per million gallons by WTP type. Chemical hauling distance is estimated at 50 miles.

Table 6. Project Component Staffing Requirements & Rates

Chemical	Unit Cost ($/dry ton)	Average Surface WTP Dose (mg/L)
Sodium hypochlorite	$1,500	3.0
Sodium hydroxide	$600	10
Aluminum sulfate	$450	5
Polymer	$2,500	0.75/0.1

Power

Power cost is based on a unit power rate of $0.0605 per kilowatt-hour.

Residuals Handling and Disposal

Residuals handling will include 100 percent liquid recycle with solids drying and disposal at a landfill. Hauling distance is estimated at 20 miles; disposal costs are estimated at $50 per cubic yard.

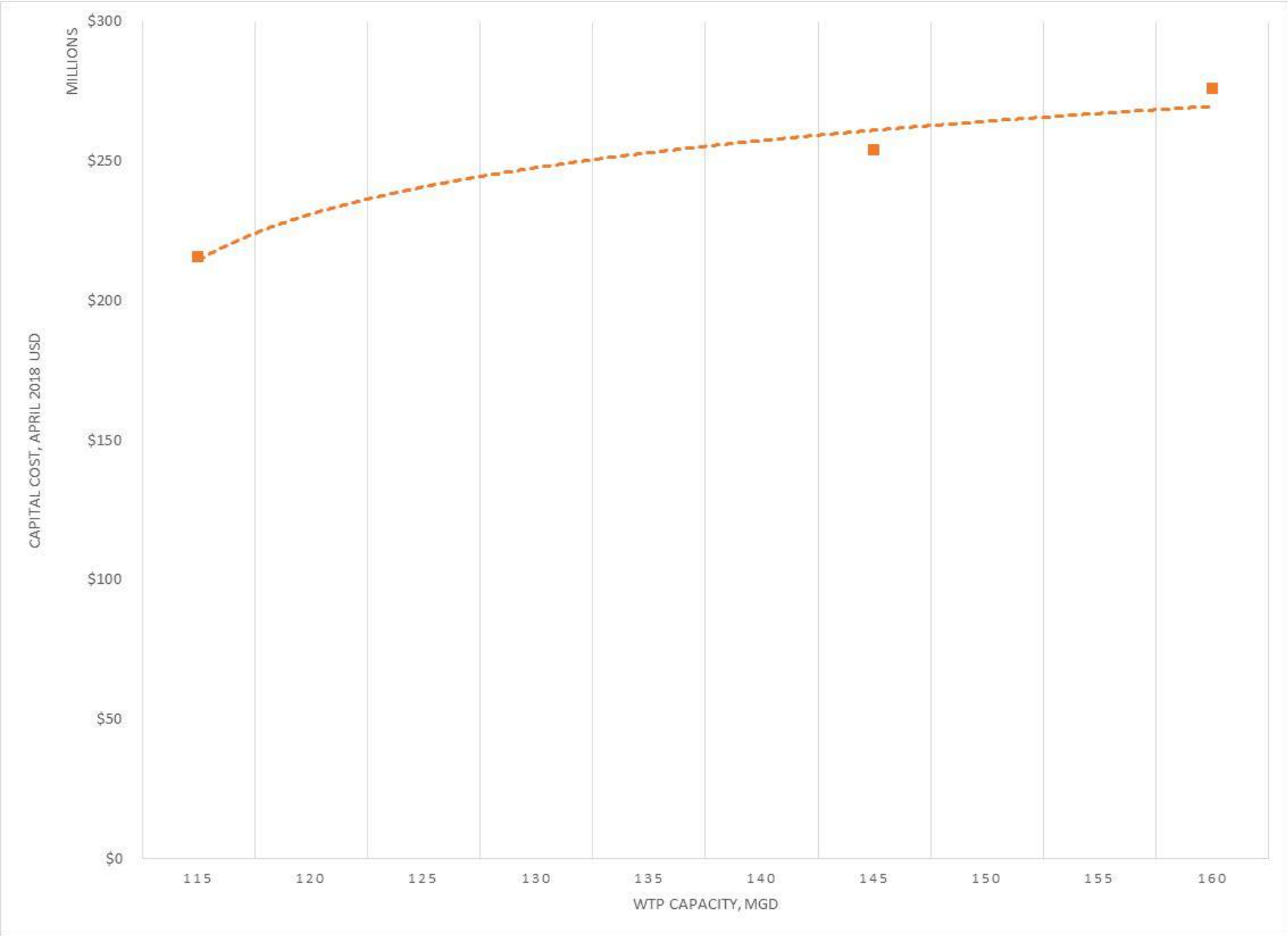


Figure 2. Draft Granular Media Filtration Cost Curve for Construction, Millions USD

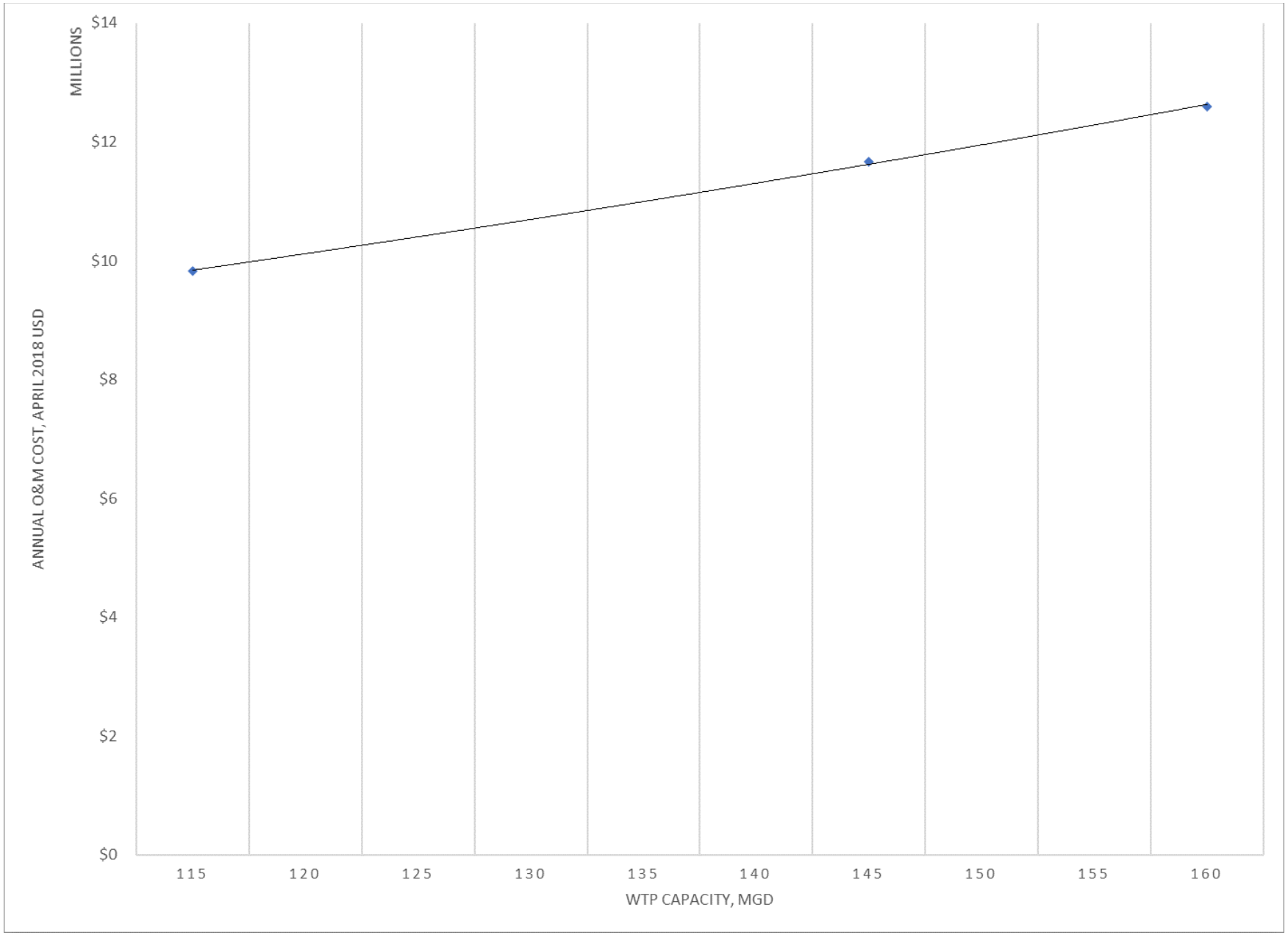


Figure 3. Draft Granular Media Filtration Cost Curve for Annual O&M, Millions USD

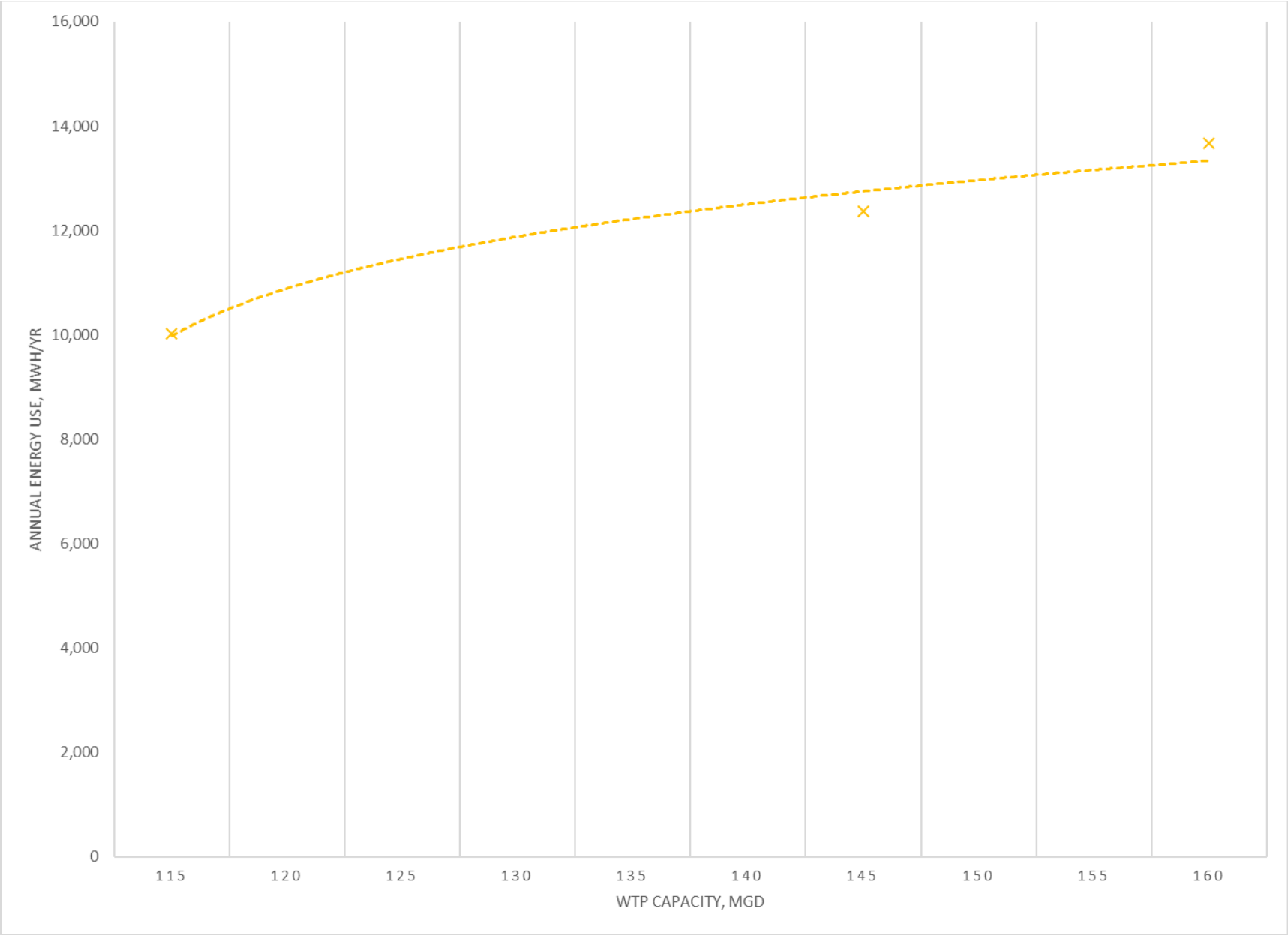


Figure 4. Draft Granular Media Filtration Curve for Annual Energy Use

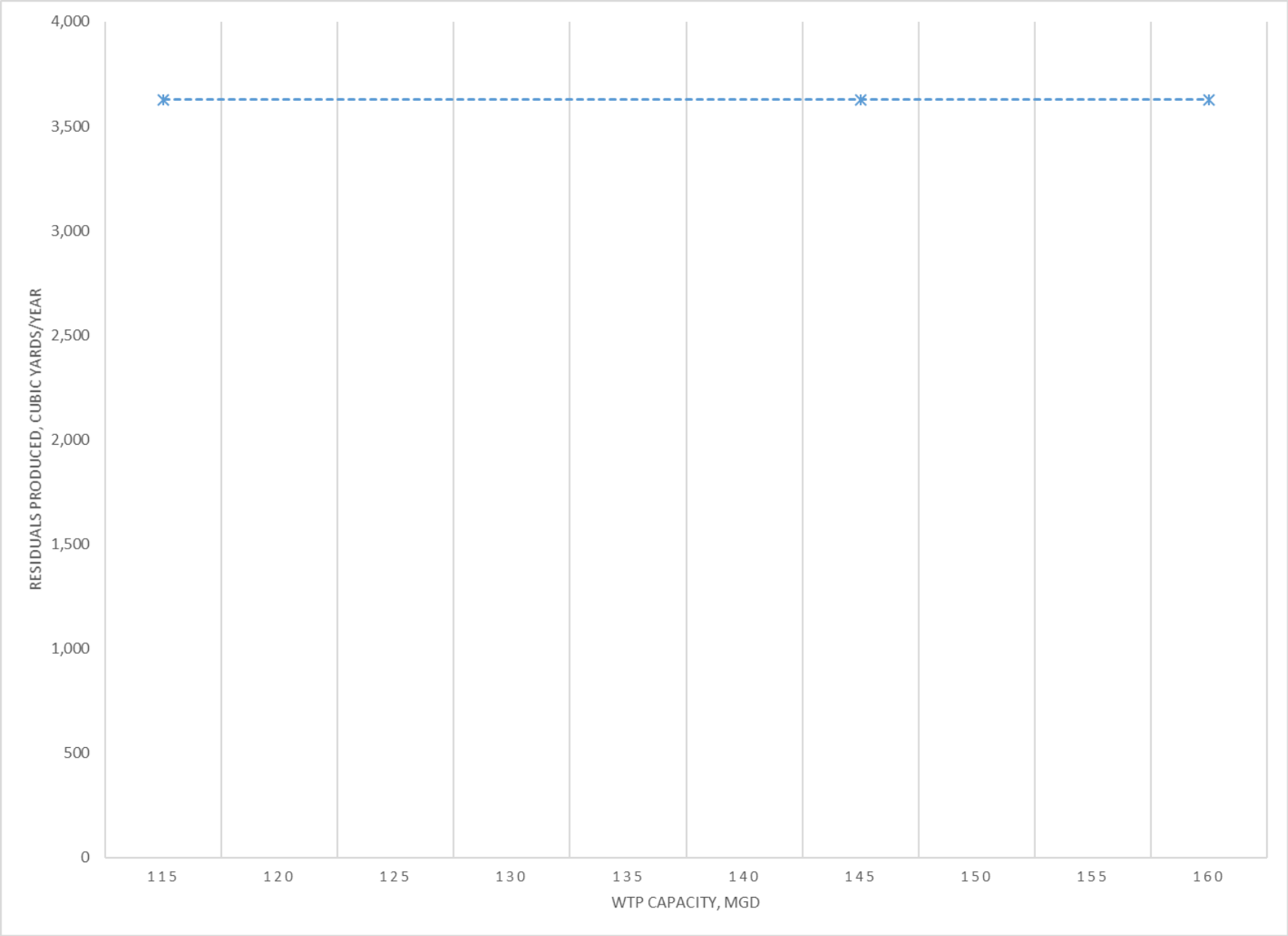


Figure 5. Draft Granular Media Filtration Curve for Annual Residuals Produced

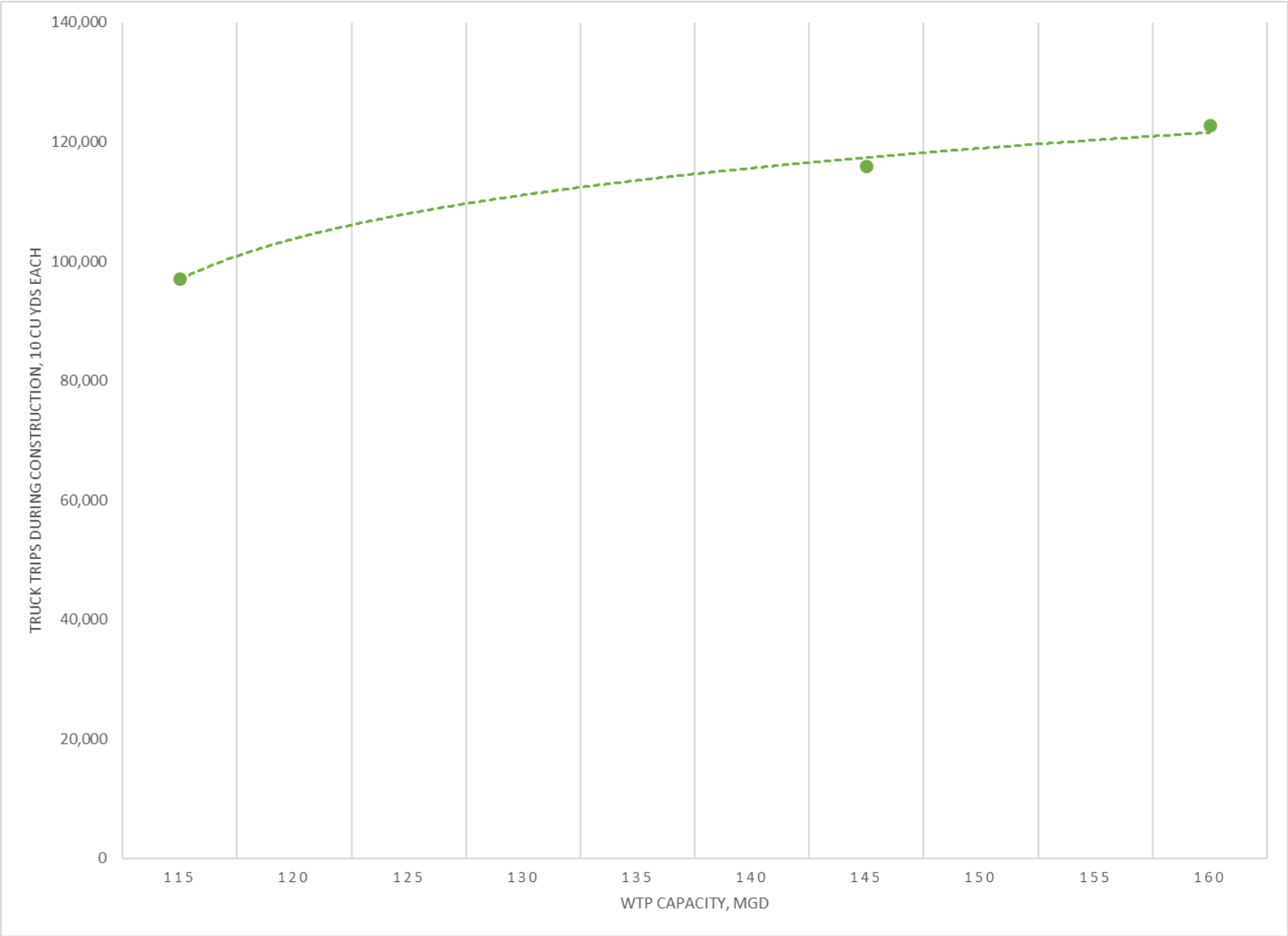


Figure 6. Draft Granular Media Filtration Curve for Truck Trips during Construction

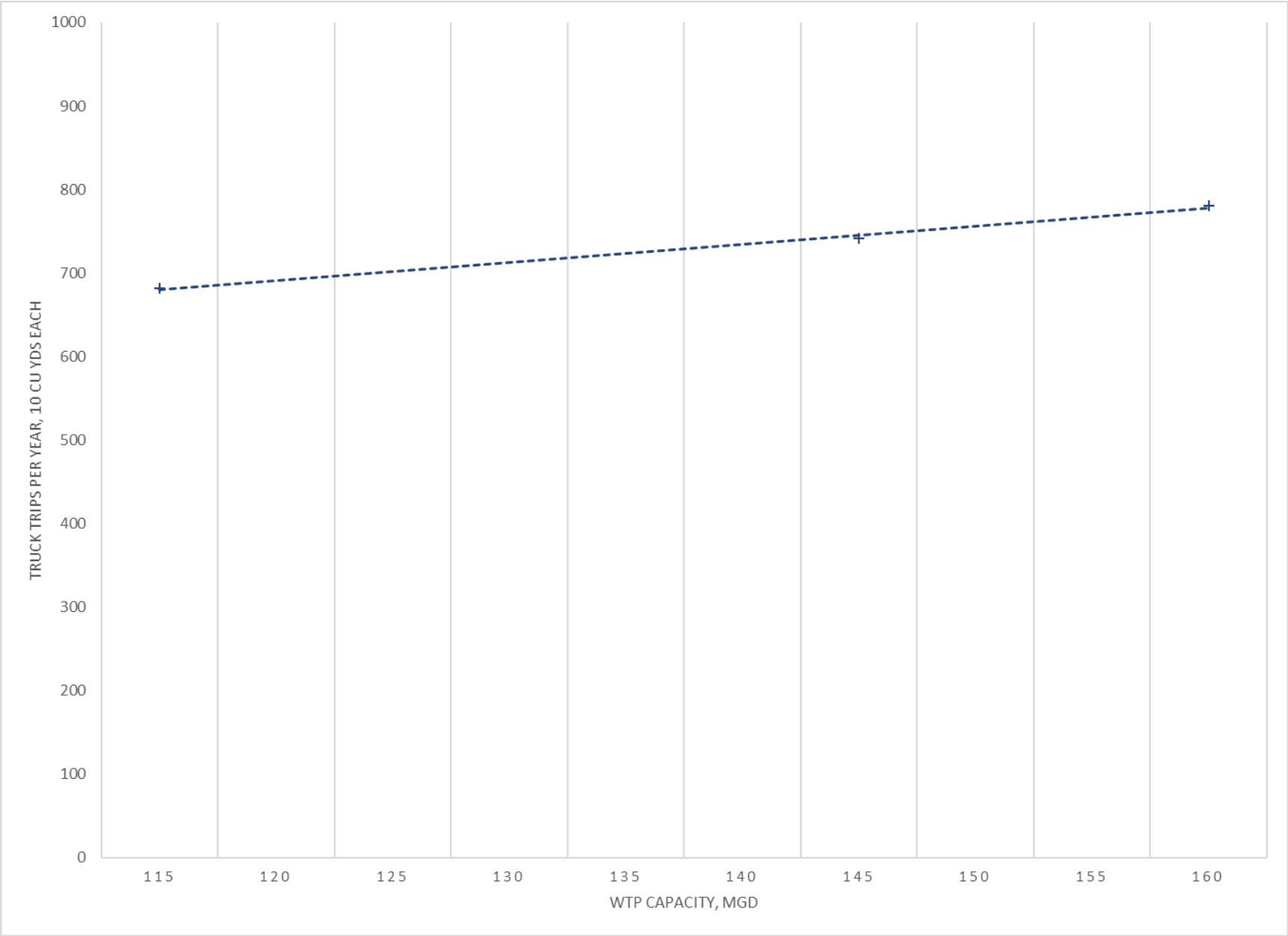


Figure 7. Draft Granular Media Filtration Curve for Truck Trips Annually

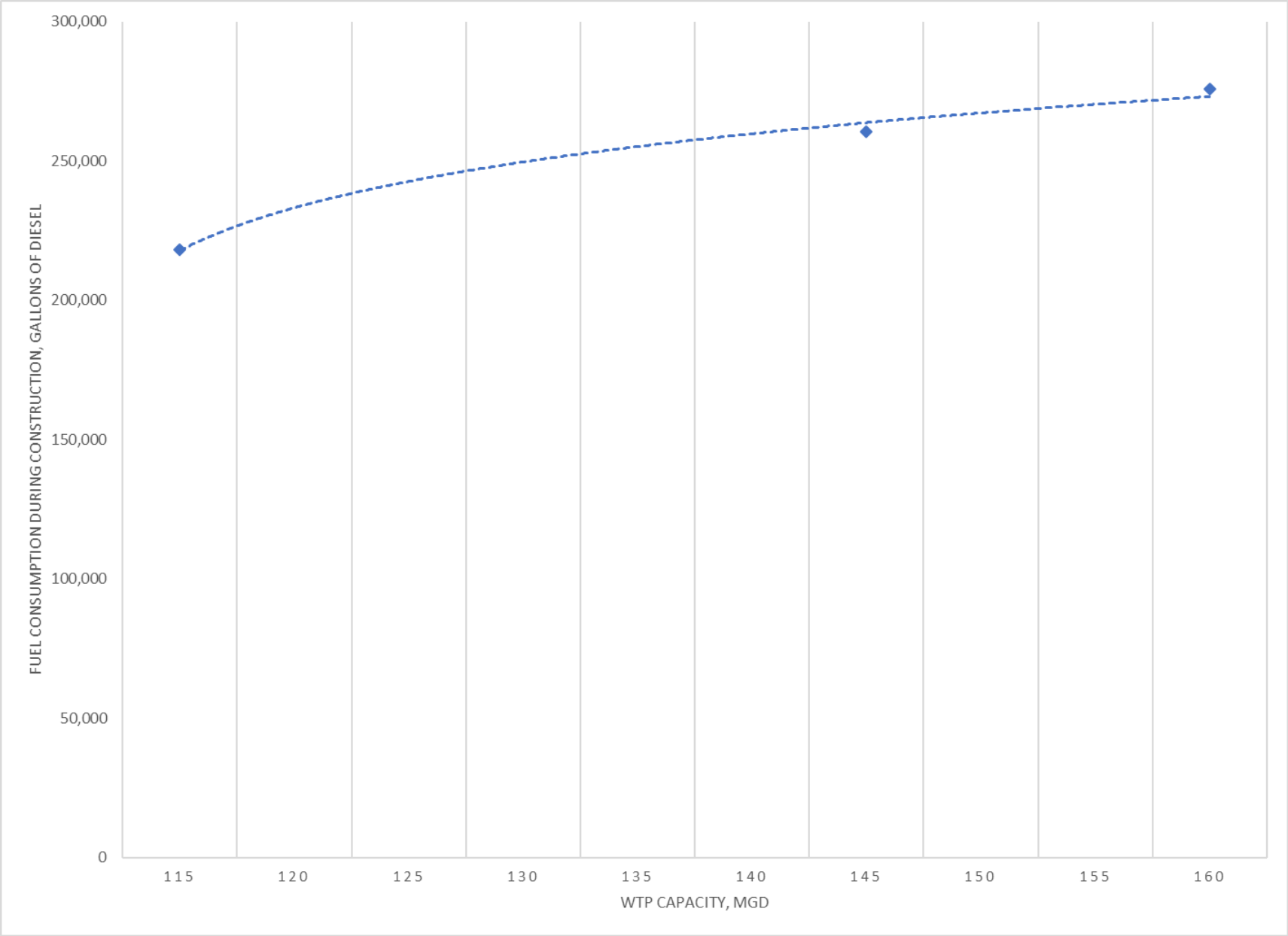


Figure 8. Draft Granular Media Filtration Curve for Fuel Consumption During Construction

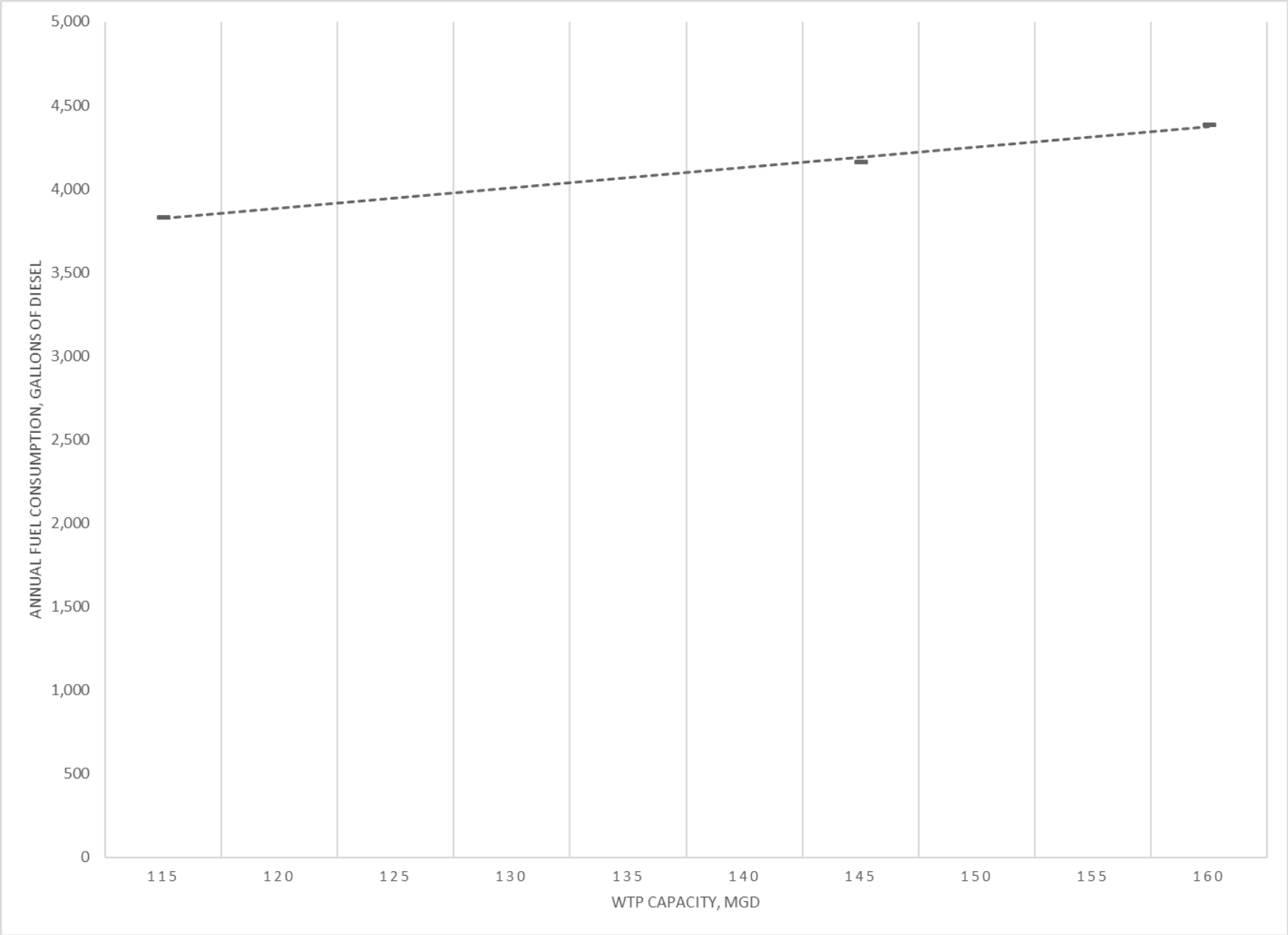


Figure 9. Draft Granular Media Filtration Curve for Fuel Consumption Annually

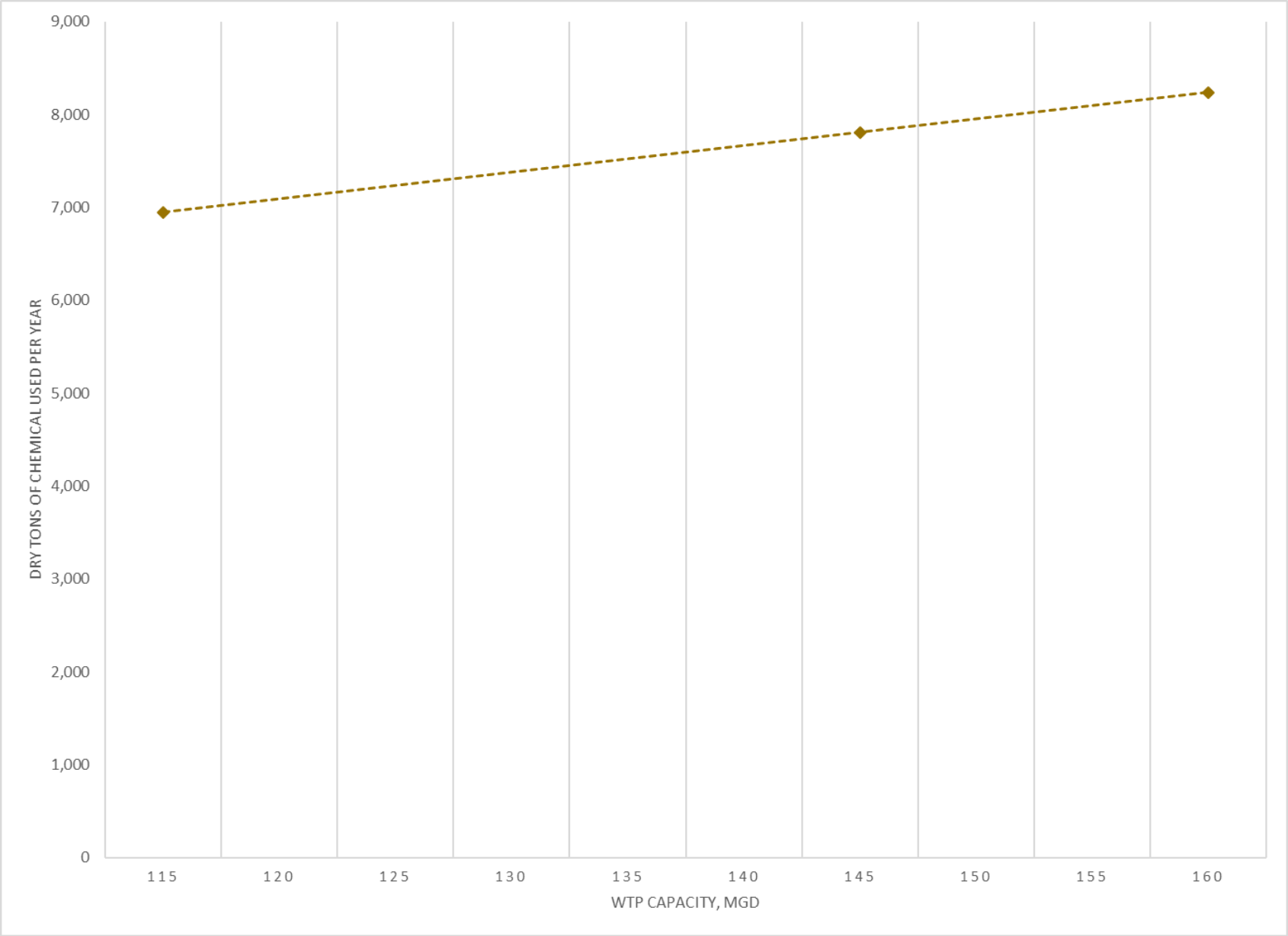
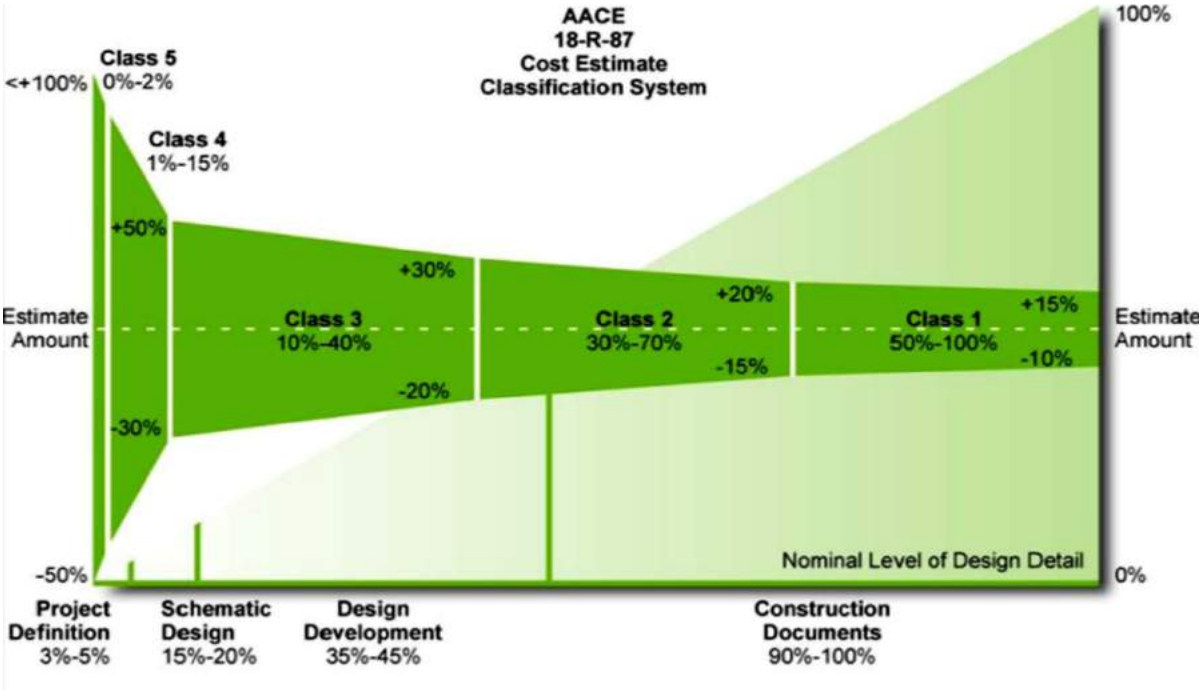


Figure 10. Draft Granular Media Filtration Curve for Chemical Use per Year

Attachment
Cost Estimate Definition

Cost Estimate Definition

The Portland Water Bureau granular media filtration cost estimates were prepared based on 1-to-5-percent-complete preliminary engineering. As such, they are considered Class 5 estimates, as defined by Association for the Advancement of Cost Engineering International. The typical expected accuracy range for a Class 5 estimate is –20 to –50 percent on the low side and +30 to +100 percent on the high side.



Because the water supply schemes defined for this analysis only include major process design criteria inputs sufficient to advance the concept to 0 to 2 percent complete, and rely on information available at the time, the cost estimates produced from the tool developed from the guidance herein, and any resulting conclusions about project financial or economic feasibility or funding requirements, are to be used as preliminary guidance only in project evaluation and implementation.

To proceed with the project, detailed strategic planning, business development, project screening, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval are needed.

The final costs of a project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimate developed using the method described in this TM. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed, before making specific financial decisions or establishing project budgets, to help ensure proper project evaluation and adequate funding.

Technical Memorandum

Date:	September 11, 2018
Project:	Bull Run Filtration Project
To:	David Peters, PE, and Michelle Cheek, PE – Portland Water Bureau
From:	Christopher Bowker – Portland Water Bureau Pierre Kwan, PE, Aparna Garg – HDR Dan Speicher – Jacobs
Reviewed by:	Phillippe Daniel, PE – HDR
Approved by:	Andy McCaskill, PE – HDR
Subject:	**Filtration Plant Site Alternatives**

1.0 Introduction

The Portland Water Bureau (PWB) is in the planning phase for the design and construction of a new filtration plant to treat their existing Bull Run surface water supply. This planning phase includes technical analysis to assist PWB in making four critical decisions: procurement method, filtration plant capacity, site suitability, and filtration technology. This technical memo (TM) documents the assumptions, analysis, and decisions made to determine the location of the plant.

The decision on plant location is framed by the values-based decision-making framework, which includes specific criteria and performance scales. HDR has coordinated closely with PWB and their other consultants, Jacobs and Barney & Worth, to identify the criteria and performance scales that drove the site decision. The site selection was made after a plant capacity was identified, (see Capacity Alternatives and Decision TM), but before the filtration technology was determined.

This TM presents the initially identified site alternatives, the process to narrow down the initial site alternatives, the applicable decision framework criteria and performance scales related to the site decision, and the evaluation of the remaining site alternatives.

2.0 Background

In 2006, the Environmental Protection Agency (EPA) issued a drinking water rule called the Long Term 2 Surface Water Treatment Rule (LT2). The purpose of the LT2 rule was to reduce disease incidence associated with microorganisms in drinking water and specifically required treatment for *Cryptosporidium*. From 2012 to 2017, the Bureau had a variance from the treatment requirements for *Cryptosporidium*, by demonstrating that treatment for *Cryptosporidium* at the Bull Run watershed intake was not necessary to protect public health because of the nature of the raw water source. However, this variance was revoked in 2017 requiring that the Bureau treat the water from the Bull Run River for the microorganism

Cryptosporidium. The bilateral compliance agreement establishing this requirement was signed on December 18, 2017, and has a compliance deadline of September 2027.

In the years leading up to the issuance of LT2, as well as afterward, PWB investigated how it would meet LT2. This included analyzing the type and size of a potential treatment facility (at this point in time both non-filtration and filtration treatment were possibilities), as well as a potential location. The first significant siting evaluation effort was the 2001 Water Treatment Plant Siting Evaluation Technical Memorandum (Appendix A). This TM provided information to the Bull Run Treatment Panel (Panel). The Panel was established to advise PWB on the Bureau's options for meeting LT2 regulations as well as make recommendations on a treatment facility site. This work was summarized in Recommendations of the Bull Run Treatment Panel TM (Appendix B). Four sites were identified in these documents: Lusted Hill, Larson's Ranch, Headworks, and Powell Butte.

In 2009, PWB re-evaluated potential treatment facility sites in the draft Site Considerations for Portland Water Bureau's Water Treatment Facility TM (Appendix C). Four sites were evaluated for their ability to host a filtration-type treatment facility: Carpenter Lane, Headworks, Lusted Hill, and Roslyn Lake, (Powell Butte and Larson's Ranch were not included in this evaluation). The draft TM discussed factors and relative costs to take into consideration when choosing a site.

Based on previous studies, a total of six potential sites for a filtration facility were identified: Carpenter Lane, Lusted Hill (with expansion), Headworks, Larson's Ranch, Powell Butte, and Roslyn Lake (see Figure 1). These sites were selected on the basis of:

- Taxlot size,
- Accessibility,
- Location,
- Land use, and
- Geologic hazards

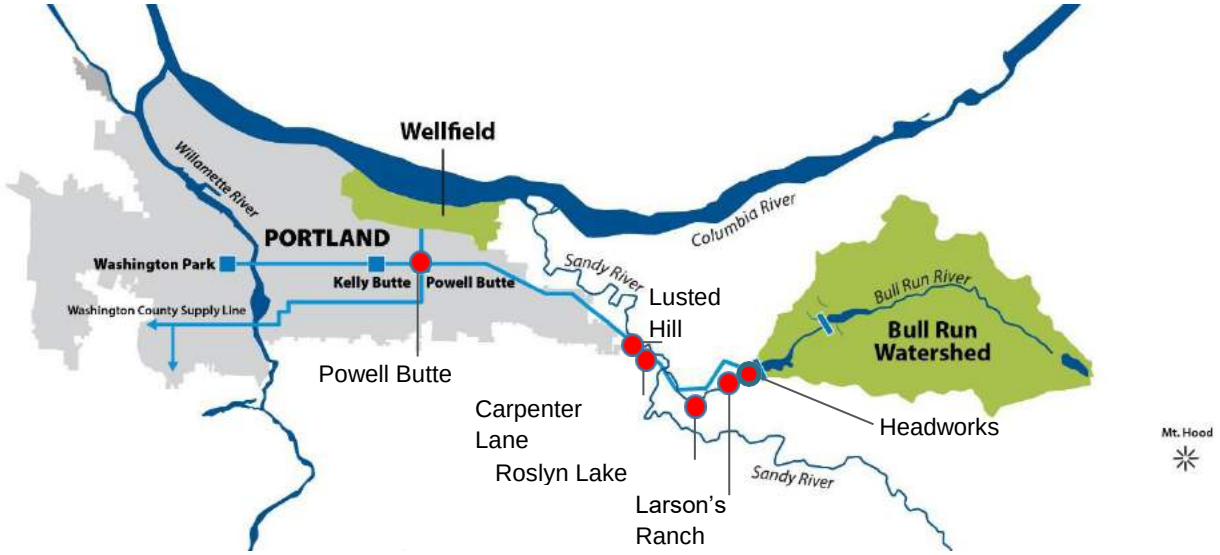


Figure 1. Approximate location of the six sites reviewed in this preliminary evaluation.

3.0 Process

Major considerations and factors affecting site choice were used to create selection criteria and many of the criteria used in this TM are based on previously identified criteria. Criteria categorized as essential are considered necessary for a filtration facility and were graded as pass/fail. In Section 5, each site is introduced, discussed, and evaluated for its ability to meet each essential criterion. Any site unable to meet one or more of these criteria was determined to be unsuitable for a filtration facility and was removed from further consideration. Sites that met all the essential criteria were then further investigated.

4.0 Explanation of Essential Criteria

Several major considerations exist that affect site choice such as cost/benefit impacts, meeting future needs, and regulatory compliance. Siting criteria that support these values are maximizing gravity flow, site proximity to existing and future conduit rights-of-way (ROWs), site size, site slopes and geologic conditions, and impacts to the compliance schedule. This section discusses major considerations, why they are important to site selection, and their application as essential criteria.

4.1 95 MGD Gravity Flow

The existing Bull Run supply is gravity operated, which is simpler and reduces costs associated with pumping water to Portland's distribution system to meet demands. Potential impacts to gravity flow must be considered as part of the site selection process. Although the goal would be to maximize gravity flow from Bull Run, it is likely that some pumping will be required to meet peak demands, depending on factors such as weather, operations, head loss through the facility, and site elevation.

An essential criterion associated with gravity flow was developed to assist in site selection. To meet this criterion, sites must allow for gravity flow equal to, or greater than, the average daily demand. This is approximately 95 million gallons per day (MGD). A site unable to meet this minimum gravity flow would typically require pumping throughout the year, negatively impacting cost.

Gravity flow was evaluated by comparing approximate site elevations to the hydraulic grade line (HGL). The HGL is the pressure head, or line, that water follows when it flows from a higher to a lower elevation. When water flows naturally from a higher to a lower elevation it is called gravity flow. A site located too far above the HGL may require most or all flows to be pumped from Headworks to the filtration facility, with gravity flow to the distribution system. A site located too far below the HGL would allow gravity flow from Headworks to the filtration facility but would require pumping to town. The existing HGL (from Headworks through the existing Lusted Hill facility to Powell Butte) provides enough gravity flow to move water into the Bureau's distribution system and meet existing demands. The closer a filtration facility is to the existing HGL, the more the PWB would be able to use gravity flow to move water through the filtration facility and downstream to the Bureau's distribution system. This would reduce pumping needs.

Sites that meet the 95 MGD gravity flow criterion will have additional issues to consider in later evaluations, such as how future changes will impact the HGL. Future projects that affect the elevation of the system inlet or outlet could impact the HGL. For example, if flow through the conduits was driven by Reservoir 2 head instead of the Diversion Dam, future gravity flow through the conduits could be increased if a higher elevation facility site is chosen. However, this would likely mean that less gravity flow would be available in the interim. These issues are not addressed herein but will likely differentiate sites that meet all essential criteria.

4.2 Proximity to Conduits Rights-of-Way

It is important that a potential site be close to the existing conduits as well as any future conduit ROW (see Figure 2). For evaluation purposes, an approximate distance of two miles was selected (this is the direct distance between the site and conduit ROW, and not the actual length of new piping needed to connect the site to the conduits). Sites on or near the existing conduits would reduce the need for additional piping to connect to the conduits. Also, sites that avoid the construction of river crossings are anticipated to simplify design and construction needs. For purposes of determining proximity to a future conduit ROW, the location of a future conduit (which was not determined as part of this report) was assumed, based on past land acquisition and planning efforts.

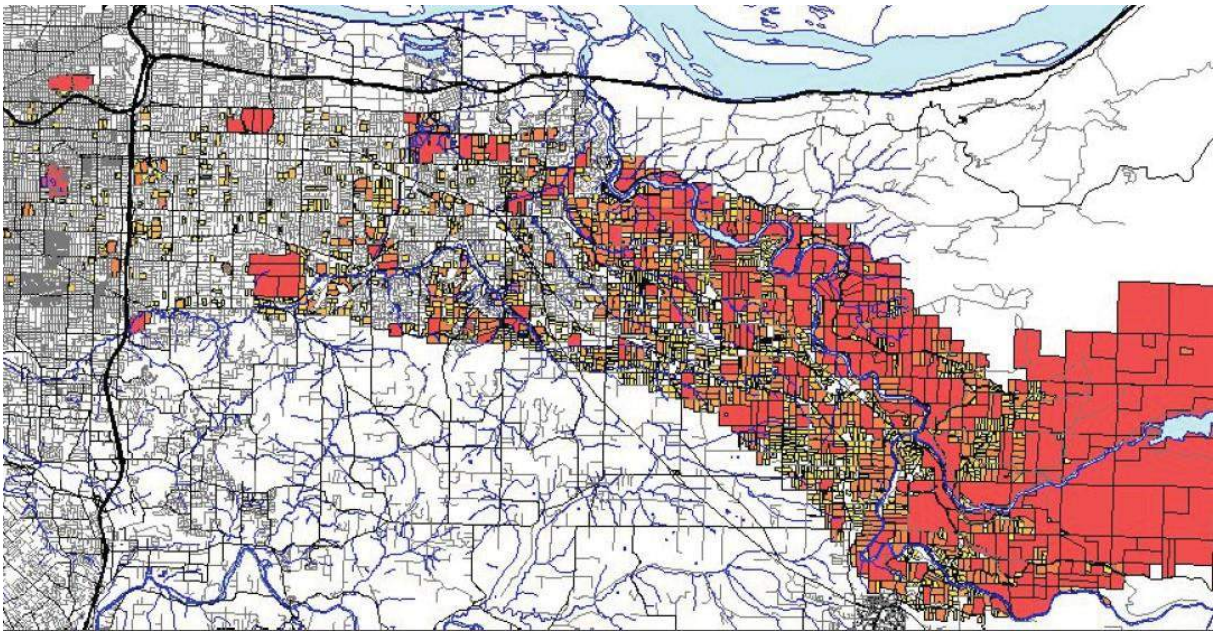


Figure 2. Parcels within two miles of the conduit ROW (parcels smaller than 4 acres were not included).

4.3 Taxlot Size

Another key requirement in selecting a filtration facility site is that it be large enough to accommodate the facility's footprint, including clear wells, solids handling, and any future expansion that may occur. The facility footprint also depends on the filtration treatment technology implemented. For most filtration technologies, the required footprint was estimated at 25 to 50 acres. Slow sand filtration would require considerably more acreage. For this evaluation, it was assumed that slow sand filtration would not be the selected filtration technology. If slow sand is selected in the future, the issue of site size would need to be revisited because the six sites would likely require expansion to accommodate this technology.

4.4 Slopes and Geologic Conditions

Depending on each site's topography and geotechnical conditions, some site earthwork will occur. However, sites with fewer steep slopes and geotechnical issues will reduce the amount of site work needed and/or expensive construction methods used to overcome these risks. All sites were previously determined to have favorable sloping conditions. Geologic conditions were identified using the Bureau's geospatial information system and the Oregon Department of Geology and Mineral Industries (DOGAMI) website. DOGAMI produced a 2016 Statewide Landslide Information Database for Oregon that was used to help determine mapped landslide areas and landslide hazard.

Taxlot size, slopes, and geologic conditions limit how and where the filtration facility can be constructed on a given site. Collectively, the area that is large enough, with favorable sloping, and free of geologic concerns is referred to as the buildable area.

4.5 Impacts to Schedule

PWB has less than ten years to plan, design, and construct a filtration facility. To meet the compliance schedule, all phases of the Bull Run Filtration project will need to be performed expediently. Potential delays impacting PWB's ability to meet this timeline should be avoided as they could lead to significant consequences. Potentially significant schedule delays could include land use reviews and permitting. For example, part of the Lusted Hill permitting process would require that PWB conduct an analysis of the surrounding area and successfully demonstrate to the county that nearby parcels are unsuitable.

4.6 Summary of Criteria

These major considerations were used to help create a list of criteria that are essential to a filtration facility site. Failure to meet these criteria would eliminate a site from further consideration. The essential criteria are:

- The site must allow for at least 95 MGD to flow through the facility and downstream to the Bureau's distribution system using gravity. This criterion assures that PWB will be able to meet average demand without pumping and would reduce operating costs.
- The distance from the existing and future conduit ROW to the site must be less than two miles.
- The buildable area must accommodate the ultimate size of the facility. This includes several key points:
  - In 2017, City Council directed PWB to construct a filtration-type treatment facility. This means that a suitable site would need at least 25 to 50 acres of buildable area.
  - Minimize site slopes to reduce impacts to construction and site earthwork.
  - The site must have space for the facility to be constructed on land free of significant geologic hazards that would require using expensive construction methods to overcome.
- The site selected is not anticipated to pose unnecessary risk to PWB's ability to meet the compliance schedule, such as due to the land use permitting process or other complications.

5.0 Site Evaluation against Essential Criteria

5.1 Carpenter Lane

This site is located less than a mile south of Lusted Hill at the dead end of Carpenter Lane east of SE Cottrell Road. This site is located above the existing HGL. Modeling indicates that 110 to 160 MGD gravity flow is available depending on the location and size of connecting piping and treatment processes. An approximate gravity flow of 130 MGD was assumed. Pumping would be required to meet demands greater than 130 MGD. Carpenter Lane passed the HGL criterion. Figure 3 is an illustration of the Carpenter Lane site relative to the HGL.

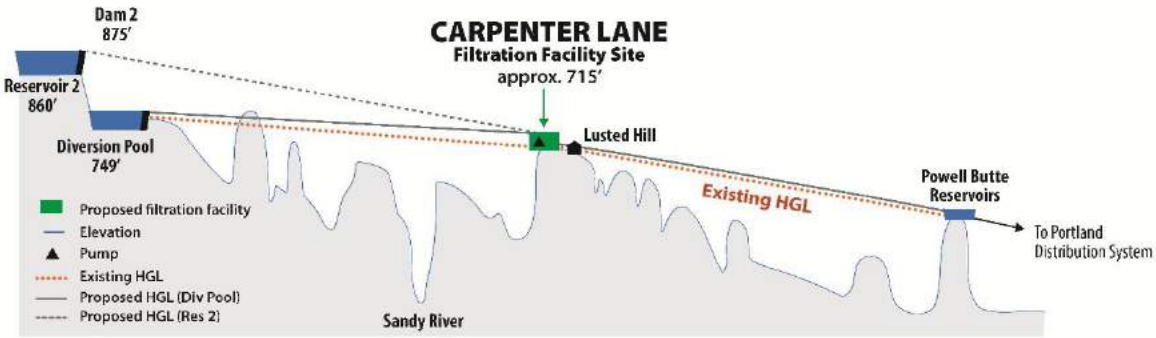


Figure 3. Illustration showing a filtration facility located at Carpenter Lane relative to the HGL. Note the facility is very close to the HGL and would have gravity flow up to approximately 130 MGD.

This site is south of the existing conduits ROWs and would require 13,200 to 21,600 feet of additional piping to connect to Conduits 2, 3, and 4. This site is in line with the anticipated alignment of a future conduit. Carpenter Lane passed the proximity criterion.

Carpenter Lane includes two large taxlots totaling approximately 90 acres. However, some of the site is in or near areas of moderate, high, and very high landslide hazards. Considering this, the buildable area is approximately 65 acres, which is large enough to accommodate a filtration facility. Carpenter Lane passed the taxlot size, slopes, and geologic hazards (buildable area) criteria.

Carpenter Lane is located in Multnomah County, borders Clackamas County, and is zoned by Multnomah County Land Use Planning as Multiple Use Agriculture (MUA-20). A facility located here would be considered a Community Service Use but classified as a Conditional Use in the MUA-20 zone. Both of these land use reviews are Type III Reviews. The filtration facility would be the primary structure with other structures listed as accessory structures. Any tower constructed to hold radio or microwave antennae is considered an accessory structure, but also a separate use. Such towers have a specific land use review. Although there may be several other review types triggered (See Appendix D), all the reviews discussed would be processed together through the Type III Review, which requires a public hearing before a Hearings Officer and approximately 150 days. There are no known significant risks to the project timeline or schedule related to land use reviews or permitting if this site were selected. Carpenter lane passed the schedule criterion.

The Carpenter Lane site is currently accessed via the Carpenter Lane ROW, which is a single-lane, unimproved road. If this site is selected, this road will either need to be widened and improved or a new access route established to the site, perhaps from SE Dodge Park Boulevard or from the south via an easement. Additionally, although the site is owned by PWB, it is rented out for use by a nursery. PWB will need to give advance notice to the renters clarifying expectations and specifying when the site would need to be vacated.

5.2 Headworks

Headworks is in the Bull Run Watershed and is the farthest east of the six sites. Headworks is the point of raw water intake into the conduits and is where chlorination occurs. A filtration facility located at Headworks would sit above the Diversion Pool, which is the driving head for the conduits and establishes the HGL (see Figure 4). A facility above the HGL would have to rely on pumping (to the facility) year-round to send water to town. As a result, Headworks did not pass the gravity flow criterion.

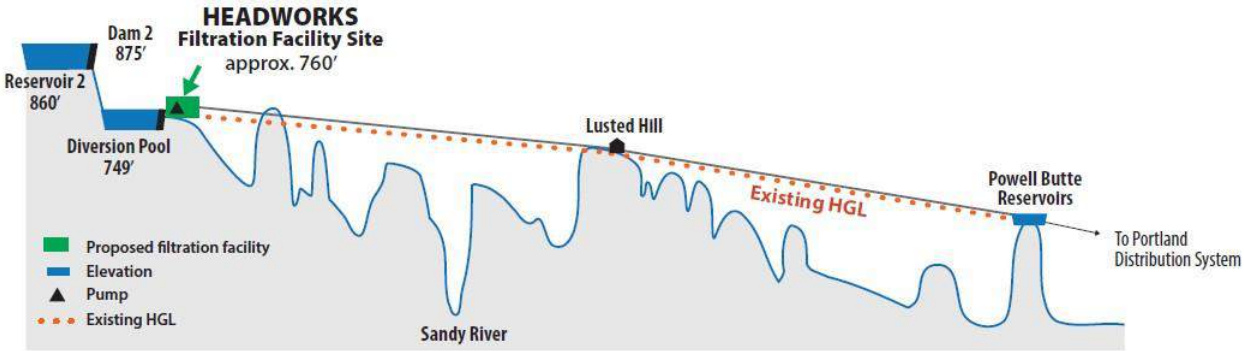


Figure 4. Illustration showing a filtration facility located at Headworks relative to the HGL. Note the facility is above the Diversion Pool and therefore the HGL. Pumping to the facility would be required.

Construction of a facility at this site would not require major extension of large pipe because Headworks is immediately adjacent to Dam 2 and the existing conduits. Since Headworks is within two miles of the existing and future conduit ROW, it passed the proximity criterion.

The existing facilities and site are constrained to a small area, bounded by Dam 2, the Bull Run River, and steep slopes. Less than two acres of land is available to be developed directly on-site while maintaining existing operations using Screenhouse 3, the Primary Intake Structure, and the Chlorine Building. Approximately 15 acres of forested land is located between Headworks, Dam 2, and the spillway but development of this land has significant issues and still wouldn't be large enough. Headworks did not pass the taxlot size criterion.

Of the six potential filtration facility sites, Headworks has the most geologic concerns. Headworks is sitting on landslide material that is susceptible to moving into the Bull Run River. These soils tend to be less susceptible to liquefaction but much more at risk to further landslide movement. Per DOGAMI, Headworks is in an area of very high landslide hazard, has the highest landslide susceptibility, and highest liquefaction probabilities of all six sites. Headworks did not pass the slopes or geologic hazards criteria.

Headworks is located in Clackamas County and is zoned as Timber District. A facility located here would be considered a Conditional Use Review and is a Type III review. Two sets of conditional use criteria must be addressed at this site: (1) general conditional use criteria that apply to any conditional use in Clackamas County; and (2) forest-related conditional use standards that address potential impacts to primary forest uses. Although there may be several other review types triggered, all the reviews discussed would be processed together through the

Type III Review, which requires a public hearing before a County Hearings Officer and approximately 150 days. Projects in the watershed are often subject to increased public input, although since development already exists at Headworks, this risk may not be significant. Portions of Headworks are within the Federal Energy Regulatory Commission (FERC) boundary. Development on any land this close to Dam 2 would require FERC approval (which may not be feasible) and introduces federal oversight to the project. Constructing a facility at this site would result in significant schedule implications related to demonstrating to FERC the minimal Dam 2 impacts and would significantly increase construction costs to reduce impacts to the dam. Headworks did not pass the schedule criterion.

5.3 Larson's Ranch

Little previous study has occurred at Larson's Ranch. Located in the Bull Run Watershed Management Unit south of Bull Run River and north of the Little Sandy River, this site is the second farthest from Portland, and is currently the most difficult to access. Constructing a filtration facility at this site would require either a new access road constructed to the southwest or would require significant improvement of the existing forest road to the site.

At 765 feet elevation, a filtration facility located at Larson's Ranch would be approximately 35 feet above the existing HGL in this area. Pumping year-round would be required upstream of a facility, although gravity flows downstream into the Bureau's distribution system would be possible. Figure 5 illustrates the fact that Larson's Ranch did not pass the HGL criterion.

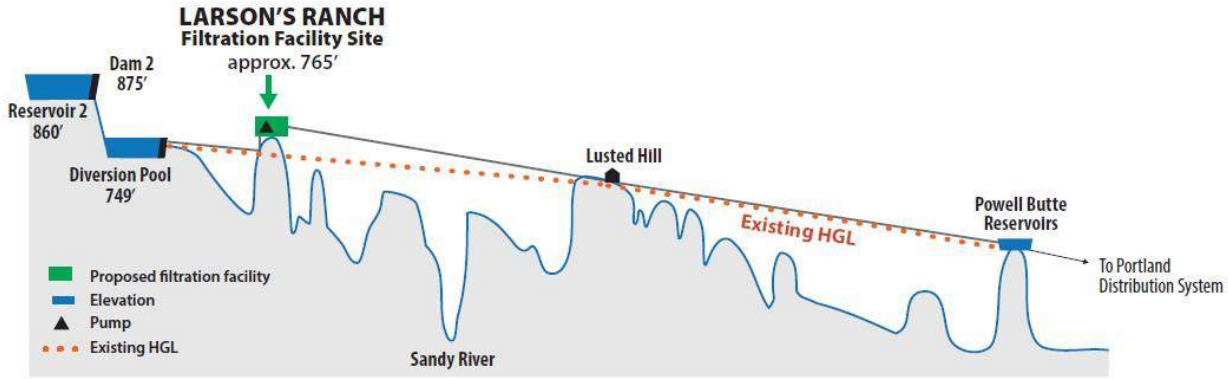


Figure 5. Illustration showing a filtration facility located at Larson's Ranch relative to the HGL. Note the facility is above the HGL. Pumping to the facility would be required.

Larson's Ranch is approximately half a mile from the conduits. Conduits 2 and 4 would each need to cross the Bull Run River twice with new crossings. These crossings would be in areas of high landslide susceptibility. It is estimated that 12,000 - 13,000 feet of additional piping would be needed to connect to all three conduits. Larson's Ranch passed the proximity criterion.

Although this site is one of the larger taxlots included for evaluation, it is bounded by rivers and significant geologic hazards, reducing the buildable area. Areas of this site have moderate landslide susceptibility and very low liquefaction susceptibility. The buildable area is

approximately 60 acres. Larson's Ranch passed the taxlot size, slopes, and geologic hazards criteria.

Larson's Ranch is located in Clackamas County and is zoned as Timber District. A facility located here would be considered a Conditional Use review and is a Type III review. Two sets of conditional use criteria must be addressed at this site: (1) general conditional use criteria that apply to any conditional use in Clackamas County; and (2) forest-related conditional use standards that address potential impacts to primary forest uses. Although there may be several other review types triggered, all the reviews discussed would be processed together through the Type III Review, which requires a public hearing before a Hearings Officer and approximately 150 days. Larson's Ranch would not likely experience significant delays due to the land use review process, but it is unknown if citizen involvement would result in any delays or impact PWB's ability to meet the compliance schedule due to this being in an undeveloped area of the Bull Run Watershed Management Unit. It's assumed that Larson's Ranch would pass the schedule criterion.

5.4 Lusted Hill

Lusted Hill is the name assigned to the pH adjustment and ammoniation facility located on a single taxlot at 6704 SE Cottrell Road. Lusted Hill is close to the existing HGL and is well-suited to maximizing gravity flow. Recent modeling has not occurred at Lusted Hill, but prior modeling performed for ultraviolet (UV) treatment scenarios estimated 200 MGD gravity flow was available at that time (see Figure 6). Headloss would be greater through a filtration facility, thus gravity flow would be less than 200 MGD but greater than 160 MGD. The actual gravity flow would depend on the location and size of connecting piping. Lusted Hill passed the HGL criterion.

Figure 6. Illustration showing a filtration facility located at Lusted Hill relative to the HGL. Note the facility is very close to the HGL and would have gravity flow.

This site is located close to the existing conduits ROWs and would likely require approximately 10,000 feet of additional piping to connect to Conduits 2, 3, and 4. This site is approximately one mile north of the anticipated alignment of a future conduit. Lusted Hill is within two miles of the existing and future conduit ROW and passed the proximity criterion.

The existing Lusted Hill site is approximately 14 acres and is too small to accommodate a filtration facility's footprint. Construction at this site would require the acquisition of additional land adjacent to this site. This would require purchasing or condemning one or more adjacent taxlots to acquire the buildable area needed. There are approximately 40 acres northwest of Lusted Hill that could provide adequate area, are crossed by Conduits 2 and 4, and are close to Conduit 3. This additional area has insignificant geologic hazards (low landslide susceptibility) impacting it. With site expansion, Lusted Hill passed the taxlot size, slopes, and geologic hazards criterion.

Lusted Hill is located in Multnomah County. The existing site is zoned by Multnomah County Land Use Planning as Commercial Forest Use (CFU) and area to the northwest is zoned as Exclusive Farm Use (EFU). A facility located at the existing site would be considered a Community Service Use but classified as a Conditional Use in the CFU zone. Both of these land use reviews are Type III Reviews. A facility located at the likely area of expansion is not specifically listed as an allowed use or conditional use in an EFU zone. A water treatment/filtration facility could be permitted in EFU zones pending an alternative site analysis, whereby a thorough analysis of all reasonable, non-EFU sites are considered along with the reasons for rejection.

To get approval to construct a filtration facility on land zoned as EFU, the following approval criteria ('Necessity Test') must be addressed as part of a land use application with Multnomah County.

> An applicant must show that reasonable alternatives have been considered and that the facility must be sited in an exclusive farm use zone due to one or more of the following factors:
>
> (A) Technical and engineering feasibility;
>
> (B) The proposed facility is locationally dependent. A utility facility is locationally dependent if it must cross land in one or more areas zoned for exclusive farm use in order to achieve a reasonably direct route or to meet unique geographical needs that cannot be satisfied on other lands;
>
> (C) Lack of available urban and non-resource lands;
>
> (D) Availability of existing rights of way;
>
> (E) Public health and safety; and
>
> (F) Other requirements of state and federal agencies.

Although it appears that siting a water treatment plant on this site would only require a Type II land use review, it may be advisable to elevate an application to a Type III if there is a likely possibility for an appeal. Regarding impact to schedule, it is estimated to take 150 days for a Type III review and 6 months with an appeal to the Oregon State Land Use Board of Appeals (LUBA). Land acquisition for the Lusted Hill site expansion could occur if the owner is interested in selling or through the condemnation process. PWB's ROW Services indicated that land acquisition via condemnation is anticipated to require approximately 14 months to complete

(and is anticipated to be the longer of the two acquisition processes). Worst case scenario, condemnation and permitting could take approximately two years. This timeline would be accelerated if the owners are willing to sell, if the appeals process is faster or if any of the phases can overlap. Thoughtful planning and project management would be essential to accommodate land acquisition and approval and still allow the project to meet the compliance schedule. Lusted Hill passed the schedule criterion.

5.5 Powell Butte

In 2001, the Panel recommended Powell Butte as a future treatment facility site due to its suitable elevation, location within the urban growth boundary, greater opportunities for public education and community recreation facilities, and the presence of an existing reservoir – thought to offer significant cost savings.

A facility at Powell Butte could be placed close to, or just below, the HGL, maximizing gravity flow to the facility (see Figure 7). However, pumping would be required to send water back up to retail and wholesale customers connected to the conduits between Headworks and Powell Butte, including the existing 16-inch Lusted Road Distribution Main connected to Conduits 2 and 4 at Lusted Hill. This would involve not only a pump station, but new pump mains to deliver water approximately 18-20 miles back east, at a significant cost and effort. Although Powell Butte passed the HGL criterion, it has significant drawbacks related to pumping filtered water back upstream (east) to customers.

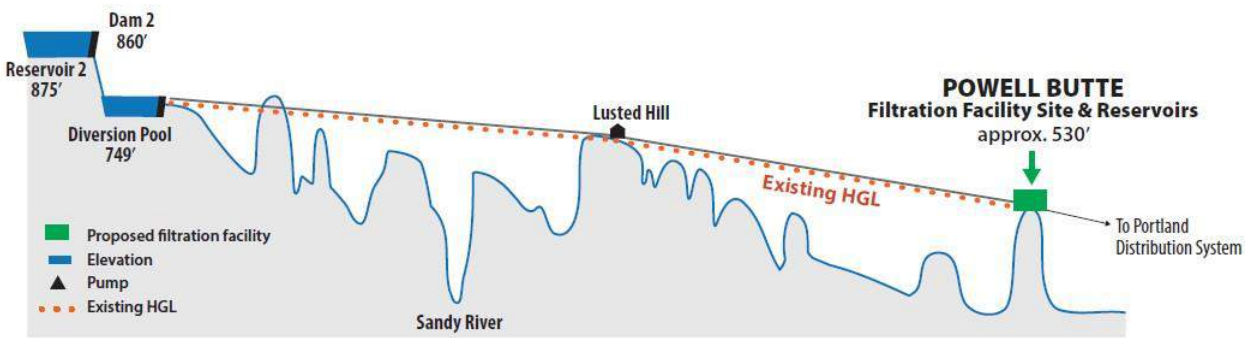


Figure 7. Illustration showing a filtration facility located at Powell Butte relative to the HGL. Note the facility is very close to the HGL and would have gravity flow.

Powell Butte is very close to existing piping infrastructure, with additional piping estimated to be less than most of the other sites, at approximately 2,000 feet. Since Powell Butte is within two miles of the existing and future conduit ROW, it passed the proximity criterion.

Powell Butte includes multiple taxlots, four of which are quite large and total over 530 acres, and therefore is large enough for a filtration facility. Powell Butte is encircled by areas of moderate to high landslide hazard. However, low landslide susceptibility exists near where a potential treatment facility would likely be sited on the butte's interior area. Considering slopes, geologic

hazards, and existing facilities, it is estimated that the buildable area is 60 acres. Powell Butte passed the taxlot size, slopes, and geologic hazards criterion.

Powell Butte is located in Multnomah County, within the city of Portland, and is zoned as Open Space, low density residential, and multi-dwelling residential. In 2001, it was recognized that siting a facility at Powell Butte would have significant impacts on the park and surrounding neighborhoods (as the Panel was completing its work, some citizens expressed concerns about the social and environmental impacts of a facility at Powell Butte). Because of uncertainties of siting a treatment facility at Powell Butte, the Panel recommended a second site (Lusted Hill) remain under active consideration should neighborhood, environmental, or other issues render Powell Butte an inappropriate location.

More recently, Powell Butte Reservoir 2 was constructed at Powell Butte. Insight and experience from this project confirmed that neighborhood, environmental, or other difficulties would be significant if PWB were to construct a filtration facility at Powell Butte. It is also anticipated that Powell Butte would be the most difficult to secure land use approvals for development. This is because the land use process would require a Major Amendment to the Bureau's Powell Butte Conditional Use Master Plan (CUMP) and would trigger a subset of other land use reviews including conditional use, environmental, and likely an adjustment review to accommodate the impacts of development in the park and to the surrounding area. The Zoning and Land Use Review Analysis for Bull Run Water Treatment Plant Siting TM concluded that larger Powell Butte land use reviews (such as Reservoir 2 and CUMP) in the past have been appealed to LUBA by the neighborhood association and other public members, creating additional monetary costs, approval delays, and political scrutiny for the project and for PWB. These risks could significantly delay site approval, permitting, and facility construction by years. Therefore, Powell Butte did not pass the schedule criterion.

5.6 Roslyn Lake

In 2008, the large area known as Roslyn Lake was drained, making it available to develop, and therefore it was included in the 2009 TM. This former reservoir was part of the Bull Run Hydroelectric project. This land is not owned by the City or PWB but was for sale as of winter 2017/2018.

Of all six sites, Roslyn Lake deviates the farthest from the HGL (it is below the HGL) and year-round pumping would be required downstream of a facility to lift water back up to the HGL and over Lusted Hill (see Figure 8). Therefore, Roslyn Lake did not pass the HGL criterion.

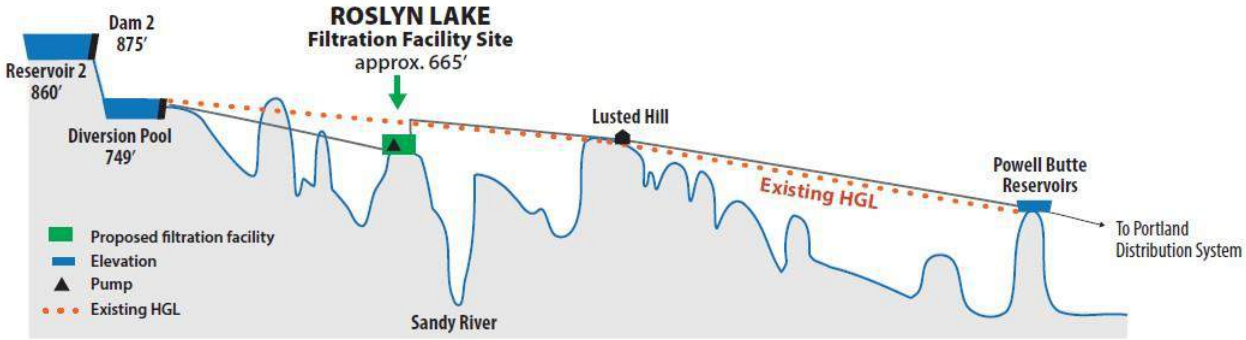


Figure 8: Illustration showing a filtration facility located at Roslyn Lake relative to the HGL. Note the facility is below the HGL. Pumping from the facility would be required.

The site is close to Conduits 2 and 4, although Conduit 3 would cross the Bull Run River twice with a new crossing. This crossing and additional Conduit 2 and 4 piping would pass through areas of high landslide susceptibility. It was previously estimated that 6,000 feet of additional piping would be needed to connect to all three conduits. Roslyn Lake is within two miles of the existing and future conduit ROW and passed the proximity criterion.

Roslyn Lake is large and relatively flat. Per DOGAMI, Roslyn Lake does not appear to be in an area of landslide hazard or have mapped landslides. It is estimated that the entire site (200+ acres) is buildable area and thus passed the taxlot size, slopes, and geologic hazards criteria.

Roslyn Lake is located in Clackamas County and is zoned as Timber and Farm Forest-10 Districts. A facility located here would be considered a Conditional Use review and is a Type III Review. Any tower constructed to hold radio or microwave antennae would be subject to review. Two sets of conditional use criteria must be addressed at this site: (1) general conditional use criteria that apply to any conditional use in Clackamas County; and (2) forest-related conditional use standards that address potential impacts to primary forest uses. Although there may be several other review types triggered, all the reviews discussed would be processed together through the Type III Review, which requires a public hearing before a Hearings Officer and approximately 150 days. There are no known significant risks to the project timeline or schedule related to land use reviews or permitting if this site were selected. Roslyn Lake passed the schedule criterion.

6.0 Summary of Sites Meeting Essential Criteria

Six potential filtration facility sites were evaluated for their ability to meet essential criteria. Table 1 summarizes the pass/fail scoring versus the essential criteria. Four of the sites failed to meet all essential criteria. Only two sites, Carpenter Lane and Lusted Hill, passed all essential criteria and were therefore evaluated further using the developed decision framework.

Table 1. Pass/Fail Results of How Well Each Initial Site Met the Essential Criteria

Site	HGL	Proximity to Conduits	Tax Lot Size	Slopes and Geologic Hazards	Schedule
Carpenter Lane	Pass	Pass	Pass	Pass	Pass
Headworks	Fail	Pass	Fail	Fail	Pass
Larson's Ranch	Fail	Pass	Pass	Pass	Pass
Lusted Hill	Pass	Pass	Pass (with site expansion)	Pass	Pass
Powell Butte	Pass	Pass	Pass	Pass	Fail
Roslyn Lake	Fail	Pass	Pass	Pass	Pass

Note: Shaded cells indicates site that meets all essential criteria.

7.0 Decision Framework and Criteria

The framework consists of eight values each having one or more criterion to help evaluate each alternative. Table 2 lists the values and criteria. Explanation of the decision framework, values, and criteria descriptions are found in the Filtration Decision Process memo. While all of the values are applied to each alternative, not every criterion in the values is applicable for the site decision. For example, the criteria "existing microbiological regulations" was determined as not applicable because the siting of the future plant has no direct bearing on how well it would meet these regulations, whereas such regulations have a significant impact on the separate filtration technology decision. The table also lists the criteria specifically excluded from the evaluation and the rationale.

Table 2. Decision Framework and Criteria Used For Siting Evaluation

Value	Criteria	Include/Exclude for Siting Evaluation	Reason
Public health and water quality	Existing microbiological regulations	Excluded	Compliance with regulations does not depend on siting of the facility.
	Organics/inorganics regulations	Excluded	Compliance with regulations does not depend on siting of the facility.
	Emerging water quality regulations	Excluded	Compliance with regulations does not depend on siting of the facility.
	Consistent water quality	Excluded	Siting does not significantly impact water quality.
	Chemical impacts	Excluded	The water treatment chemical dosage used does not depend on facility siting.
Resiliency/ reliability	Earthquake	Included	The ability to withstand seismic events is dependent on siting of the facility.
	Catastrophic water quality event	Excluded	Siting does not significantly impact the response to a catastrophic water quality event.
	Routine water quality event	Excluded	Siting does not significantly impact the response to a routine water quality event.

Value	Criteria	Include/Exclude for Siting Evaluation	Reason
Community interests	Local impacts	Included	The space between the facility and the neighbors to provide buffering from noise is a function of facility siting.
	Consistency in taste and appearance	Excluded	Water quality is not dependent on siting.
	Chemical concerns	Excluded	The water treatment chemical dosage used does not depend on siting but on treatment technology instead.
Cost benefit	Cost of construction	Included	This is a direct function of the extent of infrastructure that needs to be built at a given site.
	Total cost of delivered water	Included	The siting of the future facility has impact on the construction costs.
Future needs	Capacity	Included	The ability to maximize Dam 2 head is dependent on siting of the facility.
	Future water quality	Excluded	The size of additional processes required for the future facility is a function of its capacity, not siting.
	Available gravity capacity	Included	The gravity capacity available is dependent upon the siting of the facility.
Environmental impacts	Electricity usage	Included	The amount of pumping required is a function of the siting of the facility.
	Residuals produced	Excluded	The volume of residuals produced is independent of the facility site.
	Construction and operations fuel consumption	Excluded	The number of truck trips required depends on facility size and not site.
Integration	WTP labor	Included	The labor required to operate and maintain the pump station, the size of which is a function of hydraulics, is impacted by facility siting.
	Safety and operations	Included	Whether the facility requires a pump station to operate or not, depends on its siting.
	Corrosion control integration	Excluded	Corrosion control is related to water quality and not siting.
	Other infrastructure ramifications	Included	The need to construct connecting conduit piping and pump station depends on siting of the facility.
	Distribution system water quality	Excluded	Whether the future facility uses alternative management strategies such as groundwater is a direct function of its capacity and not siting.

Value	Criteria	Include/Exclude for Siting Evaluation	Reason
Implementation	Ease of construction	Included	Time taken to construct the facility is a function of its site.
	Implementation complexity	Included	The length of implementation schedule is a function of construction time, design, and start-up time, and is therefore related to facility siting.
	Land use permits	Included	The permitting requirements for construction and operation of the facility depends on the sites zoning.
	On- and off-site ownership	Included	Whether land acquisition is required depends on siting of the facility.

8.0 Criteria Evaluation

A quantitative score is developed for each criteria used to evaluate the two site alternatives. The quantitative score is based on either a calculated value developed from various models or a numerical score assigned to a qualitative description. For this scoring, a higher number means greater benefits and advantages whereas a lower number indicates substantial constraints and negative aspects. For this memo, only two alternatives are being considered: Lusted Hill and Carpenter Lane, hence scoring is 1 for the better alternative and 0 for the worse alternative.

This section describes each criterion, the scale used to develop the scoring, and the basis for the scoring. Table 3 summarizes the scoring. Several key assumptions have been made in order to support the criteria evaluation as follows:

1. The plant capacity is approximately 160 MGD per the April 2018 capacity decision.
2. The plant area is based on an assumption of ozone and direct filtration processes with other standard facility requirements. A total of 40 acres provides enough buildable area to construct and operate a 160 MGD plant with these processes and allows future build-out. Therefore, the difference in size between the 65 acre Carpenter Lane site and the 40 acre Lusted Hill site was not identified as a differentiating criterion except as indicated for “Local Impacts.”
3. The Carpenter Lane site is assumed to require the construction of a pump station.
4. The Carpenter Lane site requires a portion of new conduit to be constructed to connect the new facility to the existing infrastructure. The expanded Lusted Hill site is already on top of Conduits 2 and 4 and very close to Conduit 3, thereby needing fewer new connecting pipelines.
5. Property acquisition is not included in “Capital Cost” because the cost is unknown and is likely insignificant when compared with the project’s construction cost.
6. “Operating Costs” are included in “Lifecycle Cost” and are therefore not considered as a separate criterion.
7. Scores are assigned as either 1 or 0.

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Table 3. Evaluation Criteria and Valuation

Value	Public Health and Water Quality					Resiliency/Reliability			Community Interests			Cost Benefit		
Value Description	**Provide drinking water that is safe and consistent**					**Facility maximizes likelihood of continued water provision, even after a fire or disaster**			**Integrate community interests in the decision making process**			**Getting the most benefit for the dollar**		
Criteria	**Existing Micro-biological Regulations**	**Organics/ Inorganics Regulations**	**Emerging Water Quality Regulations**	**Consistent Water Quality**	**Chemical Impacts**	**Earthquake**	**Catastrophic WQ Event (forest fire, landslide)**	**Routine WQ Events (elevated turbidity, algae bloom)**	**Local Impacts**	**Consistency in Taste and Appearance**	**Chemical Concerns**	**Cost of Construction**	**Operating Costs**	**Total Cost of Delivered Water**
Performance Scale	Ability to meet existing regulations	Ability to meet existing regulations	Ability to meet future regulations	Use of Management Strategies	Chemical Selection	Ability to Maintain Supply	Half the Capacity	Treated Water Quality	Neighbors Impacted	Qualitative	Dosage	Capital Cost	Operating Costs	Lifecycle Cost
Carpenter Lane	N/A	N/A	N/A	N/A	N/A	1 point	N/A	N/A	1 point (65 acres to screen and buffer plant from neighbors)	N/A	N/A	0 points	N/A	0 points ($316 M)
Lusted Hill	N/A	N/A	N/A	N/A	N/A	0 points	N/A	N/A	0 points (40 acres to screen and buffer plant from neighbors)	N/A	N/A	1 point	N/A	1 point ($275 M)

Value	Future Needs			Environmental Impacts			Integration					Implementation			
Value Description	**Maximizes ability to make adjustments in future**			**Minimize environmental impacts**			**Optimize operability & integration with PWB's systems and practices**					**Increases ability to implement and meet compliance schedule**			
Criteria	**Capacity**	**Future Water Quality**	**Available Gravity Capacity**	**Electricity Usage**	**Residuals Produced**	**Construction and Operations Fuel Consumption**	**WTP Labor**	**Safety & Operations**	**Corrosion Control Integration**	**Other infrastructure Ramifications**	**Distribution System WQ**	**Ease of Construction**	**Implementation Complexity**	**Land Use Permits**	**On- and Off-site Ownership**
Performance Scale	Preserving Future Alternatives	Bull Run Water Quality	MGD	MWh/year	Volume produced	# Truck Trips + Operations Fuel Consumption	Required FTEs	Risk Management Program	Switching Sources/ Use of Management Strategies	Additional Infrastructure Needs	Use of Alternative Management Strategies	Risk to Schedule	Risk to Schedule	Risk to Schedule	Ownership
Carpenter Lane	1 point	N/A	0 points (130 +/-)	0 points	N/A	N/A	0 points	0 points	N/A	0 points	N/A	1 point	0 points	1 point	1 point
Lusted Hill	0 points	N/A	1 point (200)	1 point	N/A	N/A	1 point	1 point	N/A	1 point	N/A	0 points	1 point	0 points	0 points

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8.1 Earthquake

Performance Scale: The ability to resist seismic events such as earthquakes and maintain supply after a seismic event is crucial in deciding the facility site.

Note that investments in seismic reliability need to be informed by an overall vulnerability assessment as to the likely points of failure in the system. No assessment has been made as to the relative importance of the treatment plant site in the context of the entire PWB supply, transmission, and distribution systems.

Basis for Valuation: The criterion valuation is based on the alternative's improvement to the system's reliability post a seismic event. Carpenter Lane is a better option because it includes constructing more hardened conduit piping than Lusted Hill.

- Carpenter Lane: 1 point
- Lusted Hill: 0 points

8.2 Local Impacts

Performance Scale: Local impacts are defined as the number of construction trucks entering and leaving a given filtration plant site because the noise, traffic, and road dust from these truck trips are the principal impact to the neighbors. The preferred site would be one that provides more area to separate the plant from the neighbors, so as to buffer and minimize the noise, traffic and dust issues during construction as well as once the plant is operational. Note that both sites have relatively low density of development.

Basis for Valuation: The criterion valuation takes into consideration the area of the facility site. The larger the site area, the more space there is to screen and buffer the treatment plant from neighbors. Carpenter Lane has 65 acres to site the facility and provide dedicated area to screen and buffer the operating plant from adjacent neighbors, whereas the expanded Lusted Hill site only has 40 acres.

- Carpenter Lane: 1 point
- Lusted Hill: 0 points

8.3 Cost of Construction

Performance Scale: The cost of construction directly relates to the infrastructure that needs to be built at a given site. The site that requires less new infrastructure would reduce the cost of construction and would therefore be preferred.

Basis for Valuation: The following scoring is developed for this criterion:

- Carpenter Lane: 0 points, because it requires building of a new pump station and conduit piping in order to achieve 160 MGD hydraulic capacity.
- Lusted Hill: 1 point, because the expanded Lusted Hill site is already on top of Conduits 2 and 4 and very close to Conduit 3, thereby needing fewer new connecting pipelines. The site also does not require a pump station.

8.4 Total Cost of Delivered Water

Performance Scale: The total cost of delivered water is scaled on the basis of lifecycle cost. The lifecycle cost depends on the gravity flow of the Bull Run filtration plant and the need to construct a pump station at a given site. A site that reduces the need for a pump station and/or construction of conduit piping to achieve the desired hydraulic capacity could reduce the cost of delivered water.

Basis for Valuation: Carpenter Lane site requires a pump station in order to achieve 160 MGD hydraulic capacity and construction of conduit piping to connect the plant to the existing transmission system. The Lusted Hill site is capable of up to 200 MGD of gravity flow and does not require a pump station. In addition, the site is located on top of Conduits 2 and 4 and very close to Conduit 3, thereby requiring much less interconnection piping. The total alternative cost for Lusted Hill is the baseline cost of construction of $275 million. For Carpenter Lane, an additional $41.4 million is required for pump station and Conduit 5, bringing its total cost of delivered water to $316 million.

The following scores are assigned to the two sites:

- Carpenter Lane: 0 points
- Lusted Hill: 1 points

8.5 Capacity

Performance Scale: PWB values preserving the future opportunity to utilize the higher head at Dam 2, thereby preserving the opportunity to increase the overall gravity capacity of the system. The site that offers greater ability to utilize Dam 2 head is preferred.

Basis for Valuation: Driving flow with Dam 2 head could increase gravity capacity in the future. Carpenter Lane would achieve greater gravity flow than Lusted Hill due to its higher site elevation. The following qualitative scaling is developed for this criterion:

- Carpenter Lane: 1 point
- Lusted Hill: 0 points

8.6 Available Gravity Capacity

Performance Scale: The available gravity capacity of the treatment facility for a given site is important in order to maximize the ability to make future adjustments. The site that offers more gravity capacity is preferred. The points are assigned based upon the estimated million gallons per day of available gravity capacity.

Basis for Valuation: At the Carpenter Lane site, there is an estimated 130 +/- MGD of available gravity capacity. At the expanded Lusted Hill site, there is an estimated 200 MGD of available gravity capacity. The actual value at either site will vary depending on piping and treatment plant configurations. The following qualitative scaling from is developed for this criterion:

- Carpenter Lane: 0 points

- Lusted Hill: 1 point

8.7 Electricity Usage

Performance Scale: Electricity usage of the Bull Run filtration plant consists of the required treatment processes and pumping of any water into or out of the plant. By assuming that each site has the same treatment processes, the only differentiator is the amount of water pumping required. The alternative that requires a lesser amount of, or no pumping is preferred.

Basis for Valuation: The following scoring is developed for this criterion:

- Carpenter Lane: 0 points, because it does require the water to be pumped whenever demand exceeds the available gravity capacity. The frequency of pumping is not included or evaluated as part of this analysis.
- Lusted Hill: 1 point, because no pumping is required since the available gravity capacity (200 MGD) exceeds the plant capacity (160 MGD).

8.8 WTP Labor

Performance Scale: This criteria is scaled on the basis of full-time equivalent (FTE) required at the facility site. By assuming that each site has the same treatment processes, the only differentiator is the monitoring and maintenance associated with a pump station.

Basis for Valuation: The Carpenter Lane site requires a pump station, which means more labor is required compared to the Lusted Hill site. Thus, Lusted Hill is a better site for this criterion. The scoring for both the alternatives is as follows:

- Carpenter Lane: 0 points
- Lusted Hill: 1 point

8.9 Safety and Operations

Performance Scale: Safety and operations take into consideration the number and complexity of the treatment plant operations. As with the prior criteria, the assumption that each site has the same treatment processes means the only differentiator is the operation of a pump station.

Basis for Valuation: The scoring for the two alternatives is as follows:

- Carpenter Lane: 0 points, because this site requires a pump station.
- Lusted Hill: 1 point, because this site does not require a pump station.

8.10 Other Infrastructure Ramifications

Performance Scale: The performance scale is based on the need to construct new conduit piping and a pump station to connect the new facility to existing infrastructure. A site that reduces the need for conduit piping or a pump station is anticipated to reduce

infrastructure ramifications and scores higher than a site that has increased infrastructure ramifications.

Basis for Valuation: More conduit piping and a pump station needs to be constructed for the Carpenter Lane site to connect the site to the other PWB transmission infrastructure. The expanded Lusted Hill site is located next to the existing conduits and would not require extensive modification of other infrastructure.

- Carpenter Lane: 0 points
- Lusted Hill: 1 point

8.11 Ease of Construction

Performance Scale: Ease of construction takes into consideration the effect of facility site on the length of construction schedules. With all other factors being equal (capacity, filtration technology, and monthly cash flow), it might be easier to construct on one site as compared to the other.

Basis for Valuation: The following scoring is assigned for this criterion:

- Carpenter Lane: 1 point for being a greenfield site with almost no interfering infrastructure and no requirements to work around the existing system
- Lusted Hill: 0 points, because it has buried conduits that need to be protected during construction

8.12 Implementation Complexity

Performance Scale: Implementation complexity takes into consideration the effect of facility site on the length of construction schedules, design, and start-up time for the facility.

Basis for Valuation: The following scoring is assigned for this criterion:

- Carpenter Lane: 0 points, because more infrastructure (conduit piping and pump station) needs to be built
- Lusted Hill: 1 point, because less infrastructure needs to be built

8.13 Land Use Permits

Performance Scale: The time to acquire land use permits could impact the project schedule. The site that requires the least amount of permitting time, and schedule risk, is preferred.

Basis for Valuation: Carpenter Lane site is zoned MUA20 and is anticipated to follow a standard Conditional Use review process, making the land use application approval more likely.

The Lusted Hill site is zoned EFU and requires that PWB conduct an analysis of the surrounding area and successfully demonstrate to the county that nearby non-EFU parcels cannot be used. The time and effort for successful demonstration for Lusted Hill

will likely be longer than the approval process for Carpenter Lane, and land use application approval at Lusted Hill may still not occur.

- Carpenter Lane: 1 point
- Lusted Hill: 0 points

8.14 On- and Off-site Ownership

Performance Scale: The performance scale is based on whether the site is owned by the City of Portland or not. A site owned by the City would score higher than one not owned by the City.

Basis for Valuation: Carpenter Lane is a City-owned site and therefore does not require land acquisition. The additional land needed to expand Lusted Hill is not owned by the City and requires land acquisition.

- Carpenter Lane: 1 point
- Lusted Hill: 0 points

9.0 Evaluation

The PWB Filtration Team, including all representatives of the Executive Team, met on May 23, 2018, to review the performance of the site alternatives and reach a conclusion on the preferred site alternative. The decision model incorporated the values, criteria, and performance scales of the two viable site alternatives. The resulting scoring was used to highlight site differences, prompt team discussion around potential concerns, and help the team select a preferred alternative. Throughout the evaluation and review, the team reminded itself that the decision model alone does not make the decision. This context assured that the decision model and the evaluation of alternatives were designed to inform the technical team and the Executive Committee, not make the decision for PWB.

Three weighting scenarios were carried through the process to reflect the different perspectives of the PWB team members. The three weighting scenarios were:

1. Team Weighted (TW) – The PWB Filtration Team weights produced on March 27, 2018.
2. Equal Weights (EQ) – Equal weights among the eight values.
3. Split (SP) – A 60/40 split weighting where 40 percent of the weight remained with Public Health Water Quality (25 percent) and Reliability (15 percent) as identified in the team weighted scenario, and the remaining 60 percent was distributed equally among the other six values.

These weighting scenarios were carried through the evaluation process to demonstrate weighting sensitivity. The summary of these weights are shown in Table 4. Note that the Public Health and Water Quality value and its associated criteria are not included in the weighting table. Table 2 above summarizes the reasoning for excluding the Public Health and Water Quality value. The numbers in Table 4 present the relative weight of the values (highlighted in

dark blue) and the distribution of the weights across criteria within specific criteria (highlighted in light blue).

Table 4. Weighting Scenarios

ID#	Evaluation Criteria	TW	EQ	SP
2	**Resiliency/Reliability**	15	12.5	15
3	**Community Interests**	9	12.5	10
4	**Cost Benefit**	12	12.5	10
4.1	Capital cost	5.4	6.25	5
4.2	Lifecycle cost	6.6	6.25	5
5	**Future Needs**	10	12.5	10
5.1	Capacity	5.2	6.25	5
5.2	Available gravity capacity	4.8	6.25	5
6	**Environmental Impacts**	7	12.5	10
7	**Integration**	12	12.5	10
7.1	WTP Labor	5.3	4.17	3.33
7.2	Safety & Operations	3.2	4.17	3.33
7.3	Other ramifications	3.5	4.17	3.33
8	**Implementation**	10	12.5	10
8.1	Ease of Construction: Risk to schedule	2.2	3.125	2.5
8.2	Implementation Complexity: Risk to schedule	3.1	3.125	2.5
8.3	Land use permits	2.4	3.125	2.5
8.4	On- and Off-site ownership	2.2	3.125	2.5

The performance ratings of the alternatives found in Table 3 and the weighting of the values and criteria found in Table 4 are the inputs for the evaluation of the site alternatives. The normalized performance rating multiplied by the weight and added across values and criteria produces a value score. Table 5 demonstrates this calculation.

Columns K and L in Table 5 list the values and criteria and their associated weights. In the calculation in Table 5, the weights that are showcased are those associated with the Team weighting scheme (TW) in Table 4. Column B of Table 5 displays the weight percentage of each value/criterion. This weight percentage is the number that is carried through the evaluation calculation. Columns E and F summarize the performance ratings of each site alternative. These are the same numbers that are presented in Table 3 and further characterized in Section 8. Columns C and D reflect the minimum and maximum performance ratings among the alternatives. Columns G and H are the normalized performance ratings of the two alternatives. Normalization (calculating performance in a 0 to 1 scale) is done for all performance scales to allow for common application in the evaluation. Regardless of the scale used to demonstrate performance of the alternatives (i.e., performance scale of site acres for Community Interests/Local Impacts), normalization produces a 0 for the worst performer and a 1 for the best

performer within each value/criterion. Columns I and J are the calculated values scores for each value/criterion. This is the multiplication of the weight (Column B) times the Normalized Rating (Column G or H) times 100 (the 100 is just to make the result a more manageable number). The calculations within each cell of Columns I and J reflect the contribution of value the respective alternative receives from the specific value/criteria. The summation of these contributions down Column I or J produces the total value score for each site alternative. The result for Carpenter Lane is 48.1 and for Lusted Hill is 51.9. These total values scores demonstrate, relatively, how well the alternatives perform against the values and criteria. The higher the number, the better the relative performance.

Table 5. Value Score Calculations

A	B	C	D	E	F	G	H	I	J	K	L
	Weight %	Raw Ratings				Normalized Ratings		Value Scores (weight times normalized rating times 100)			
Value/ Criteria No.	TW	Minimum	Maximum	Carpenter Lane	Lusted Hill	Carpenter Lane	Lusted Hill	Carpenter Lane	Lusted Hill	**Value**/Criteria	Assigned Weight (TW)
2	20.0%	0	1	1	0	1	0	20.0	0.0	**Resiliency/Reliability/**Earthquake	15
3	12.0%	0	1	1	0	1	0	12.0	0.0	**Community Interests/**Local Impacts	9
4.1	7.2%	0	1	0	1	0	1	0.0	7.2	**Cost Benefit/**Cost of Construction	5.4
4.2	8.8%	0	1	0	1	0	1	0.0	8.8	**Cost Benefit/**Cost of Delivered Water	6.6
5.1	6.9%	0	1	1	0	1	0	6.9	0.0	**Future Needs/**Capacity	5.2
5.2	6.4%	0	1	0	1	0	1	0.0	6.4	**Future Needs/**Available Gravity Capacity	4.8
6	9.3%	0	1	0	1	0	1	0.0	9.3	**Environmental Impacts/**Electricity Usage	7
7.1	7.1%	0	1	0	1	0	1	0.0	7.1	**Integration/**WTP Labor	5.3
7.2	4.3%	0	1	0	1	0	1	0.0	4.3	**Integration/**Safety & Operations	3.2
7.3	4.7%	0	1	0	1	0	1	0.0	4.7	**Integration/**Other Ramifications	3.5
8.1	3.0%	0	1	1	0	1	0	3.0	0.0	**Implementation/**Ease of Construction	2.2
8.2	4.2%	0	1	0	1	0	1	0.0	4.2	**Implementation/**Implementation Complexity	3.1
8.3	3.2%	0	1	1	0	1	0	3.2	0.0	**Implementation/**Land Use Permits	2.4
8.4	3.0%	0	1	1	0	1	0	3.0	0.0	**Implementation/**On & Off-site Ownership	2.2
						Total Value Scores (sum of all values/criteria value scores):		**48.1**	**51.9**		

Figures 9 through 11 demonstrate the performance of the two site alternatives within the three different weighting scenarios. The numbers below each stacked bar present the summation of the value score. Each color of the stacked bar represents the contribution the alternative received from each value. Each value has criteria that are used to gauge the performance of the alternatives. The size of the colored bar is determined by multiplying the performance score the alternative received (Table 3) by the weight of the specific criterion (Table 4). The results of the criteria scores are then added to produce the total contribution per value. The higher the total score, the higher the collective performance of the alternative against the values.

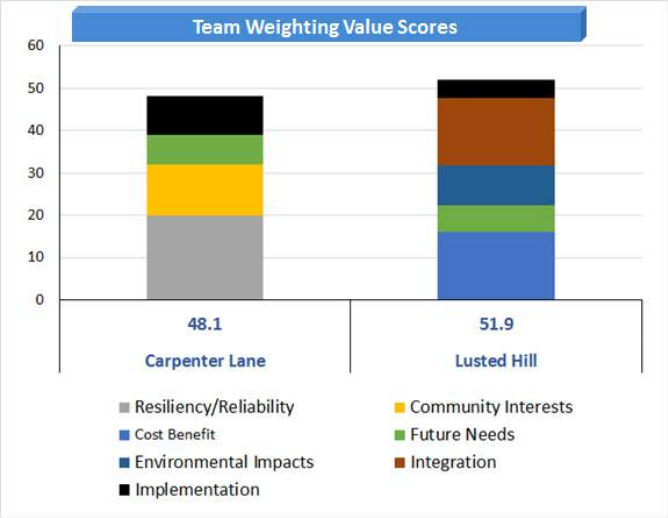


Figure 9. Team Weighting Value Scores

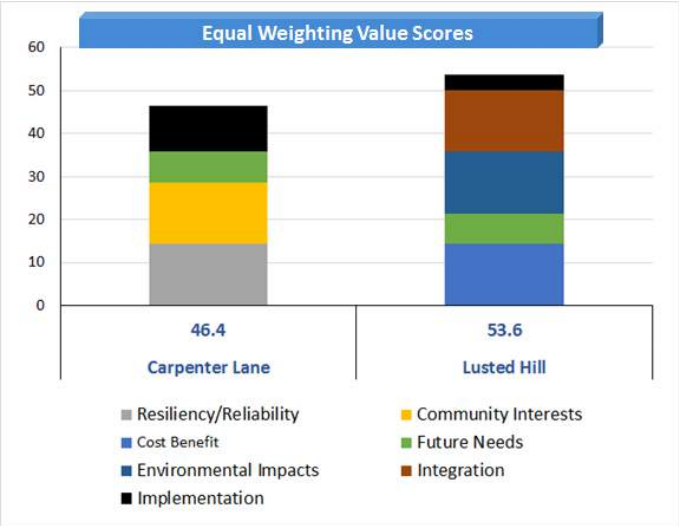


Figure 10. Equal Weighting Value Scores

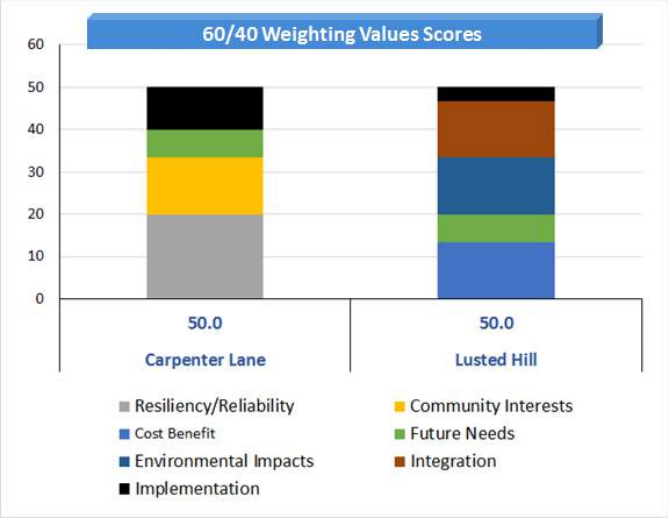


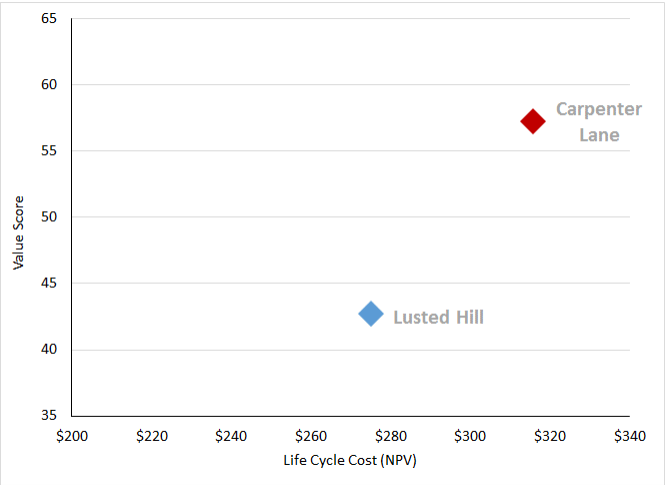
Figure 11. 60/40 Split Weighting Value Scores

In two of the three weighing schemes, Lusted Hill has a slight numerical advantage over Carpenter Lane. The split weighting scheme (the third weighting scheme) shows the two alternatives performing evenly.

Another means to evaluate the performance of the alternatives is to contrast the total cost of the alternatives (the actual cost of construction plus the cost of total delivered water) against their total value score. This comparison provides another view of the value received versus the total cost of the alternative. The value score for this calculation includes Resiliency/Reliability, Community Interests, Future Needs, Environmental Impacts, Integration, and Implementation values. To avoid double counting of the cost element, the Cost Benefit value is removed from the calculation of the value score. The resulting total value score is then graphically plotted against the total alternative cost (see Figures 12 through 14). The results demonstrate the superior position of Carpenter Lane in terms of cost and cost per unit of value.

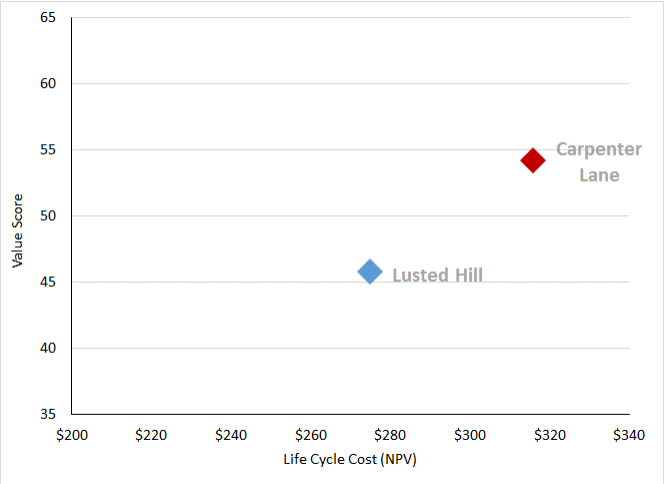
The total alternative cost is based upon the addition of a baseline cost of construction of $275 million for a 160 MGD facility. The total cost of delivered water is added to this baseline cost to produce the total alternative cost associated with each site. Lusted Hill has no additional cost of delivered water. Carpenter Lane has an additional cost of delivered water of: $41.4 million – a $13.1 million pump station and $28.3 million for 2.8 miles of Conduit 5.

This comparison also allows for a calculation of the investment required per unit of value. The table associated with the scatter plot presents the total cost ($M) to gain a unit of value. The table also demonstrates the additional alternative cost and resulting additional value in the movement to more valued alternatives. The same three weighting scenarios are evaluated.



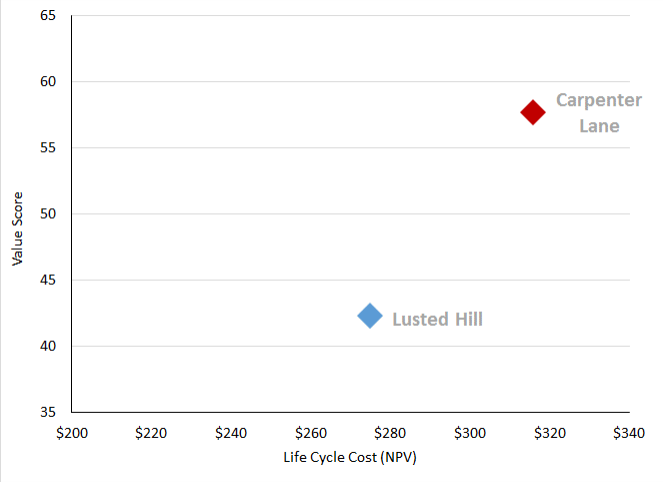
	Value Score	Alternative Cost $M	$M per unit of value (lower better)	Additional value	Additional Alternative Cost $M	Additional $M per unit of value
Carpenter Lane	57.3	$ 316.00	$ 5.52	14.5	$ 41.00	2.83
Lusted Hill	42.7	$ 275.00	$ 6.43	---	---	---

Figure 12. Team Weighting Scatter Plot[1]



	Value Score	Alternative Cost $M	$M per unit of value (lower better)	Additional value	Additional Alternative Cost $M	Additional $M per unit of value
Carpenter Lane	54.2	$ 316.00	$ 5.83	8.3	$ 41.00	4.92
Lusted Hill	45.8	$ 275.00	$ 6.00	---	---	---

Figure 13. Equal Weighting Scatter Plot[2]



	Value Score	Alternative Cost $M	$M per unit of value (lower better)	Additional value	Additional Alternative Cost $M	Additional $M per unit of value
Carpenter Lane	57.7	$ 316.00	$ 5.48	15.4	$ 41.00	2.67
Lusted Hill	42.3	$ 275.00	$ 6.50	---	---	---

Figure 14. 60/40 Split Weighting Scatter Plot[3]

All of the scatter plot views demonstrate the performance benefit of Carpenter Lane, but with additional investment required.

The PWB Filtration Team produced one additional view of the performance data. Further discussion on May 23, 2018, moved the team to reconsider the influence of some of the criteria; in particular, the weighting of the values and criteria. This was done to help the technical team and the Executive Committee better understand the importance and influence of specific criteria, demonstrate tradeoffs, and support conversation among the team members. Based upon the technical team's deliberations, a refreshed weighting scheme was produced. Table 6 below displays the results of this modified weighting scheme. The modified weighting scheme is the first set of numbers, the last column presents the original weighting scheme for comparison. Note that the Public Health and Water Quality value and its associated criteria are not included in the weighting table because that value was deemed to not be applicable to the evaluating the site alternatives.

[1] The total alternative cost is based upon the addition of a baseline cost of construction of $275 million for a 160 MGD facility. The total cost of delivered water is added to this baseline cost to produce the total alternative associated with each site. Lusted Hill has no additional cost of delivered water. Carpenter Lane has an additional cost of delivered water of: $41.4 million – a $13.1 million pump station and $28.3 million for 2.8 miles of Conduit 5.
[2] ibid
[3] Ibid

Table 6. Modified Weighting Scheme

ID#	Evaluation Criteria	Modified Weighting SP	Original Weighting SP
2	**Resiliency/Reliability**	10	15
3	**Community Interests**	5	10
4	**Cost Benefit**	10	10
4.1	Capital cost	5	5
4.2	Lifecycle cost	5	5
5	**Future Needs**	20	10
5.1	Capacity	6	5
5.2	Available gravity capacity	14	5
6	**Environmental Impacts**	10	10
7	**Integration**	10	10
7.1	WTP Labor	3.33	3.33
7.2	Safety & Operations	3.33	3.33
7.3	Other ramifications	3.33	3.33
8	**Implementation**	30	10
8.1	Ease of Construction: Risk to schedule	7.5	2.5
8.2	Implementation Complexity: Risk to schedule	7.5	2.5
8.3	Land use permits	7.5	2.5
8.4	On- and Off-site ownership	7.5	2.5

The modifications to this new weighting scheme included a decrease in Resiliency/Reliability and Community Interests values (which some team members thought seemed over-valued), and an increase in Future Needs and Implementation values (which some team members thought seemed under-valued), and an increase in Future Needs and Implementation values (which some team members thought seemed under-valued due to the possible complexities of land use). This was done primarily to reflect the strong influence of land-use upon the schedule. The resultant scoring from this revision is shown on the following figures 15 and 16.

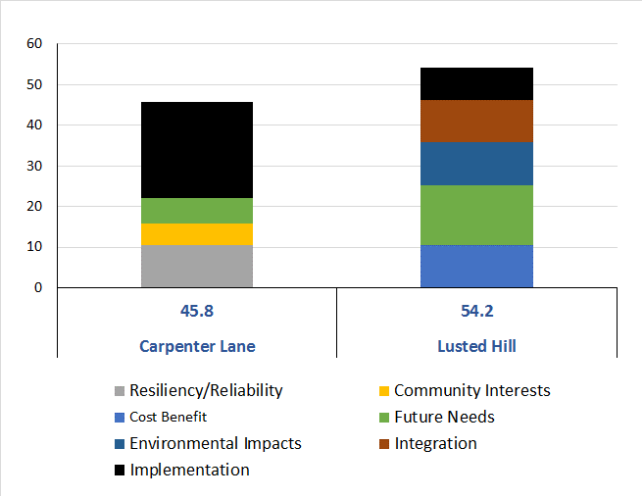
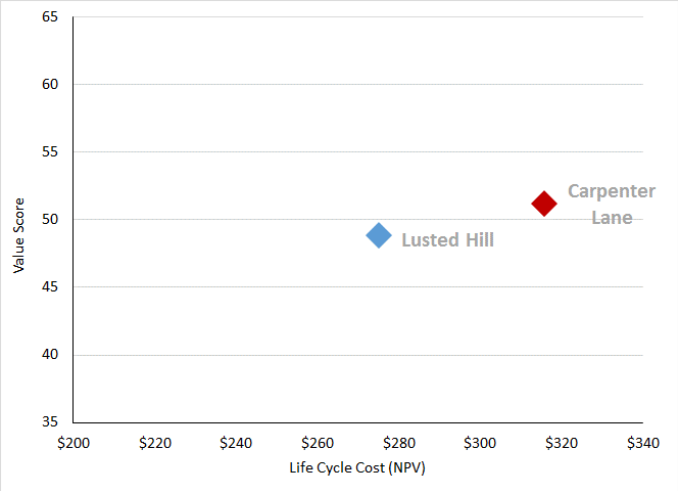


Figure 15. Modified Team Weighting Value Scores



	Value Score	Alternative Cost $M	$M per unit of value (lower better)	Additional value	Additional Alternative Cost $M	Additional $M per unit of value
Carpenter Lane	51.2	$ 316.00	$ 6.17	2.4	$ 41.00	17.41
Lusted Hill	48.8	$ 275.00	$ 5.63	---	---	---

Figure 16. Modified Weighting Value Scatter Plot

Again, this modified weighting scheme demonstrated that Lusted Hill value score when incorporating all values (Figure 15), but Carpenter Lane was a better alternative in the value versus alternative cost view (Figure 16).

All four weighting scenarios were used to help the Filtration Team discuss the pros and cons of each site, which included the uncertainty associated with land use application approval at Lusted Hill and the additional costs associated with Carpenter Lane. At two times in the deliberations, voting was cast for a preferred alternative. No clear consensus was reached by the project team but the pros and cons of both options were relayed to the Executive Committee for their consideration.

Upon seeking legal advice on setting up a facility on a land designated as EFU, the following feedback was received:

Under ORS 215.275, a utility facility for public service may be sited on EFU land in a nonmarginal lands county if reasonable alternatives have been considered and the facility must be sited on EFU land due to one or more of the following six factors:

- Technical and engineering feasibility;
- The proposed facility is locationally dependent. A utility facility is locationally dependent if it must cross land in one or more areas zoned for EFU in order to achieve a reasonably direct route or to meet unique geographical needs that cannot be satisfied on other lands;
- Lack of available urban and non-resource lands;
- Availability of existing rights of way;
- Public health and safety; and
- Other requirements of state or federal agencies.

Per these factors, the availability of existing ROWs (Conduits 2 and 4) is the most reasonably applicable factor. This single factor is likely insufficient to support rejecting Carpenter Lane as a reasonable alternative. The fact that Carpenter Lane is an available non-resource land, condemned for the purpose of a future filtration plant is also a factor that will likely weigh heavily against any argument that the filtration plant must be sited on EFU land.

The other point of discussion during the Executive Committee meeting was handling capacity at the Carpenter Lane site. Since the Carpenter Lane site is located higher than the existing HGL, the gravity flow capacity would be less than 160 MGD (approximately 130 MGD), the chosen capacity of the future facility. Although the site can be connected to Dam 2 to take advantage of higher head in the future, construction of Conduit 5 and connecting to Dam 2 are not part of the treatment plant development. To provide capacity of 160 MGD, a combination of treatment facility elevation, pumping, and piping choices will need to be developed. Further, after Tualatin Valley Water District reduces their demand, the stress year summer average demand is anticipated to be around 110 MGD. In that case, 130 MGD might be sufficient to meet the near-term average day demands.

10.0 Recommendation

The results from the decision model were discussed at length by the PWB Filtration Team and the Executive Committee. Since the scores for both the alternatives were so close in all three initial weighting schemes and the modified weighting scheme, the filtration team and the Executive Committee were split between the two sites. A major concern was with Lusted Hill being an EFU zoned site. Receiving a conditional land use approval on EFU zoned land was identified as a significant hurdle. Team members with more extensive knowledge of state land use felt an approval was unlikely to be granted. Others felt that even if an approval would eventually be granted, the approval process would be drawn out to the point where it would likely prevent PWB from meeting the compliance deadline.

The team was concerned about the risk to the schedule of siting the facility within an EFU zone. To be better informed about this risk, the Executive Committee consulted with the City Attorney. The City Attorney's opinion was that in this situation attempting to build on EFU land would be an unacceptable risk to the schedule. Therefore, Carpenter Lane was selected by the Executive Committee.

Appendices

A. Bull Run Treatment Decision

B. Bun Run Treatment Panel

C. Draft Site Considerations for PWB Water Treatment Facility

D. Zoning and land Use Review Analysis for Bull Run Treatment

Appendix A: Bull Run Treatment Decision

BULL RUN TREATMENT DECISION PROJECT

TECHNICAL MEMORANDUM: WATER TREATMENT PLANT SITING EVALUATION

This Technical Memorandum summarizes the results of siting investigations for a potential future water treatment facility for the City of Portland.

BACKGROUND

Treatment for the inactivation of the parasite *Cryptosporidium* will be mandated by federal regulation, scheduled for promulgation in 2003. It is anticipated that the schedule for compliance with this regulation will require the installation of additional disinfection or filtration treatment for the Bull Run supply by 2011.

In April 2001, the Portland Bureau of Water Works (Bureau) convened the Bull Run Treatment Panel (BRTP) to evaluate options for the future treatment of the Bull Run supply. The BRTP included representatives from a broad range of interests and backgrounds, including public health, environmental protection, wholesale water customers of the City, the business community and the public at large. The BRTP was asked to make recommendations to the Bureau and to Portland City Commissioner Eric Sten on three specific questions:

- What type of treatment should Portland use to meet its water quality goals?
- Where should the treatment facility be sited?
- How should the facility be financed and implemented?

Siting evaluations were conducted in order to provide information to the BRTP. The BRTP was asked to conduct its deliberations within a framework that included considerations of long-term water supply, demand and related issues in the region.

SITING EVALUATION TECHNICAL SUMMARY

This Technical Memorandum summarizes the technical information and analysis that was presented to the BRTP. This information provided the basis for the siting recommendation given above.

Site selection criteria

A set of site selection criteria was developed by the Bureau in order to screen the universe of potential treatment sites. These criteria were categorized by the Bureau as

either “essential” or “desirable”. The essential criteria are “pass/fail”, in that any site unable to meet one or more of these criteria would not be considered. This criteria list served as the primary screening tool. The list of desirable criteria is much longer, and was used by the BRTP to select among potentially feasible sites. These criteria consider relative costs and benefits, and can be measured either qualitatively or quantitatively.

Tier 1 - Essential Criteria. These criteria are essential to the proper functioning of the water treatment facility. Failure to meet the criteria eliminates a site from consideration. The BRTP reviewed and approved these criteria. The essential siting criteria are:

- The distance from the existing Bull Run transmission conduits to the treatment plant site must be less than 2 miles. This criterion functions as a surrogate for cost, and sets a limit on the acceptable cost of transmission into and out of the treatment plant. For an initial plant capacity of 250 mgd, an approximate cost for connection to the existing conduits is $30 million. This assumes that two 84-inch diameter lines would be constructed and intertied to the existing conduits. Transmission costs have been taken from the technical report *Supply, Transmission and Storage Analysis* (CH2M Hill & Montgomery Watson, August 2000) and updated based on the current Seattle-area Construction Cost Index of 7556 (May 2002). Costs include construction, engineering and administration, environmental studies and permitting. Potential environmental mitigation costs are not included in this cost estimate.
- The size of the parcel must accommodate the ultimate size of the facility. The facility is assumed to be ultimately expandable to 500 million gallons per day (mgd) of capacity. For non-filtration technologies (UV and ozone), the required size of the parcel is 5 to 10 acres. For filtration treatment (direct filtration or membranes), the required size of the parcel is 25 to 50 acres. Based on the BRTP’s recommendation for membrane treatment, the required minimum parcel size is 25 acres.
- The parcel must be located outside a geologic hazard zone. Site geology must be suitable for construction.
- Site slopes must be less than 20 percent over at least 90 percent of the area of the parcel.
- The facility must be able to achieve a minimum flow by gravity of 95 mgd. This flow is equal to the current average winter demand. This criterion assures that the Bureau will be able to deliver a base level of supply by gravity and prevents a situation where the Bureau is completely dependent on pumping facilities to meet demand. The Bull Run system currently operates entirely by gravity to deliver water to major storage reservoirs at Powell Butte, Mount Tabor and Washington Park. Some pumped service is required to provide supply to the west hills and portions of south Washington County. The gravity flow criterion constrains the elevation of suitable sites. If a potential treatment site is too high, water will not be able to flow into the plant by gravity. Similarly, if the site is too low, water cannot flow out of the plant for

delivery. It is assumed that pumping would be required to achieve the full plant flow of 250 mgd.

Tier 2 – Desirable Criteria. These site criteria were developed by the Bureau. They are not essential to the functioning of the facility, but will affect cost, reliability, and ease of operation. These criteria are:

- In Water Bureau ownership or vacant with ability to purchase. The criterion assumes that the City would not condemn existing residential or commercial developments in order to acquire property
- Distance to conduits equal/less than 1 mile
- Maximizes gravity flow
- Secure site
- Ease of locating SCADA/communications
- Ability to secure environmental permits
- Known site conditions
- Power availability
- Power reliability
- minimize upstream customers
- maximize available head
- good work location for staff
- minimize emergency response time
- ability to use/treat multiple sources
- ease of access
- no pretreatment required for conduits
- minimize construction costs
- compatibility with existing operations
- compatibility with existing facilities
- compatibility with potential future regional connections
- ease of FERC permitting
- ease of waste stream discharge
- compatibility with land use
- minimize neighborhood opposition
- outside of wild and scenic corridors
- favorable hydraulic conditions at high flows
- educational/public value

GIS Screening for Essential Criteria

GIS is a computer system that is capable of assembling, storing, manipulating and displaying geographically-referenced information. GIS has many applications, and is commonly used for development planning and siting. A GIS system can integrate many different sets of information and overlay them to evaluate a site with respect to multiple criteria. This approach was used in the siting evaluation. The criteria listed above were translated into physical features that could be mapped, and information was graphically layered to eliminate unsuitable sites in an iterative process. The sections below provide a step-by-step discussion of the site screening process.

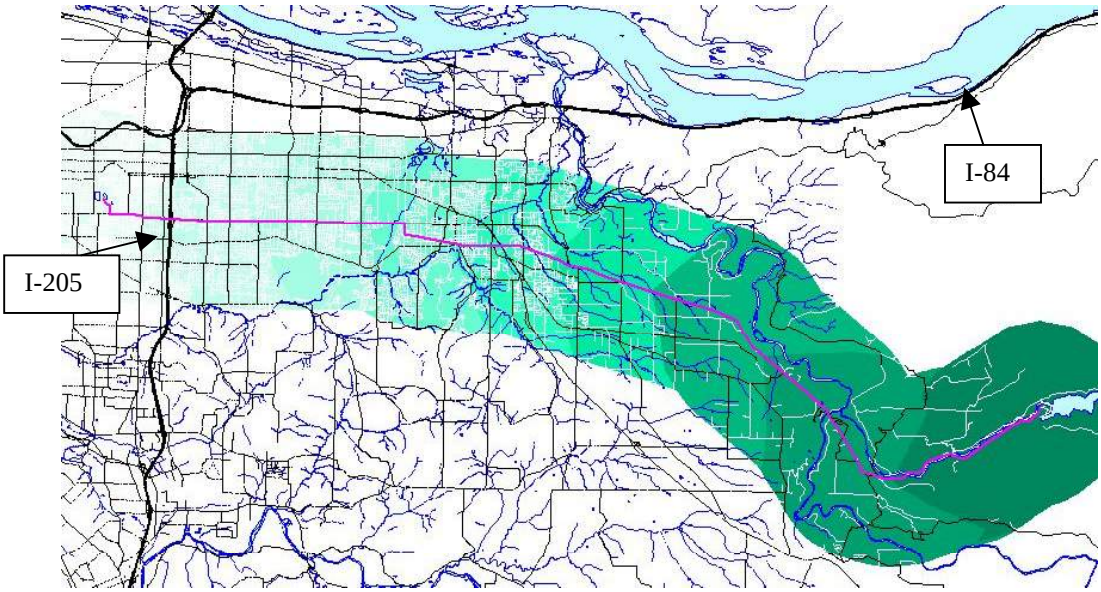
Step 1. Data from Metro's Regional Land Information System (RLIS) was used as a starting point for development of the site screening GIS database. The RLIS files are the most accurate and current files available. These files contain multiple data sets including: streets, tax lots, service boundaries, land use and zoning designations, environmental conditions including water features (i.e. streams, rivers and wetlands) and major structures. The RLIS data files were supplemented with a Digital Elevation Model (DEM) created from the US Geological Survey (USGS). The DEM file provided a virtual model of the geographic landform of the region, and was used to screen potential sites for elevation and slope.

Step 2. The alignment of the existing Bull Run supply conduits was incorporated into the GIS database, as shown in Figure 1. In order to simplify the analysis, a generalized conduit alignment was developed to approximate the centerline of the three existing conduits.

Figure 1
Existing Conduit Alignments

Step 3. A two-mile buffer was established along each side of the generalized conduit alignment. This created a visual representation of the first essential site selection criteria. The buffer was approximate and did not account for road access, terrain or major barriers such as freeways and rivers. Figure 2 illustrates the 2-mile buffer.

Figure 2
Two-Mile Buffer Along the Generalized Conduit



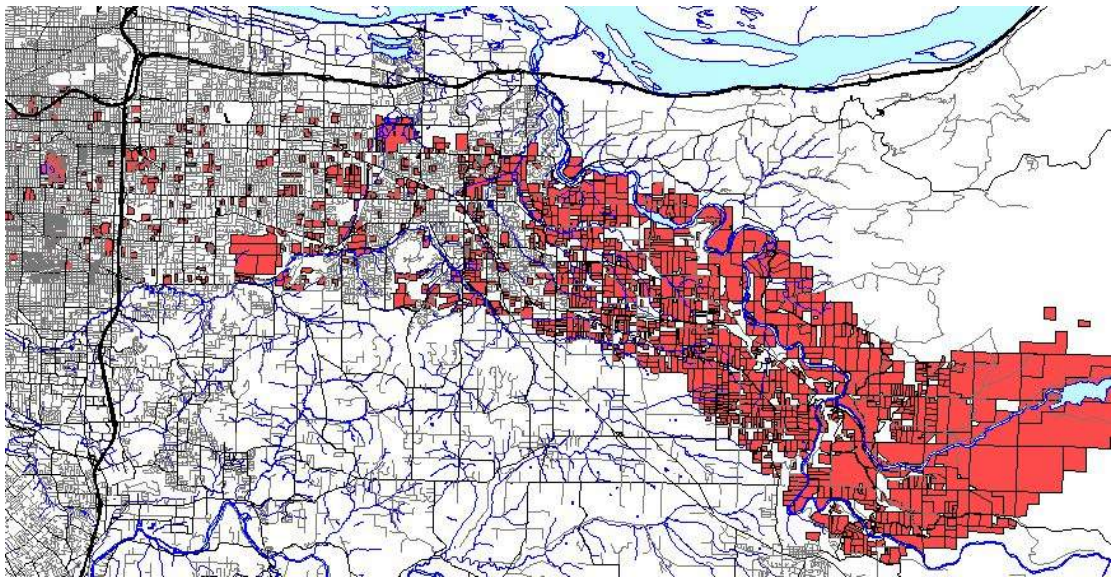
Step 4. The minimum parcel size as described above is 5 acres for a disinfection only treatment process. Filtration processes are more space intensive, and could require as much as 50 acres of land to achieve an ultimate capacity of 500 mgd. The GIS database was sorted by parcel size. As a simplifying assumption, no allowance was made for assembling smaller parcels to create a parcel of adequate size. Subsequent analysis considered areas within parcels that might limit development. Figure 3 shows a breakdown of parcels within the two-mile corridor by size classifications: >5 acres but < 15 acres, >15 acres but < 25 acres and >25 acres. Parcel size classifications are shown in Figure 3.

Step 5. Site slopes have the potential to limit construction on the site. Maximum acceptable slopes for construction of the treatment facility were defined as 20 percent. The analysis sorted parcels into slope ranges of 0-10 percent, 10-20 percent and above 20 percent. This information is shown in Figure 4. If a parcel had a portion that met the

minimum size requirement with acceptable slopes, that parcel was considered adequate, even if parts of the parcel had slopes outside the acceptable range.

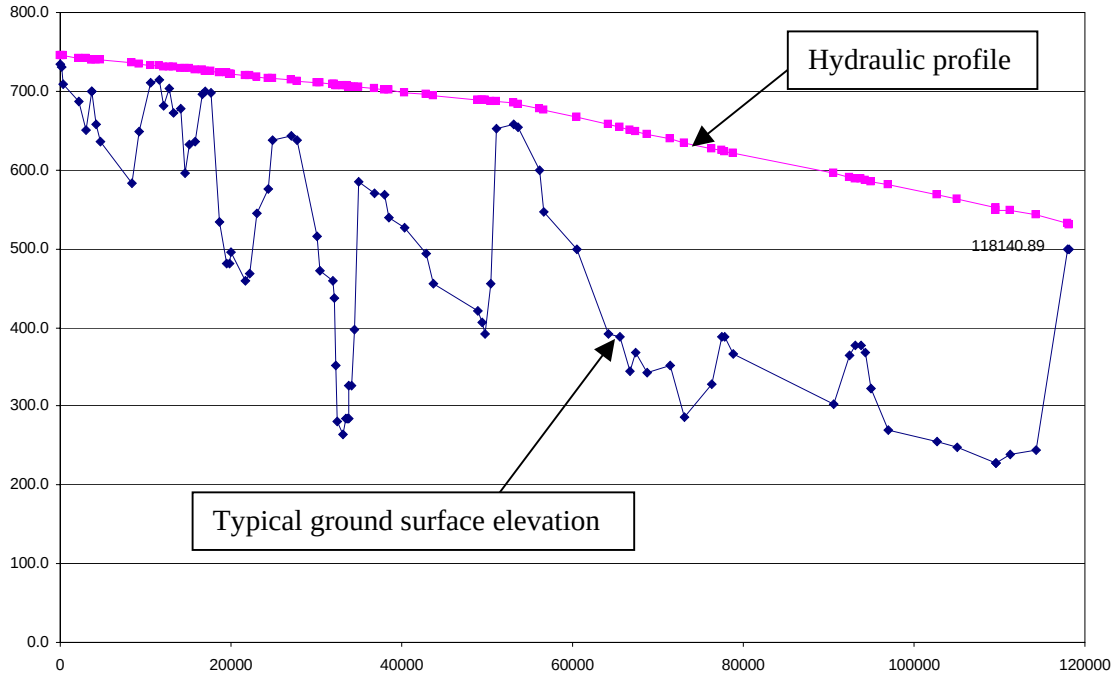
Step 6. The information generated for site slope, parcel size and distance from conduits was combined to provide a preliminary view of the universe of sites meeting most of the essential criteria. This view is given in Figure 5.

Figure 5
Parcels Meeting Size, Distance and Slope Criteria



Step 7. Site elevation was the final essential criteria to be evaluated. Specifically, the site must be capable of achieving a flow by gravity of 95 mgd. In a gravity system, water possesses energy (also known as "head"), and that energy is dissipated as water flows downhill from the Bull Run watershed to the City. Energy is primarily lost through friction in the piping, valves and fittings of the conduit system. The profile of energy loss through the system determines the acceptable elevation of the treatment facility. The facility must be at an elevation below the potential head at any location, yet high enough to retain energy for subsequent distribution. Thus, the acceptable elevation will vary along the conduit route, and must also account for head loss between the facility and the conduits. Figure 6 illustrates the energy profile for existing Conduit 4 at its origin in the Bull Run outlet works to its connection at the Powell Butte Reservoir.

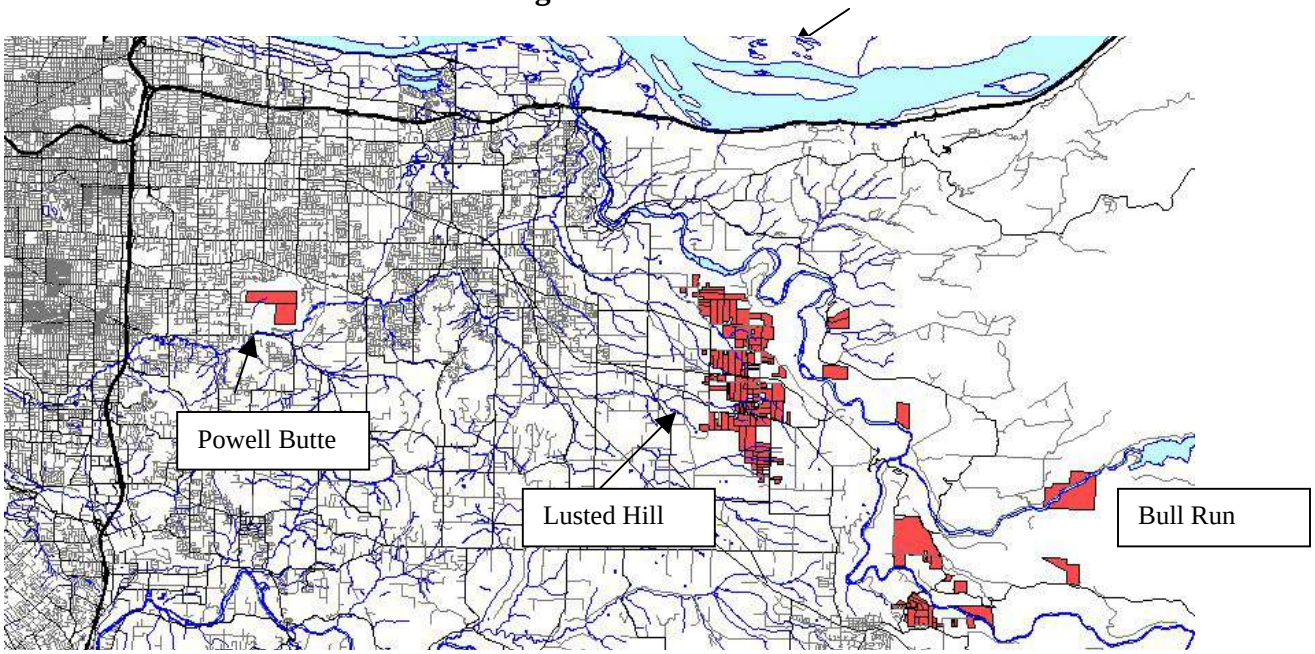
Figure 6
Hydraulic Profile of Conduit 4



For the siting evaluation, a gradient of headloss along the generalized conduit alignment was created. Headloss along the lateral lines connecting the treatment plant to the conduits was also accounted for, within the two-mile buffer. A three-dimensional surface representing acceptable elevation was created along the conduit alignment. The range of acceptable ground elevation was assumed to extend from 0 to 15 feet below the hydraulic profile, because some flexibility is provided by the ability to lower the water surface on a particular site by burying the water-holding structures. Site elevation data and the headloss surface profile were layered in order to identify hydraulically acceptable sites. This view is shown in Figure 7. A second iteration was performed to identify additional sites lying from 15 to 30 feet below the hydraulic grade line. No additional sites were found in this elevation range that met the other essential site criteria.

Step 8. In the final iteration, all essential criteria were layered to observe those sites capable of meeting criteria. This view is shown in Figure 8. Suitable parcels are shaded red.

Figure 8
Parcels Meeting All Essential Criteria



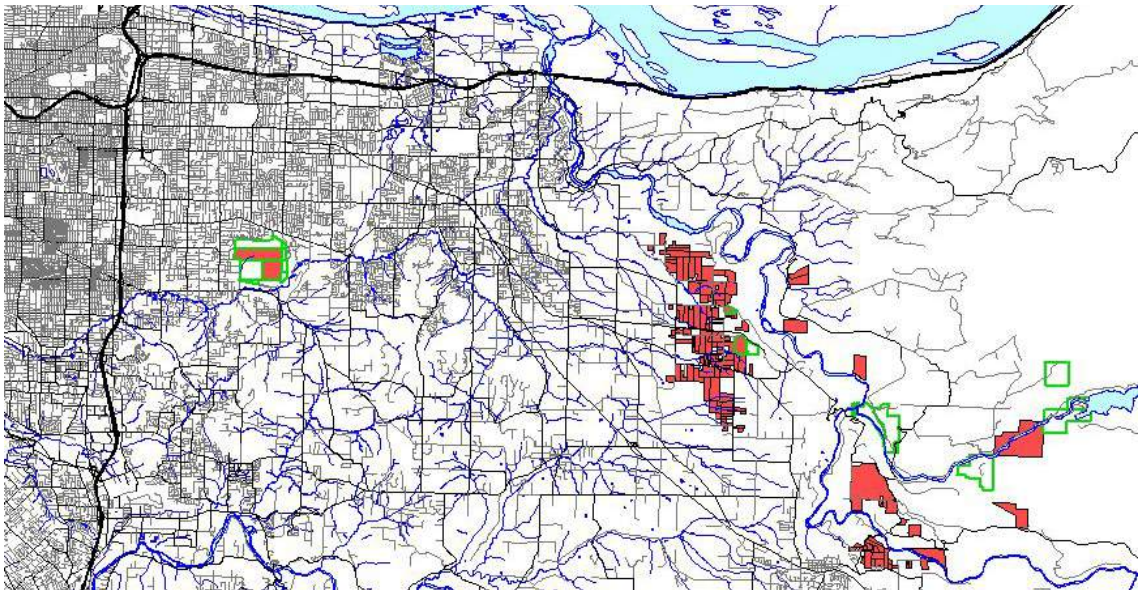
To the west, the Powell Butte property is seen to meet all essential criteria. Further east, multiple parcels in the Lusted Hill area meet the criteria. Even farther east, parcels in and around the Bull Run watershed also meet these criteria.

GIS screening of desirable criteria

Some additional evaluation was undertaken to provide information on the suitability of acceptable sites with respect to non-essential criteria. Specifically, land ownership and zoning were evaluated using the GIS tool. The results of an iterative evaluation of these criteria are given below.

Land ownership. This criterion assumes that sites already in City ownership are preferable, and that the Bureau would not condemn existing residential or commercial developments in order to acquire property. Figure 9 overlays City ownership on those sites meeting all essential criteria. City ownership is shown by the green boundary, and acceptable sites are shaded red. Powell Butte and Lusted Hill parcels meet all of these criteria. With the exception of a small area (less than 10 acres) at the Bull Run Headworks, most of the City's property in the Bull Run area is not at suitable elevation for a treatment facility.

Figure 9
Sites Meeting Essential Criteria Overlain with City Ownership



Land Use and Zoning. The relationship of sites meeting the essential criteria to the Urban Growth Boundary (UGB) is shown in Figure 10. Only the Powell Butte site is within the UGB. Sites outside the UGB are subject to state regulations for resource protection. Specifically, lands designated by the state as Exclusive Farm Use (EFU) or equivalent timber zone are subject to stringent regulations limiting development. A GIS view was created to evaluate the compatibility of sites meeting essential criteria having resource lands designations. Presumably, parcels having such designations would be much more difficult for siting. Figure 11 shows a view of acceptable sites that are also free of restrictive resource lands designations.

Figure 10
Relationship of Sites to UGB

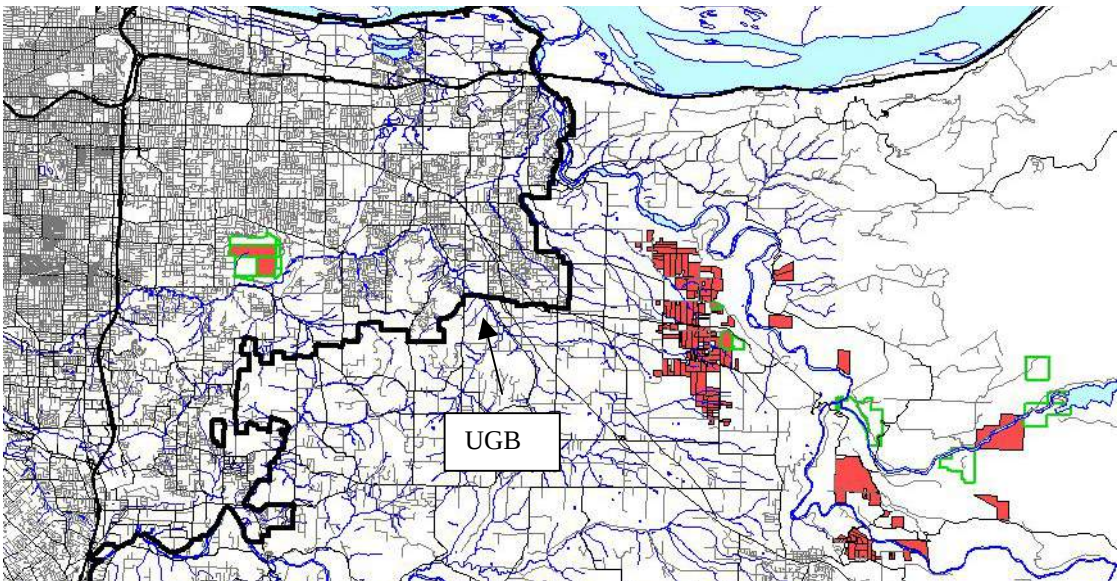
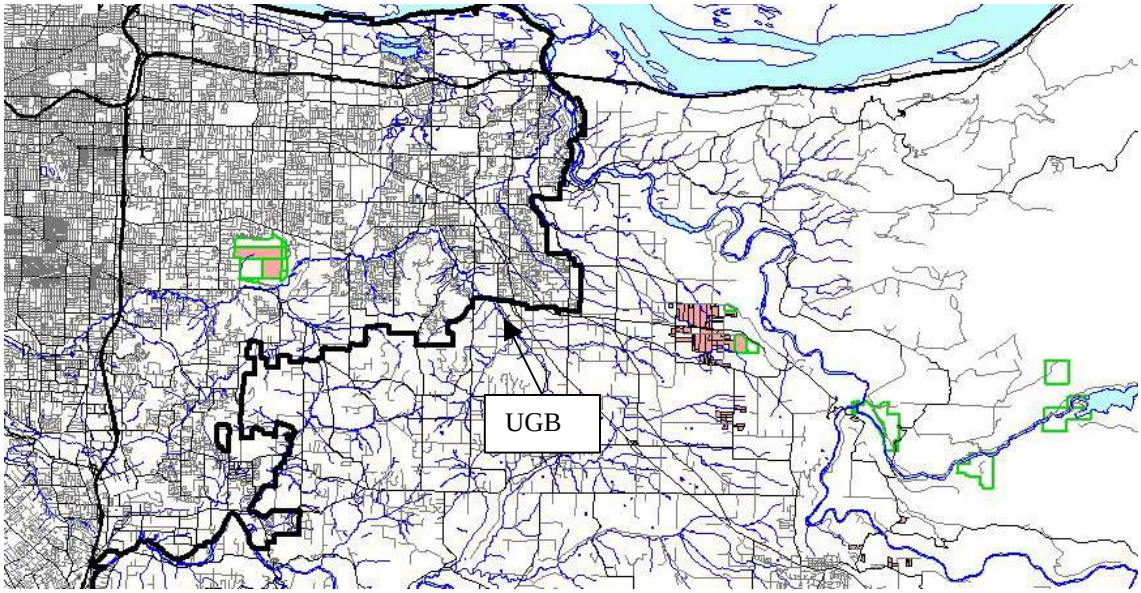


Figure 11
Relationship of Sites to Non-Resource Lands Designation



The Powell Butte site and the Lusted Hill area are still acceptable according to these criteria. The BRTP requested additional information on whether the treatment plant could trigger a conflict with the Statewide Planning Goals related to development outside the UGB for the Lusted Hill site. Additional research was conducted on the compatibility of the treatment facility at Lusted Hill, and a memorandum summarizing these findings is contained in the Appendix. In summary, neither the Statewide Planning Goals nor the Oregon Administrative Rules will prevent the siting of a facility at Lusted Hill. Multnomah County would need to approve a conditional use permit. County approval will be based on the nature of the impacts, and these would need to be carefully addressed by the Bureau.

Summary of candidate sites

The GIS tool was applied in order to identify a field of sites that met all essential criteria. Limited evaluation of sites with respect to land use and ownership was also conducted using GIS. The evaluation resulted in the identification of three primary sites for a future treatment facility. The characteristics of these sites are described below.

Bull Run Headworks. The parcel size in City ownership is about 10 acres. It is the current location for disinfection treatment with chlorine. The site is closed to public access and is within the Mount Hood National Forest Management Unit. The existing conduits number 2, 3 and 4 originate at the Headworks. The primary advantage of this site is its compatibility with existing operations, including proximity to the conduits, the presence of utility connections and microwave communication and good geotechnical knowledge of the site. The major disadvantages are the severe space constraints, difficult access for construction and operation in this remote location and vulnerability of the facilities to landslides. Space is adequate in the Bull Run for UV and ozone disinfection facilities up to an ultimate capacity of 500 mgd, and for membrane filtration at 250 mgd. Space constraints would preclude the ability to expand a membrane facility to the ultimate capacity of 500 mgd. Space in the watershed is inadequate for direct filtration at the initial capacity of 250 mgd.

Lusted Hill. The land in Bureau ownership totals almost 100 acres, and is comprised of several parcels. One parcel at Lusted Hill is the site of a downstream Bureau treatment facility, where ammonia is added to the chlorinated supply. The balance of the Bureau's property is currently in use for farming and nursery operations. The available properties are located from 1 to 1.2 miles from the existing conduits. Access for construction and operation would be much easier here, compared to the Bull Run site. Plenty of space is available. Potential obstacles to siting at Lusted Hill are land use impacts in this rural residential area, the presence of homes immediately adjacent to the property, construction in a scenic river corridor and treatment plant discharge to the federally- protected Sandy River. Although this site meets the essential criterion of distance to conduits of less than

2 miles, significant costs would be incurred by the need to construct major inlet and outlet transmission connections to the conduits.

Powell Butte. The parcel size in Bureau ownership is 578 acres. This site was purchased by the Bureau in 1925 specifically for the siting of water facilities. Powell Butte functions as the hub of the existing water system. Water from the Bull Run flows to an existing 50 million gallon buried reservoir at Powell Butte, and is then distributed by gravity to the region. The Powell Butte reservoir also receives the City's groundwater supply when the Columbia South Shore Wellfield is in operation. Powell Butte's location and elevation are the reasons that this site is the central point for storage and distribution of the region's two primary water supplies. Distance to the conduits is measured in hundred of feet. The major advantages of this site is its function as the hub of the existing water system, and its location within the UGB. This site also provides the best opportunities for public education and awareness of water quality, treatment and supply. It provides good access for construction and operation. The major disadvantage of the site relates to its current function as a nature park hosting multiple recreational uses. The property is overlain with an Open Space designation that is intended to preserve open space and natural areas. Environmental and neighborhood issues must be carefully evaluated by the Bureau. Plant overflow and site drainage will present engineering challenges.

Conclusions

Essential and desirable criteria were developed to screen potential treatment plant sites in the area extending east of Interstate 205 and south of the Columbia River, to the Bull Run Headworks. Essential criteria were developed by the Bureau and reviewed by the BRTP. These criteria were deemed to be critical to the proper functioning of a treatment plant. Individual tax lots were evaluated with respect to these essential criteria using GIS. Results of this screening exercise identified Powell Butte, the Lusted Hill area and a small area in the Bull Run watershed as suitable for siting of a facility.

A limited evaluation of sites with respect to desirable criteria was conducted using the GIS tool. A review of land ownership and zoning indicate that all three sites are feasible, with the Bull Run site being restricted to facilities less than 10 acres in size. This would eliminate the possibility of constructing direct filtration treatment in the Bull Run watershed.

Appendix B. Bull Run Treatment Panel

City of Portland

Report and Recommendations of the Bull Run Treatment Panel

September 2002

MWH

September 12, 2002

Mr. Erik Sten
Commissioner of Public Works
Portland City Council
1220 SW 4th Avenue
Portland, Oregon 97204

Mr. Dan Saltzman
Commissioner of Public Affairs
Portland City Council
1220 SW 4th Avenue
Portland Oregon 97204

Dear Commissioners Sten and Saltzman:

The Bull Run Treatment Citizens Panel is pleased to transmit its final report and recommendations for your consideration. We thank you for the opportunity to work with City of Portland staff and the community in considering the important questions you asked us to address:

What treatment methodology should Portland use to meet its water quality goals?
Where should the treatment facility be located?
How should the facility be financed and delivered?

In considering these questions, the Panel reviewed a number of technical reports and received presentations from public agency and national experts on water treatment technologies and public health issues. The Panel sought feedback from the public through focus groups, community meetings, public hearings, and public comment at its regular meetings. As directed by its charge, the Panel considered the treatment question within the context of broader water supply and demand issues in the region.

A clear majority of the Panel supports filtration as the preferred technology to treat Bull Run water. Filtration technology will enable Portland's system to meet the pending federal regulation regarding *Cryptosporidium*, improve the reliability of the system, make additional water available from current storage at Bull Run, and facilitate future expansion of Bull Run should the region elect to pursue that supply option. Membrane filtration is preferred over direct filtration, for reasons detailed in the report.

The Panel's selection of Powell Butte as the preferred site for a filtration facility is based solely on consideration of water system issues such as site ownership, location and elevation. Citizens and interest group users of Powell Butte Nature Park have voiced concerns over this recommendation. If the Council decides to pursue filtration, the Panel recommends that a community-based siting process be conducted to provide the opportunity to more fully consider the siting issue.

It should be noted that full consensus regarding the preferred treatment option was not achieved by the Panel. Of fourteen panelists, twelve support filtration, one prefers ultraviolet light treatment and one abstained from the recommendations.

We look forward to actively participating in the Council's discussion of this topic when it comes before you later this year. Please feel free to contact us should you have questions or want to discuss our recommendations further.

Sincerely

Serena Cruz
Chair
Citizens' Panel on Bull Run Treatment

Lloyd Anderson

Bill Blosser

Greg DiLoreto

Jay Formick

Gary Larsen

Dave Rouse

Charles Shi

Dr. David Shute

Chris Thomas

Dr. Catherine Thomasson

Jay Waldron

Cathryn Young

Citizen's Panel on Bull Run Treatment

Commissioner Serena Cruz, Panel Chair

Lloyd Anderson
Bill Blosser
Bud Clark
Greg DiLoreto
Jay Formick
Gary Larsen
Dave Leland
Regna Merritt
Dr. Gary Oxman
Dave Rouse
Charles Shi
Dr. David Shute
Chris Thomas
Dr. Catherine Thomasson
Jay Waldron
Harold Williams
Cathryn Young

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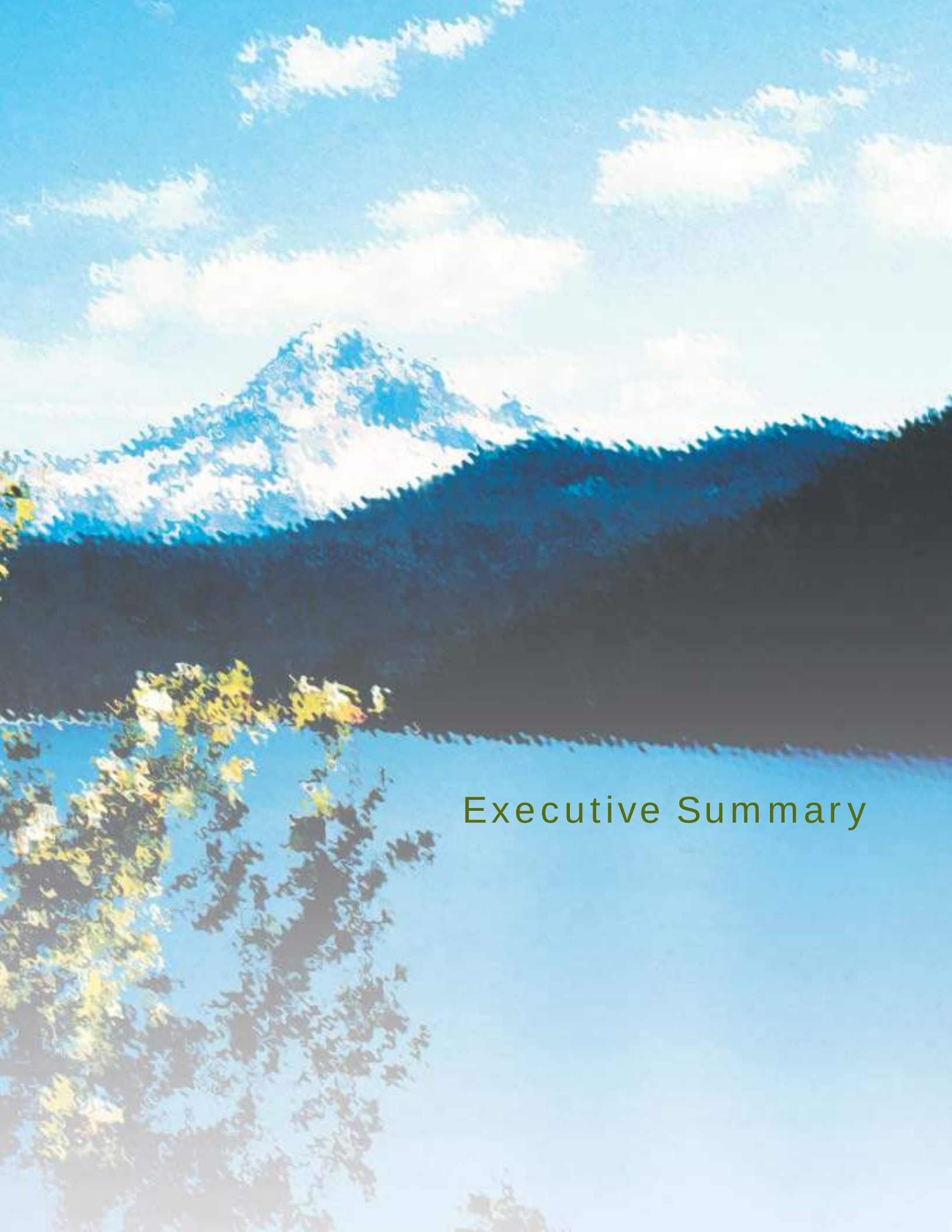
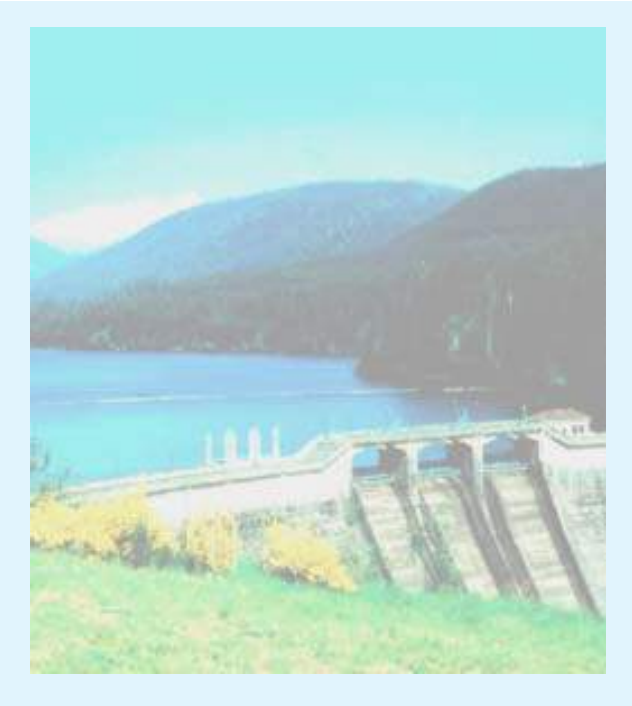


Executive Summary



Part I. Executive Summary

Next year, the federal Environmental Protection Agency (EPA) is scheduled to promulgate new regulations requiring that treatment of Bull Run water be modified to assure protection of public health from naturally occurring microbial contaminants, including the waterborne microorganism *Cryptosporidium*. The implications of the regulations are significant for Portland, because current treatment of Bull Run water with chlorine is not sufficient to inactivate *Cryptosporidium*.

The Bull Run Treatment Panel (Panel) was established to advise the Portland Water Bureau and its Commissioner on Portland's options for meeting these regulations. The Panel was asked to consider the treatment question within the context of long-term water supply, demand and related issues in the region.

The Panel was asked for recommendations on three specific questions:

- *What treatment methodology should Portland use to meet its water quality goals?*

There are four basic methodologies for treating Bull Run water to meet the anticipated federal regulations – ozone disinfection, ultraviolet light disinfection, direct filtration and membrane filtration. Each of these methodologies has different costs and benefits, some of which go beyond regulatory compliance to address other water quality and supply goals.

The Panel was not asked to consider a "no treatment" option because EPA is not expected to include such an option for unfiltered systems in the new regulations.

- *Where should the treatment facility be located?*

Four potential sites were initially identified for a treatment facility – the Headworks facility at Bull Run, Powell Butte, Lusted Hill and Larson's Ranch. In addition, an analysis was conducted to identify other potential sites on the basis of size, accessibility, location, land use, geologic hazards, and other considerations.

- *How should the facility be financed and delivered?*

There are several options for implementation of the treatment decision, including design-bid-build (the traditional approach to building public projects) and alternative approaches such as design-build, design-build-maintain and design-build-operate.

Summary of Panel Recommendations

The Panel makes the following recommendations in response to its charge:

- *What treatment methodology should Portland use to meet its water quality goals?*

A clear majority of the Panel recommends membrane filtration technology. Membrane technology will meet federal regulatory requirements for removal of *Cryptosporidium* and provide additional public benefits for Portland and other users of the Bull Run system. Although membrane filtration is the most expensive of the four treatment technologies, a majority of the Panel concludes that the higher cost of membrane filtration is justified by the additional benefits it provides.

The Panel recognizes that because the technology is evolving, there are certain uncertainties associated with membrane filtration. The Panel makes specific suggestions regarding strategies to reduce the uncertainties associated with membranes in Section 5.6 of the report.

- *Where should the treatment facility be located?*

The Panel recommends that the treatment facility be located at Powell Butte. The Panel's siting recommendation is based solely on consideration of water system issues such as site ownership, location and elevation. The Panel recognizes neighborhood concerns and recommends that as part of the siting process the Water Bureau fully engage the community in discussion of the issues surrounding location of the treatment facility.

- *How should the facility be financed and delivered?*

A majority of the Panel recommends that a design/build approach be pursued to deliver the treatment facility. The Panel did not conduct a thorough review of alternatives to traditional public financing of the project, and therefore does not make a recommendation regarding financing.

Panel Background

The Panel's membership included representatives from a broad range of interests and backgrounds, including public health, environmental conservation, wholesale customers of the Bull Run system, the business community, and the public at large. Ex officio Panel members representing state and local public health agencies and the Water Bureau provided additional technical expertise.

The Panel held its first meeting in April 2001 and met monthly (excepting August 2001) through June 2002. All meetings of the Panel were held in centrally located, accessible meeting facilities. Meetings were open to the public and opportunity for public comment was provided at each meeting. Additional public involvement opportunities were provided through focus groups, a community workshop and several public hearings.

This executive summary presents the Panel's key findings and recommendations. The Panel's full report, including more detailed explanations of treatment options and a full description of the Panel's findings and recommendations, follows. Additional detail can be found in the appendices and other referenced material at the back of the report.

Panel Values

The Panel adopted values and assumptions to guide the treatment decision. The values and assumptions cover a wide range of issues, from water quality and conservation to affordability and worker safety. To summarize, the following values were most relevant to the Panel's decision-making.

- *Safety* – Bull Run water must be safe to drink – meeting or exceeding all regulatory standards.

- *Reliability* – The drinking water supply must be reliable, with adequate safeguards from weather-driven and seasonal shortages and catastrophic events (e.g. seismic events, landslides, forest fires).

- *Quality and Aesthetics* – In addition to being safe and reliable, it is also important that the water supply is consistent in quality, well suited for everyday use and that it contains a minimum of added chemicals. Drinking water should be clear (i.e., no sediment, cloudiness or color), free of chemical odors and pleasant to drink.

- *Cost and Affordability* – The cost of treatment must be affordable and represent a good value for ratepayer dollars spent. It must be allocated fairly among Portland and other users of Bull Run water according to a cost-of-service model.

- *Protection of the Environment* – The treatment decision should be consistent with protection of the environment and with the City's sustainability goals, especially with respect to water and energy conservation. It should also be consistent with protection of the Bull Run watershed, not only because it is a primary source of the region's drinking water, but also because it supports valuable ecosystem processes, fish and wildlife habitat, old-growth forest and wildlands values.

Key Panel Findings

- The Bull Run is a protected watershed. As a result, Bull Run water normally needs minimal treatment to meet or exceed all current state and federal drinking water standards. Certain weather events can raise the turbidity of Bull Run water above federal standards for unfiltered systems, in which case the system must be shut down.

- Based on the protected nature of the Bull Run watershed, monitoring results that reveal *Cryptosporidium* only at low levels, and the absence of epidemiologic evidence of illness caused by *Cryptosporidium*, the Panel's perspective is that the risk of disease from *Cryptosporidium* is relatively small for Bull Run users.

- All four of the principal treatment technologies will inactivate or remove *Cryptosporidium* to the levels necessary to achieve regulatory compliance for Bull Run. Three of the four – ozone disinfection, direct filtration and membrane filtration – will provide additional public benefits. The additional benefits afforded by these technologies include improved reliability (filtration options), additional source capacity (filtration options), and better water aesthetics (ozone and filtration options).

- Projections made in connection with recent regional water studies indicate that over 4.8 billion gallons of new capacity will be required to meet peak season demand for water throughout the region by the year 2050. Major potential sources of additional supply to meet future needs include the Tualatin/Trask watershed, the Willamette River, the Clackamas River and expanded capacity at Bull Run.

- Filtration technologies would enable the use of up to 2.0 billion gallons of additional water from Bull Run reservoirs. In addition, filtration technologies would facilitate expansion of Bull Run supply by protecting water quality during construction related to modifying Dams 1 and 2 to increase storage capacity or developing a third dam.

- The cost of a treatment facility ranges from approximately $55 million for UV disinfection at Headworks to approximately $200 million for a membrane filtration plant at Powell Butte. The table on the next pages summarizes the cost of alternative treatment technologies for a 250 mgd capacity plant at various locations.

- Information received by the Panel showed that the incremental increase in monthly residential water bills as a result of treatment (costs associated with plant only) would range from a little over $1.00 per month for ultraviolet light treatment to about $3.50 per month for membrane

Cost Estimates of Treatment Options

Treatment Process	Location	Capital Cost Plant Only (millions)[1]	Annual O&M Costs (millions)
UV Disinfection	Headworks	$55	$5.2
Ozone Disinfection	Headworks	$66	$6.2
Direct Filtration	Lusted Hill Powell Butte	$203 $179	$6.5*
	Lusted Hill Powell Butte	$204 $202	$8.0*

* Annual O&M costs are the same for both the Lusted Hill and Powell Butte sites.

filtration[2] in the peak month of the 20-year debt repayment period. Input from two focus groups and one public meeting indicated that residential ratepayers would be willing to absorb the increase projected for filtration to obtain the additional increment of safety and other values afforded by these treatment options.

- The Panel was asked to review four initial sites for a treatment facility (Headworks, Larson's Ranch, Lusted Hill and Powell Butte) and to explore the possibility of other sites. Analysis revealed no additional sites. Analysis of different combinations of treatment technologies and sites showed there are no clear advantages to siting an ozone or UV plant at sites other than Headworks. These two options, along with the possibility of siting a membrane plant at Headworks or a direct or membrane filtration facility at Lusted Hill or Powell Butte, were further analyzed for cost and other considerations.

Recommendations

The following recommendations are based on the Panel's consideration of a large quantity of data, numerous technical presentations and other information regarding the costs, benefits and risks associated with various treatment technologies, facility sites and project delivery mechanisms. Ultimately, however, the treatment decision could not be reduced to a simple cost/benefit calculation. Instead, the Panel's recommendations evolved from a more subjective weighing and balancing of costs and benefits against the values adopted by the Panel to guide the treatment decision.

1. What treatment methodology should Portland use to meet its water quality goals?

As noted, all four of the treatment technologies reviewed by the Panel will meet the requirements of the anticipated EPA rules. The filtration options also

[1] Cost of a 250 mgd capacity plant exclusive of additional reservoir storage, transmission expansions or distribution system storage. Costs shown in 2001 dollars.

[2] The full cost of membrane filtration - including the treatment plant and associated supply and transmission costs for a 250 mgd plant - was estimated at about $5.00 per month for the typical residential customer

address supply and reliability, thereby supporting two of the key values embraced by the Panel. On the other hand, the Panel's values also reflect a concern for cost and affordability – and the filtration options are much more expensive than the two disinfection options.

In developing their response to the treatment question, Panel members spent considerable time weighing whether the added benefits provided by filtration justified the additional cost. Results of their collective consideration of this question are reflected in the following recommendations.

- A clear majority of the Panel believes that the benefits of treatment by filtration (direct or membranes) justify the additional costs of these technologies. The Panel therefore, recommends a filtration strategy. The Panel's rationale can be summarized as follows:

  - Filtration provides a more robust barrier to pathogens and is more adaptable to meeting potential future regulatory requirements.

  - Filtration will increase the reliability of the system by enabling Bull Run water to be delivered during times of high turbidity. Wholesale customers, in particular, place a high value on increasing system reliability through filtration.

  - By enabling drawdown of the reservoirs during the onset of fall rains, filtration will increase the total water available from the Bull Run by an estimated 2 billion gallons (approximately 10%). Currently, the Water Bureau limits the amount of water it takes from available storage in the fall to minimize the risk from significant turbidity events.

  - This increased supply will, in turn, provide one or more of the following benefits: (a) provide the City with additional capacity to meet endangered species requirements (if any), (b) decrease the need to use the Columbia South Shore Wellfields as a summer augmentation source and (c) delay the need to develop other supply sources to meet increasing customer demand.

  - Filtration can improve water quality by removing organic materials that color the water in the fall. This is an aesthetic issue of particular importance to Portland's wholesale customers.[3]

  - Assuming reduced reliance on the wellfield, filtration will decrease in-plant treatment costs for industrial customers. These customers now must be able to treat varying water qualities from the Bull Run and the wellfield, which impacts their operations and increases their costs. Industrial customers will also benefit from improved reliability of supply to meet production requirements.

  - Filtration will make Portland's supply more reliable and consistent and thus comparable to other filtered sources in the region (all other surface water supply in the region is filtered). Portland's increased ability to retain its wholesale customers will spread system operations costs, thereby lowering rate increases for Portland customers.

  - Filtration provides Portland and the region with more flexibility to meet future water needs. The potential exists to expand Bull Run supply by raising the height of Dams 1 and 2 or building a third dam. Filtration would likely be needed during development of any of these projects to protect water quality from the effects of construction and meet federal regulatory standards.

- The Panel considered detailed information on the advantages and disadvantages of direct filtration and membrane filtration. After weighing the information, a clear majority of the Panel recommends membrane filtration over

[3] Ozone disinfection also removes color. Membrane filtration will require an additional treatment step to remove color.

direct filtration, because membrane filtration technology:

- Offers the greatest flexibility to adapt to changing circumstances because of the potential to upgrade membranes without altering the basic structure or functioning of the facility.

- Is simpler to operate, with less chance for operator error in chemical dosing and other operator-driven adjustments.

- Has the ability to remove smaller-sized contaminants without the use of coagulating agents.

- Generates less solid waste.

- Requires a lesser amount and fewer types of chemicals.

- Has a smaller "footprint", resulting in less impact on the environment and providing greater flexibility to increase capacity or add treatment to deal with future regulations.

- The Panel recognizes that because the technology is evolving, there are uncertainties associated with membranes. The Panel recommends that prior to implementation of membrane treatment, the Water Bureau address these uncertainties as follows:

  - To provide adequate cost competition, assure there are at least two acceptable suppliers of installable membranes.

  - Require that membrane suppliers have facilities in operation that utilize the same component size and configuration that will be utilized as building blocks in the Portland treatment plant.

  - To minimize scale-up concerns, require demonstration of successful operation of at least one membrane plant with a minimum capacity of approximately 100 mgd.

  - To assure membrane performance, require membrane suppliers to guarantee performance for at least 10 years.

  - To assure long-term availability of membranes, require contractual arrangements with membrane suppliers that allow Portland to manufacture replacement membranes itself if replacements are not available from the original supplier.

  - To alleviate concerns about potentially harmful chemicals leaching from membranes, review the National Sanitation Foundation (NSF) certification process for membrane materials that membranes are currently required to meet, and require supplemental certification testing if appropriate.

- The Panel recommends that direct filtration remain under consideration as a back-up treatment technology. Direct filtration has a long track record of effective treatment of municipal water supplies, with many installations of the size needed in Portland. Should the Water Bureau not be able to implement the risk management strategies for membrane treatment described above, the Panel recommends that the City Council work with the Bureau to review the reasons for not meeting the strategies and the options then available, including the use of direct filtration. Because of the many benefits of membrane filtration, some Panel members would prefer that the City wait for further development of membrane technology instead of moving immediately to direct filtration.

- The Panel notes that the least expensive way to achieve compliance with the anticipated regulations is by installing ozone or UV treatment. UV carries the lowest cost of the four treatment options. The Panel observes, therefore, that if the City wished only to achieve regulatory compliance at the lowest cost, it would select UV treatment. A minority of the Panel recommends UV as the preferred treatment strategy.

- One Panel member recommends that UV treatment be installed to meet federal requirements to address *Cryptosporidium* in the short-term, and that membrane filtration be held as a long-term capital goal for the Bull Run.

2. Where should the treatment facility be located?

- From a water system perspective, the Panel recommends that the filtration facility be sited at Powell Butte. The City of Portland purchased this 578-acre property in 1925 to serve as a site for future water facilities. Powell Butte's location and elevation make it a central point for storage and distribution of Portland's water supplies. It is located within Portland's urban growth boundary, a key consideration for permitting. Powell Butte's urban location has the additional benefit of providing greater opportunities to use the treatment facility to contribute to public awareness of water resource management issues and to develop public education and community recreation facilities.

- The Panel recognizes that siting the treatment facility at Powell Butte will have impacts on the park and surrounding neighborhoods. The Panel believes the advantages of a Powell Butte site warrant a serious effort to resolve these potential impacts. As the Panel neared completion of its work, some citizens expressed concerns about the social and environmental impacts of siting a filtration treatment facility at Powell Butte. The Panel recommends that the Water Bureau fully engage the community in future deliberations and decision-making regarding the siting of the facility.

- The Panel recommends that the Lusted Hill site remain under active consideration as an alternate to Powell Butte should neighborhood, environmental or other issues render the Powell Butte site an inappropriate location for the treatment facility.

3. How should the treatment facility be delivered?

- A majority of the Panel recommends that the City pursue a design-build approach to project delivery. Design-build provides advantages to the City in time and money savings, and reduces the risks and uncertainties of membrane filtration at a large scale. If a design-build approach is pursued, the City and the Water Bureau must carefully and thoughtfully develop the design and operating criteria that will define the project.

- The Panel recommends that the Water Bureau and the City further evaluate other aspects of alternative delivery, including those that include treatment plant operation.

Additional Recommendations

- To meet the anticipated 2011 deadline for addressing the *Cryptosporidium* regulations, and to achieve the other water quality benefits of treatment, the Panel recommends that the Water Bureau begin the next phase of work related to the treatment project in 2003. The next phase of work is expected to include such tasks as community-based planning for the treatment facility, applying for necessary permits, pilot testing and additional review of alternative project delivery approaches.

- The Panel's support for filtration is premised on the assumption that the cost of treatment will be allocated fairly among Portland and other users of the Bull Run system on a cost-of-service model. To protect the current and future interests of all parties, the Panel recommends that the financial, ownership, cost sharing and/or contractual arrangements regarding treatment are in place before major financial commitments (i.e. construction) are made.

- To address affordability issues, the Panel recommends that the Water Bureau – and other utilities whose ratepayers will share in the cost of

treatment – evaluate current programs for low-income ratepayers, adopt changes to improve the accessibility and coverage of these programs, and work aggressively to ensure that the programs are fully utilized by eligible customers.

- The Panel recommends that to the greatest extent possible, implementation of the treatment decision be timed to avoid overlapping with other large maintenance and capital improvement projects such as capping and repairing the reservoirs, replacement of the water distribution system or expansion of Bull Run.

- EPA's regulations regarding treatment for *Cryptosporidium* are scheduled for adoption in mid-2003. Since final rule language was not available, the Panel had to rely on language in an "agreement in principle" adopted by a stakeholder group as part of the rule-making process and an EPA "pre-proposal draft" based on that agreement. Should the final rule represent a substantially different regulatory approach or requirements, or provide different options for addressing *Cryptosporidium*, the City and Water Bureau should revisit the Panel's recommendations.

Summary

The Panel recognizes and appreciates the significance of the treatment question to Portland and the region. Few public services are more essential than the provision of safe drinking water, and few places are blessed with better, safer water than that provided by Bull Run. Bull Run's status as one of the few large, unfiltered public drinking water systems remaining in the United States is a source of pride to some – and concern to others. The potential for Bull Run to help meet the growing need for water in the region is both welcomed and questioned. All these views were represented on – and debated by – the Panel. The Panel hopes its report and recommendations reflect this diversity of thought and opinion. The Panel also hopes its report and recommendations reflect a goal shared by all its members – to protect the precious heritage of Bull Run while preparing the system to meet the demands and challenges of an uncertain future.

Report and Recommendations

Part II. Report and Recommendations

1.0 Introduction

1.1 History

President Benjamin Harrison designated the Bull Run Forest Reserve and closed the forest to entry and development in 1892. Three years later, via a system built largely by hand, the first Bull Run water flowed into the City of Portland.

The Bull Run system was expanded throughout the 20th century to meet the region's growing need for water. Conduits were added, dams were constructed to impound the source water, and supply lines were built to allow transmission of Bull Run water to Portland and surrounding areas.

Protection of the Bull Run watershed has been addressed through a series of legislative actions over the past hundred years. Through the 1904 Trespass Act, Congress prohibited all human entry into the Bull Run Reserve. Exceptions were limited to the Water Board, federal and state officers, forest rangers and others actively protecting the forest and water.

View of Bull Run Watershed and Dam 2.

While logging became legal with the 1977 passage of Public Law 95-200 (see Appendix 1.0), other types of human activity were generally restricted, limiting the introduction of pollutants into the Bull Run Management Unit. Federal legislation in 1996 and 2001 amended PL 95-200, increasing protection for the watershed and the entire Bull Run Management Unit including general prohibitions against logging.

The excellent quality and protection of its source water have allowed Bull Run to operate as one of only a few large, unfiltered water systems in the United States. Bull Run water was essentially untreated until 1929, when chlorine was first used as a disinfectant. In 1957, the Portland Water Bureau began adding ammonia to the water at the system's headworks, a process meant to ensure maintenance of a persistent chlorine residual that continues to disinfect water as it travels through the distribution system.

Chlorine residual levels were increased throughout the system in 1989 to comply with a federal drinking water regulation known as the Total Coliform Rule. Portland modified its treatment of Bull Run water twice in the 1990's – first in 1991, by modifying disinfection practices to meet the requirements of the Surface Water Treatment Rule, and again in 1997 by adding corrosion treatment to meet the requirements of the Lead and Copper Rule.

New federal regulations affecting Portland's management of the Bull Run system are due to be adopted in 2003. Language describing the regulations is contained in a "pre-proposal draft" of the Long-term 2 Enhanced Surface Water Treatment Rule (available at http://www.epa.gov/safewater/lt2/st2eswtr.html). The purposes of the rule are to improve control of microbial pathogens, specifically the protozoan *Cryptosporidium*, in drinking water, and to address risk trade-offs associated with disinfection by-products. The implications of the rule are significant for Portland, because current treatment of Bull Run water with chlorine is not sufficient to inactivate *Cryptosporidium*.

Disinfection and Corrosion Treatment Facility.

In anticipation of the federal government's promulgation of this rule, the Portland Water Bureau and its Commissioner-in-Charge convened a citizen panel to review the proposed drinking water regulations and related issues and make recommendations regarding Portland's treatment options. This report describes the Panel's decision-making process, including the Panel's findings and recommendations. Additional detail is provided in a series of technical memos and other material appended to the report.

1.2 Charge to the Panel

The Bull Run Treatment Panel (Panel) was charged to advise the Portland Water Bureau and its Commissioner on treatment options for Portland's primary water source within a decision-making framework that included consideration of long-term water supply, demand and related issues in the region. The Panel was asked for recommendations on three specific questions:

- *What treatment methodology should Portland use to meet its water quality goals?*

The Panel was asked to look at four basic methodologies for treating Bull Run water – ozone disinfection, ultraviolet light disinfection, direct filtration and membrane filtration.The Panel was not asked to consider a "no treatment" option because Enviormental Protective Agency is not expected to include such an option for unfiltered systems.

The four treatment methodologies are briefly described in Section 4.0. Additional detail can be found in the Appendix 2.0.

- *Where should the treatment facility be located?*

Four potential sites were initially identified for a treatment facility – the Headworks facility at Bull Run, Powell Butte, Lusted Hill and Larson's Ranch. In addition, an analysis was conducted to identify other potential sites on the basis of size, accessibility, location, land use, geologic hazards, and other considerations.

- *How should the facility be financed and delivered?*

The Panel was asked to review "traditional" financing as well as alternative financing and implementation approaches such as design-build and design-build-operate.

1.3 Summary of Panel Recommendations

The Panel makes the following recommendations in response to its charge:

- *Treatment methodology* – A clear majority of the Panel recommends membrane filtration technology. Membrane technology will meet federal regulatory requirements for removal of *Cryptosporidium* and provide multiple other public benefits for Portland and other users of the Bull Run system. Although membrane filtration is the most expensive of the four treatment technologies, a majority of the Panel concludes that the higher cost of membrane filtration is justified by the additional benefits it provides.

  The Panel recognizes that because the technology is evolving, there are certain uncertainties associated with membrane filtration. The Panel makes specific suggestions regarding strategies to reduce the uncertainties associated with membranes in Section 5.6.

- *Facility siting* – The Panel recommends that the treatment facility be located at Powell Butte. The Panel's siting recommendation is based solely on consideration of water system issues such as site ownership, location and elevation. The Panel recognizes neighborhood concerns and recommends that the Water Bureau engage the community in a thorough discussion of the issues surrounding location of the treatment facility.

- *Facility financing and delivery* – A majority of the Panel recommends that the City pursue a design/build approach to project implementation. The Panel did not conduct a through review of alternatives to traditional public financing of the project, and therefore does not make a recommendation regarding financing.

1.4 Process and Timetable

The Panel held its first meeting in April 2001 and met monthly (excepting August 2001) through June 2002. All meetings of the Panel were held in centrally located, accessible meeting facilities. Meetings were open to the public and opportunity for public comment was provided at each meeting. A project team of consulting engineers, Water Bureau employees and others provided technical briefings and data to the Panel as needed to provide for informed decision-making. Ex officio Panel members representing state and local public health agencies and the Water Bureau provided additional technical expertise.

The Panel's work was conducted in three phases:

- Orientation (background information; goals, values, criteria) April - October 2001;
- Analysis/Evaluation (applying goals, values, criteria to options) November 2001-February 2002; and
- Recommendation (draft recommendations and report) March - June 2002.

1.5 Public Involvement

The Panel conducted its decision-making through an open public process. Through this process, citizens and ratepayers from across the region were informed about and involved in the treatment issue.

The focal point for public outreach was the Panel itself, which served as a conduit to many interested organizations. Panel members were selected to be broadly representative of key constituent groups sharing an interest in the Bull Run system. Among the organizations and interests represented on the Panel were residential, industrial and wholesale customers; Bull Run advocacy groups; environmental / clean water advocates; low-income ratepayers; medical community and public health officials; Portland Utilities Review Board (PURB) and citizens.

During the first phase of its work, the Panel oversaw the development of a public involvement plan. Public outreach methods were targeted as

appropriate to reach different audiences based upon their level of interest: highly interested, interested, or less interested general public. This approach is illustrated in the *public involvement pyramid* shown on the next page. Based on the plan, the Panel organized and participated in a series of public outreach activities designed to inform and involve citizens in the treatment decision. These activities are summarized below.

- *Stakeholder Interviews* - At the outset of the project, interviews were conducted with more than 30 key stakeholders, who were asked to share their advice on issues surrounding Bull Run treatment. The results contributed to the *values* and *assumptions* adopted by the Panel to guide its decision-making.

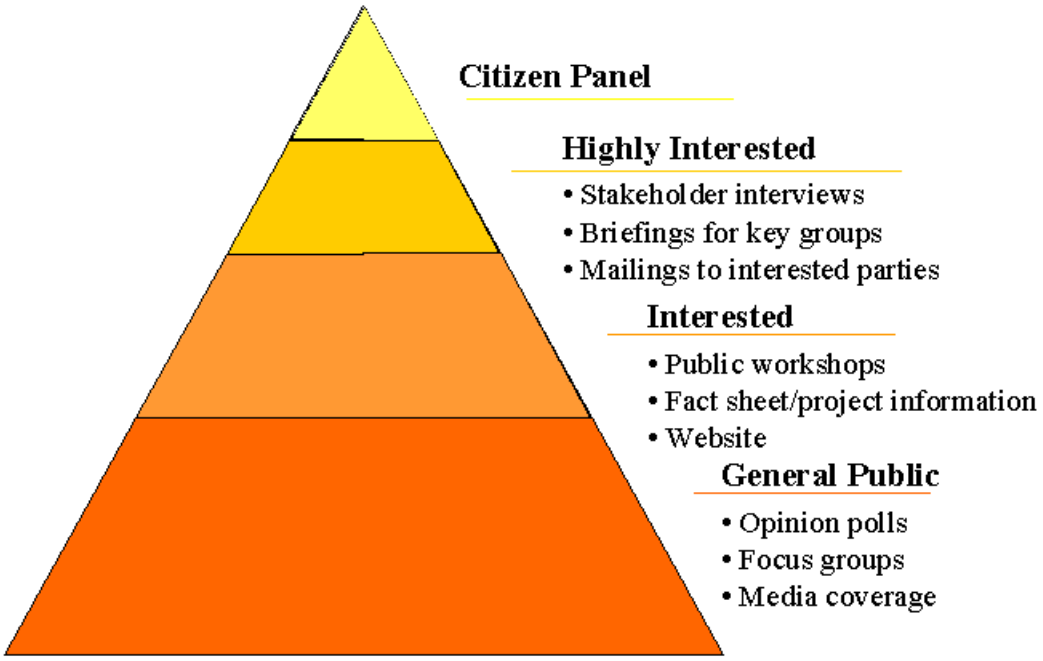
- *Polling* - The Panel reviewed results of previously conducted public opinion polls related to drinking water quality and cost.

- *Focus Groups* - To gauge broad-based public opinion, two focus groups were held in October and November 2001. The 42 participants – water customers selected at random from throughout the Bull Run service area – were asked to serve as "citizen advisors", giving their views on the issues and choices being considered by the Panel.

- *Public Hearings* - Four public hearings were held at various locations across the Bull Run service area: in Beaverton, Gresham, and Portland. More than 40 citizens participated in the hearings.

- *Public Information* - Information materials, including a project fact sheet, were developed and distributed to interested parties.

Public Hearing on Draft Report



Public Involvement Pyramid

- *Speakers Bureau* - During the decision process, the project team gave presentations and updates to regional water suppliers, the Portland Utilities Review Board, Water Bureau employees, and other interested groups.

- *Website* - A website (www.bullrun.ci.portland.or.us) was established to offer information on the treatment decision and key planning documents, including Panel meeting and presentation summaries, to interested citizens and groups.

- *Media Coverage* - The Portland Water Bureau contacted media representatives to update them as the treatment decision process progressed. Project team members also appeared on community cable television broadcasts. News items, editorials and letters about the Bull Run treatment decision process were published in a variety of publications, including: *The Oregonian, Portland Tribune, Gresham Outlook, and Daily Journal of Commerce*. These items appeared approximately monthly over the 18-month course of Citizen Panel's work.

- *Report to the Community* - The Panel's findings and recommendations were summarized in a report designed for the lay public and policymakers.

The results of public input and advice regarding Bull Run treatment are discussed in Section 4.9. Additional information regarding public involvement can be found in Appendix 3.0.

2.0 Context for Panel Recommendations

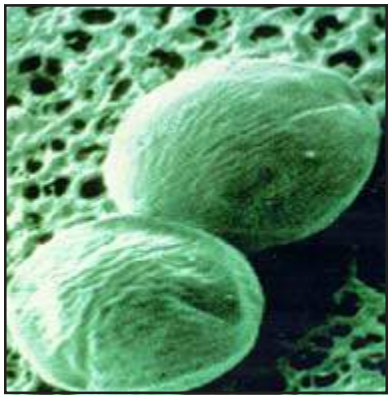
The context for the Bull Run treatment decision process has both national and regional dimensions. At the national level, a series of rulemaking activities by the Environmental Protection Agency (EPA) set the stage for and triggered the need to review treatment options for Bull Run. Understanding the evolution of these regulations over the past decade helped the Panel better understand the implications for Portland. Discussions with wholesale customers regarding the future ownership and management of the Bull Run provided perspective on the role of Bull Run in meeting the region's growing need for water and the significance of treatment in that equation.

2.1 Regulatory Context

Both the state and federal governments have roles in overseeing drinking water treatment in the United States. At the federal level, the Environmental Protection Agency has been responsible for establishing and enforcing rules related to drinking water since 1974, when Congress adopted the Safe Drinking Water Act.

Through amendments to the Act in 1986, Congress directed that all surface supplies of drinking water be filtered to ensure that consumers are protected from exposure to microbial pathogens found in rivers, lakes, and streams. EPA responded to Congress' direction in 1989 by promulgating the Surface Water Treatment Rule (SWTR). Under the SWTR, public water systems were required to filter surface sources of drinking water unless they met certain defined water quality and disinfection requirements and maintained a watershed control program. The Bull Run is one of a relatively small number of systems not required to filter because it has continuously met the specific criteria for safe water in the rule. (Compliance with the SWTR did require that the disinfection process used at Bull Run be modified to address *Giardia*, one of the microbial pathogens covered by the rule.)

Federal regulation of drinking water continued to evolve during the 1990's. In 1998, following several years of negotiated rulemaking, EPA promulgated the Stage 1 Disinfectant/Disinfection Byproducts Rule and the Interim Enhanced Surface Water Treatment Rule (IESWTR). The first rule lowered the standard for exposure to certain by-products of the water treatment process. The second rule focused on improving the performance of water filtration plants to reduce the risk of epidemic occurrences of waterborne illness from microbial contaminants, especially the water-borne microorganism *Cryptosporidium*.[4]



Photograph of *Cryptosporidium*, the target of new EPA regulations.

Beyond being required to include *Cryptosporidium* in their watershed control programs, unfiltered systems were not addressed in the IESWTR. However, in 1999, EPA began conducting a second negotiated rule-making process focused in part on the risks posed by low-level ("endemic") transmission of waterborne pathogens. Endemic transmission is thought to be associated with low-level, intermittent exposure of a population to disease-causing organisms. Such transmission is not typically

4. Although *Cryptosporidium* is found in most surface waters in the United States, only a few epidemic outbreaks of illness traced to *Cryptosporidium* in drinking water have been documented. The first such outbreak, which occurred in 1987 in Carrollton, Georgia, affected 13,000 people. The most significant U.S. outbreak occurred in 1993 in Milwaukee, Wisconsin, where an estimated 400,000 people became ill. In both cases, the municipal water systems in question were operating within state and federal drinking water standards in effect at the time. Problems with plant design and/or operation/maintenance were cited as reasons for the problems in both cases.

detected by traditional disease surveillance mechanisms, and represents the kind of risk that might be associated with unfiltered systems. This effort produced draft rule language expected to be promulgated as the Stage 2 Disinfection/ Disinfectant Byproducts Rule and the Long Term 2 Enhanced Surface Water Treatment Rule.

Of particular interest to the Panel is the latter rule, which as drafted would require water systems to conduct site specific risk analyses for *Cryptosporidium* and take action to improve treatment to address the endemic risks of waterborne pathogens. Under the current pre-proposal draft of the rules, unfiltered systems, including Portland, would be required to provide a minimum of 99% inactivation or removal of C*ryptosporidium*. This requirement would bring unfiltered systems in line with the minimum level of treatment being provided by filtered systems meeting performance criteria established in the IESWTR. The required level of removal or inactivation is not achieved by current disinfection of Bull Run water.

The Long Term 2 Enhanced Surface Water Treatment Rule is expected to be promulgated by EPA in mid-2003. The negotiated agreement provides eight years for water systems to comply following promulgation of the rule.

2.2 Regional Context

Bull Run – A Regional Resource

The Bull Run system provides drinking water to approximately 800,000 people – more than 450,000 of those in the city of Portland (primarily in Multnomah County) and 317,000 outside the city. Portland wholesales water to fourteen water districts and cities. Major wholesale customers include the City of Gresham, the City of Tigard and the Tualatin Valley Water District. Currently, wholesale customers account for 44% of annual water demand.

A shared stake in the region's water has engendered significant regional cooperation in planning for, conserving and developing water supplies, as reflected by several recent long-range plans and studies. The most comprehensive of these studies is the Phase 2 Regional Water Supply Plan (RWSP), completed in 1996. Other important studies are the Infrastructure Master Plan for the Portland water system (October 2000) and the Regional Transmission and Storage Strategy developed for the Regional Water Providers Consortium (July 2000). The Panel relied on regional supply and demand projections developed for these plans in its deliberations regarding the treatment question.

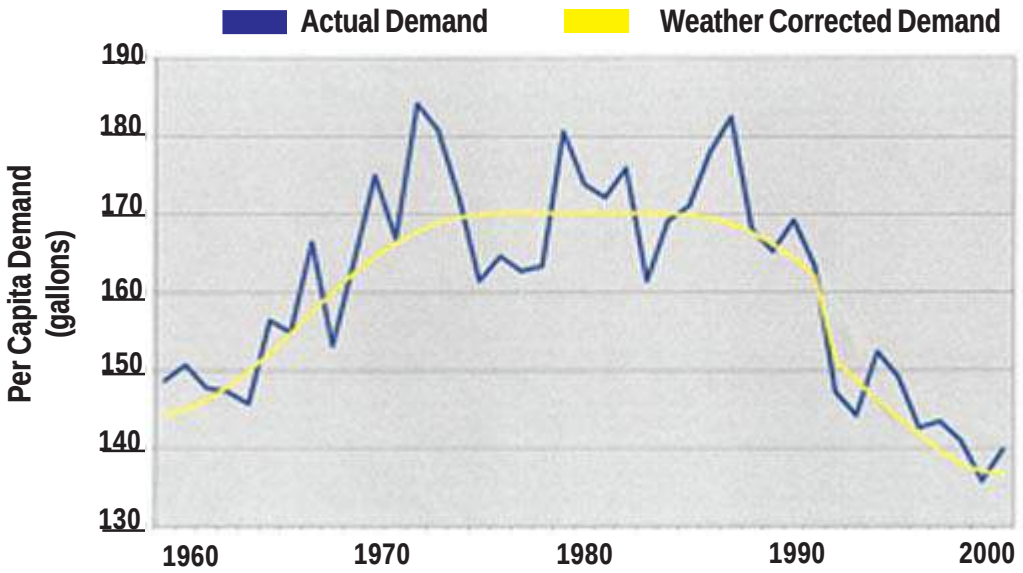
Regional Water Supply and Demand

Regional supply and demand is relevant to the treatment issue for two reasons. First, two of the treatment technologies under consideration (the filtration technologies) would enable additional water to be made available from Bull Run. The significance of this benefit depends on the extent of the regional need for new supply and the degree to which filtration could help address that need. Second, the filtration options improve the reliability of the supply. This is a major issue for wholesale customers, who represent a substantial portion of the overall demand for Bull Run water.

In reviewing the supply and demand question, the Panel was presented with year 2050 projections for "peak season" supply needs[5], using estimates from the Regional Water Supply Plan and Regional Transmission and Storage Strategy[6]. Current peak

5. The forecasting approach used in the RWSP was based on individual forecasts for each of 47 water providers. Growth in demand was based on population and employment rates developed by Metro. Some of the considerations incorporated into the RWSP model were naturally occurring conservation (the reduction in water demand due to changes in water service technologies, building codes, appliance standards and the competitive marketplace), reductions in demand due to increases in water prices, and peak day demand. Forecasts included baseline (mid-level), low and high growth scenarios.

6. The "peak season" is the season of heaviest demand on the system – the hottest, driest months of the year. In Portland, peak season occurs during the extended summer drawdown period when demands are higher than stream inflows.



Per capita water demand has dropped as conservation programs have been implemented.

season capacity and year 2050 peak season demand are summarized in the tables on page 9.[7]

The numbers shown in the table indicate that:

- Approximately 4.8 billion gallons of additional peak season capacity will be needed to meet regional demand by the year 2050;
- The most significant "shortages" will occur in Washington and Clackamas counties.

7. The Panel notes the limitations of the long-term demand estimates. First, the projections used by the Panel estimate the demand for water in the year 2050, nearly five decades from now. While modeling tools have improved in recent years, it is still difficult to make accurate projections that far into the future.

Second, the future demand projections presented to the Panel are based on certain assumptions about population and economic growth, demographic and land use changes, conservation trends and other factors. Endangered Species Act listings and global warming may also impact the regional demand picture. Estimates for different demand "nodes" represent aggregations of local projections based on a variety of source data and forecasting methodologies. This variability in sources and methodologies can affect the comparability of the numbers being used.

New regional demand forecasts to 2050 are currently being developed as part of the Regional Water Supply Plan update. This update will provide a comprehensive water demand forecast, using a common set of assumptions and methods. Revised demand figures will be available in mid-2003. The significance of filtration as a means to increase regional water supply should be evaluated with respect to these revised regional demand forecasts.

- Without expanded capacity at Bull Run, Portland will need to rely more on the Columbia South Shore Wellfields than it currently does[8] , or make use of other approved sources.

According to the forecasts, much of the increased demand for water in the region will occur by 2020. Additional information on supply, demand and Endangered Species Act considerations is provided in Appendix 4.0.

Demand Nodes, Major Sources, Current Capacity and Year 2050 Peak Season Demand

Demand Node	Major Sources	Peak Season Capacity (Bgal)	Year 2050 Peak Season Demand (Bgal)
EAST	Bull Run River CSS Wellfield	20.0 8.6 28.6	21.6
SOUTH	SFWB Lake Oswego CRW NCCWC	3.0 2.4 4.5 1.5 11.4	14.0
WEST	Trask/Tualatin Willamette	9.0 2.3 11.3	20.5
TOTAL		**51.3**	**56.1**

The demand forecasts used in the RWSP incorporate naturally occurring water conservation, i.e., conservation resulting from plumbing code changes and changing technologies such as clothes washers that use less water and energy. The plan projected that demand could be reduced by as much as 76 million gallons per day by the year 2050 through conservation, out of an anticipated peak day demand of 350 mgd in this time period. These estimates are a projected maximum, based on implementation of a wide range of conservation measures, including residential and commercial education, audits, incentive programs, aggressive conservation rate design and ordinances restricting outdoor water use for new development.[9]

8. Current use of the wellfields is limited by city policy to seasonal augmentation and emergency back-up of Bull Run.
9. A review of potential conservation savings conducted by the Regional Water Providers Consortium in 1999 reduced the estimate of probable savings that could be achieved by 2020 by about 20 percent. This reduction in the estimate of conservation potential was primarily due to the recommended elimination of the outdoor landscaping ordinances, due to trade group and public opposition. A second major reason for the reduction in savings estimates was a lower projection in the number of residential and commercial accounts from Metro. The RWSP Update project will review projected conservation savings.

Even accounting for demand reduction through conservation, however, the RWSP projected that additional supply would be needed by 2050. Through the RWSP and the Regional Storage and Transmission Strategy, the region has embraced an overall supply framework to address these future needs. The supply framework includes conservation, aquifer storage and recovery, the use of the CSSW to meet peak season and emergency demands, better interties between supply and demand nodes in the region, and the development of additional source water in the future. A third reservoir in Bull Run was among the sources preliminarily evaluated, but the plan made no recommendation about which source option should be pursued.

Regional Water Authority Initiative

The RWSP culminated several years of cooperative work by the region's water utilities to develop common water demand forecasts and water supply and conservation strategies. This plan, and the Regional Transmission and Storage Strategy that followed, have provided the framework for much stronger regional cooperation on water supply and distribution issues.

With these efforts as a backdrop, in 2000 the City of Portland began negotiating new long-term contracts with its wholesale customers. During this process, it became clear that some wholesale customers hoped to institutionalize regional cooperation by acquiring an ownership interest in their water supply. In response to this interest, in April 2001 – the same month the Panel began meeting – Portland City Commissioner Eric Sten, then Commissioner-in-Charge of the Water Bureau, initiated discussions with regional water utilities and the public regarding the possibility of developing a regional drinking water agency. Commissioner Sten, Water Bureau staff, and the suburban water utilities represented on the Panel have kept the Panel apprised of the status of those discussions.

The Panel faced a unique challenge in deliberating the treatment issue during the same timeframe that the regional water authority question was being actively discussed. Questions related to the size and location of a treatment facility, and the allocation of the cost of treatment among users of the system, were made more complicated by the uncertainty surrounding the ultimate configuration of ownership and management. As the Panel was developing its recommendations, it was informed that the scope of the regional water authority discussions had narrowed to focus on regional ownership and management of the Bull Run system, rather than "full regionalization" of all major supply and distribution systems in the region.

3.0 Assumptions and Values

The recommendations contained in this report are based in part on technical considerations – factors like the efficacy of various treatment methodologies, regional supply and demand projections and the geologic stability of prospective treatment facility sites. At the same time, the Panel recognized that the treatment decision couldn't be based solely on technical matters. The decision also needs to reflect the goals, concerns and desires – that is to say, the *values* – of the region and its citizens.

Accordingly, during the first stages of its deliberations the Panel worked to identify and agree on a set of values to guide the treatment decision. The panel also agreed on certain assumptions about the process and the decision. The purpose of the assumptions was to clarify a number of premises or "givens" about the treatment decision and to provide assurances to panel members and the public regarding the relationship between the treatment decision and other issues of concern regarding Bull Run.

The Panel's values were tested against – and found to be consistent with – public and stakeholder values through a series of focus groups, public meetings and interviews. In addition the various treatment options were subjected to a qualitative evaluation against the panel's values. (See Appendix 5.0 for this evaluation.) This exercise helped illuminate the differences among the options and focused discus-

sion on those options most consistent with the panel's values.

Following are the consensus assumptions and values adopted by the BRTP.

3.1 Assumptions

- New federal regulations will be adopted requiring unfiltered water systems – including Portland's Bull Run system – to provide additional treatment. Portland will comply with the new regulations.
- Separate discussions regarding possible regionalization of the Bull Run system and development of new water sources will be ongoing during the treatment decision process. The Treatment Panel must consider various future scenarios, and its recommendations may inform these other discussions.
- The treatment decision process will consider several options for Bull Run's future customer base: serving Portland customers only; serving the current customer base – including Gresham and Tualatin Valley Water District as wholesale customers; or serving a larger regional area.
- Consistent with City policy, Portland will continue to rely on Bull Run as its primary source of drinking water supply. The Portland wellfields' chief role will be for seasonal augmentation and emergency supply. (If additional supply is developed or customer demand on the Bull Run supply is reduced significantly, the role of the wellfield as a summer augmentation supply could change.)
- The Bull Run watershed will continue to be protected, in compliance with PL 95-200 as amended and other applicable federal law, regardless of future treatment.
- Four alternative water treatment technologies have been proven to be effective in deactivating *Cryptosporidium*: UV disinfection, ozone, direct filtration and membrane filtration.
- Bull Run is a regional water source, and the region will participate in the treatment decision process.
- Evaluation of facility size and capacity will be based on a range of demand assumptions that include maximum use of current sources (including non-potable sources where feasible and appropriate) and water conservation.
- Portland will exercise leadership and foresight in caring for its water supply and in planning for and ensuring the safety, quality and reliability of the Bull Run system.

3.2 Values

- Bull Run water must be safe to drink - meeting or exceeding all regulatory standards.
- The treatment decision must be based on the best available scientific information, taking into account that scientific understanding of public health issues is evolving, and regulatory standards may change over time.
- The cost of treatment must be affordable and represent a good value for ratepayer dollars spent.
- The cost of treatment will be allocated fairly among Portland and other users of Bull Run water according to a cost-of-service model.
- The drinking water supply must be reliable, with adequate safeguards from weather-driven and seasonal shortages and shortages due to catastrophic events (seismic, fires, other).
- We value high quality water - water that is consistent in quality, well suited for everyday use and that contains minimum added chemicals.
- The treatment process should be flexible and "tunable" to meet changing requirements and the variability in natural conditions.
- The treatment decision should be consistent with protection of the environment.
- We value water that is clear (i.e., no sediment, cloudiness or color), free of chemical odors and pleasant to drink.
- The treatment process should be consistent with the City's sustainability goals, especially with respect to water and energy conservation.
- We value the unique nature of Bull Run as a water source - protected and requiring

minimal treatment.

- The decision process should include consideration of worker safety, operational impacts, impacts to the transmission system and other system-wide impacts and benefits.
- We value the Bull Run watershed not only because it is the source of our drinking water, but also because it supports valuable ecosystem processes, fish and wildlife habitat, old-growth forest and wildlands values.

4.0 Panel Findings

During the course of its deliberations the Panel was briefed on a wide range of issues, including evolving public health concerns about drinking water, the technology behind current water treatment methods, the sites available for locating a new treatment facility, and alternative methods of financing and delivering a treatment plant. In addition, because it was charged to make its recommendations within the context of regional water needs, the Panel received information on long-term supply and demand projections and related issues in the region. The following findings represent a synthesis of the information, facts, trends and issues most relevant to the treatment decision.

The protected nature of the Bull Run is key to high quality water.

4.1 The Bull Run Source

The Bull Run is a protected watershed. The storage reservoirs at Bull Run are surrounded by publicly owned federal forest land, the management of which is carefully regulated to ensure the safety and quality of Portland's primary water source. The Bull Run Management Unit is closed to public use. Federal law generally prohibits logging in the Bull Run Management Unit. As a result of these protections, Bull Run water normally needs minimal treatment to meet or exceed all current state and federal drinking water standards.

Portland water customers are justifiably proud of the superior "aesthetics" of their drinking water, and of the pristine character of the Bull Run watershed. Except during the fall and in periods of extreme low water or major storm events, the water that flows from Bull Run is clear. Certain weather events can raise the turbidity of Bull Run water above federal standards for unfiltered systems, in which case the system must be shut down.

4.2 Public Health Benefits and Regulatory Requirements

- *Cryptosporidium*, the pathogen to be regulated by pending federal regulations, is a water-borne microorganism. In healthy people with normal immune systems, *Cryptosporidium* causes a mild-to-moderately severe diarrheal illness typically lasting one to two weeks. In healthy people, the illness is sometimes complicated by dehydration needing medical treatment; this may be more of a problem for young children, pregnant women and the elderly. In individuals with significant immune system problems (e.g., HIV/AIDS, and cancer or transplant chemotherapy), infection with *Cryptosporidium* often causes chronic diarrhea, which can be debilitating and life-threatening.

- Transmission of relatively high numbers of *Cryptosporidium* organisms through water tends to result in sudden outbreaks of illness ("epidemics") that are relatively easy to detect. *Cryptosporidium* transmission can also occur on an ongoing or episodic basis at low levels (i.e., "endemic" transmission). This pattern of transmission typically produces illness at levels that are not readily detected by routine public health monitoring. The EPA and the Centers for Disease Prevention and Control (CDC) have been concerned about the risks and associated public health and economic impacts of both patterns of *Cryptosporidium* transmission. Both patterns have been drivers for EPA's rulemaking under the Safe Water Drinking Act, and for CDC's pursuing epidemiologic studies of drinking water-borne illness.

- Results of water testing indicate that *Cryptosporidium* organisms occur in Bull Run water at low levels. It is not clear how often *Cryptosporidium* is present in Bull Run water because testing is technically unreliable. Since the watershed is closed to human entry and use by domestic animals, wildlife is the probable source of *Cryptosporidium* in Bull Run water. *Cryptosporidium* is highly resistant to chlorine;

Monitoring Results for *Cryptosporidium* in Bull Run.

Year	Samples	Mean (#/100L)	Peak (#/100L)
1995	16	< 1	< 2
1996	13	0.6	4
1997	15	0.8	5
1998	24	0.1	1
1999	85	1	30
2000	48	0.2	4
2001	4	0.2	1

- Routine epidemiologic monitoring ("surveillance") by state and local public health agencies has not revealed any evidence of past or current transmission of *Cryptosporidium* through Bull Run water. This strongly suggests that Bull Run has not been a source of any significant outbreaks (epidemics) of illness caused by Cryptosporidium. Despite this, it is possible that low levels of illness due to *Cryptosporidium* do occur in the community, but are not detected. Failure to detect such endemic illness might happen for two reasons. First, routine disease surveillance systems are not designed to reliably detect small changes in the occurrence of illnesses that have common, nonspecific symptoms (like those caused by *Cryptosporidium*). Special studies are needed to assess the occurrence of such illnesses and identify their causes.

  Second, current methods of sampling and detection for *Cryptosporidium* are widely acknowledged to be unreliable.[10] This compromises both the ability to detect the occurrence of *Cryptosporidium* in the water supply, and the ability to analyze any association between its occurrence and illness in the community.

- The Panel's perspective is that the risk of disease from *Cryptosporidium* is relatively small for Bull Run users. While it recognizes its responsibility to be cautious in interpreting the evidence, the Panel believes that treatment will add only a small degree of safety to the Bull Run water supply – one that probably will not be measurable. The Panel bases this belief on three findings: 1) the protected nature of the Bull Run watershed, which has eliminated human and bovine sources of *Cryptosporidium*, 2) monitoring results that reveal *Cryptosporidium* only at low levels, and 3) the absence of epidemiologic evidence of epidemic or endemic transmission of *Cryptosporidium* via Bull Run water.

10. The standard method for detecting protozoa in water samples is the indirect fluorescent antibody (IFA) procedure. This method has been heavily scrutinized. Generally this method is regarded as having low capture and recovery efficiencies. The results are widely variable both within and among laboratories; it is difficult to perform and requires a skilled microscopist; and it can determine neither viability nor speciation of oocysts and cysts. The cost of analysis is also significant. The Water Bureau reports that a typical cost is $750 per sample to obtain a detection limit of 1 cyst per 100 liters. New analytical methods are under development.

- The Panel received information showing that scientific understanding of drinking water contaminants and their potential risk to public health is continuously evolving. For example, research is ongoing regarding the risks of exposure to disinfection by-products and other organic chemicals. The Panel believes that drinking water regulations are likely to become more stringent and cover an ever-wider range of contaminants over time. Filtration methodologies are more likely to satisfy future regulatory requirements, whereas disinfection methodologies may not.

4.3 Types of Treatment

There are four treatment technologies that will either inactivate or remove *Cryptosporidium* as required under the pending regulations: ultraviolet (UV) light disinfection, ozone disinfection, direct filtration, and membrane filtration. A brief summary of each, along with its advantages and disadvantages, is provided below. The treatment options are described in more detail in a technical memorandum found in the Appendix 2.0

- *Ultraviolet Light* - Under this technology, water flows past ultraviolet lamps. UV light damages replicating DNA in *Cryptosporidium* oocysts[11], preventing their reproduction. UV has been shown to be highly effective against *Cryptosporidium*. It is inexpensive, and requires the use of no additional chemicals.

UV lamps used to disinfect water

Applications of UV technology to drinking water are relatively new and small compared to the application needed for Bull Run. Issues involved with the patenting of UV technology may increase operating costs over time.

- *Ozone* - Ozone is a powerful oxidant that destroys the walls and cell contents of *Cryptosporidium* oocysts. In addition to effectively addressing *Cryptosporidium*, ozone controls colors, tastes and odors in source water and reduces disinfection by-product formation. Many large-scale applications exist.

  Ozone may increase the potential for bacterial re-growth in the distribution system. It is an energy-intensive technology.

- *Direct Filtration* – With direct filtration technology, water passes through sand and carbon filters to physically separate organisms from drinking water. Coagulants are added to the water prior to filtration.

  Direct filtration is a time-tested technology used by many water utilities and installed at sizes comparable to that needed for Bull Run. Direct filtration plants require larger sites for installation, creating additional challenges for siting. Issues related to the health impacts, handling and disposal of coagulant materials are a concern. Large *Cryptosporidium* outbreaks have occurred in water systems that use direct filtration.

- *Membrane Filtration* - Membrane filtration uses micro-porous fiber membranes to provide an absolute physical barrier to organisms and other contaminants. With this treatment method, chemicals are not required to achieve effectiveness against *Cryptosporidium*.

11. The *Cryptosporidium* life cycle includes the formation of hardy, microscopic oocysts that are infectious and have been found to be resistant to common chemical disinfectants. The *Cryptosporidiosis* disease is transmitted by the ingestion of oocysts excreted by infected humans and animals.

Water is drawn through membrane fibers.

At the present time, there are no installations of membrane filtration treatment plants close to Portland's required size. Membrane filtration is the most expensive of the four alternatives.

4.4 Other Benefits of Treatment

The Panel's review of the four principal treatment technologies showed that all options except ultraviolet light provide public benefits above and beyond mere regulatory compliance. Among the many other benefits afforded by treatment are improved reliability (filtration options only), additional source capacity (filtration options only) and better water "aesthetics" (color and taste – ozone and filtration).

Improved System Reliability

- Over the last six years the Bull Run supply has been shut down three times due to high turbidities after winter storms (13 days in February of 1996, 8 days in December of 1998, and 18 days in November of 1999). These events have been triggered by peak flows during rain and snow events, the effects of which can be exacerbated by the extensive system of roads in the watershed.

- These shutdowns – and the possibility that the system could be shut down for even longer periods due to catastrophic events like landslides or forest fires in the watershed – undermine the real and perceived reliability of the Bull Run supply. A consistent, dependable water supply is a key system performance measure for all users of Bull Run, including wholesale and large industrial customers. For example, when the system is shut down, wholesale customers must off-load demand to alternative sources. Industrial customers may be required to modify their in-house treatment of water to meet specific manufacturing needs. Millions of gallons of treated water left in the conduits must be disposed of by the Water Bureau.

- Providing filtration would virtually eliminate the need for these shutdowns, improving the reliability of the Bull Run source. Turbidity spikes measured during storm events in Bull Run source water since 1996 have ranged between 8 and 26 NTU – well within the treatment capability of membrane filtration.[12] Disinfection treatment would not provide the benefits of increased supply reliability.

Additional Source Capacity

- As noted in Section 2.0, projections made in connection with recent regional water studies indicate that over 4.8 billion gallons of new capacity will be required to meet

12. Currently, there are about 120 operating drinking water treatment facilities in the U.S. that use the type of membrane filtration process contemplated for the Bull Run. These systems operate at source water turbidities that are on average, higher than Bull Run throughout the year, and reach as high as 4,000 NTU during storm events. The majority of these plants treat surface water from reservoirs, lakes and rivers that are subject to storm-driven turbidity spikes similar to those observed in the Bull Run watershed.

The Environmental Protection Agency conducted a recent survey of 24 U.S. utilities using membrane filtration (EPA, April 2001). The most commonly reported treatment challenge among these utilities was an increase in raw water turbidity following rain or winter storm events. Most utilities surveyed stated that a primary benefit of membrane filtration is its ability handle influent water quality fluctuations.

Turbidity plume moving through reservoir after a storm.

peak season demand throughout the region by the year 2050.[13] Future demand in Portland's current direct service area can be met by minor expansions of existing supplies (based on ongoing use of the Columbia South Shore Wellfields), but new sources of supply will be needed to meet the growth in demand in Washington and Clackamas counties. Major potential sources of additional supply for these areas include the Tualatin/Trask watershed, the Willamette River, the Clackamas River and expanded capacity at Bull Run.

(Note: The Panel did not study expansion capacity for other sources, the constraints on expanding capacity for other sources or the implications of such expansion. The Panel also did not make any judgement about expansion of Bull Run.)

- A growing population will not be the only source of pressure on the region's water system in the future. The City of Portland and others in the region have obligations to meet the Clean Water Act and the Endangered Species Act. The latter, in particular, has implications for meeting regional water needs, as listed fish may require increased instream flows during periods of high customer demand on the system. The potential for climate change – which could increase the number and intensity of storm events, or result in longer, warmer summers in the Pacific Northwest – also exists.

- Portland's ability to expand the amount of water currently available from the Bull Run source is constrained by two factors. First, the onset of fall rains – at a time when the reservoirs are at their lowest, and surrounded by exposed, unvegetated shore and bank – elevates the risk of significant turbidity events. To minimize this risk, the Water Bureau limits the amount of water it takes from available storage. Currently, the Water Bureau is able to make use of approximately 10 billion gallons of the 17 billion gallons stored at Bull Run. Filtration would address this risk factor, enabling the Water Bureau to use up to 2.0 billion gallons more of the water stored in existing reservoirs.

Risk of turbidity from exposed shore and bank limits current reservoir rawdown.

- The second factor affecting source water availability is the current capacity of the reservoirs. The potential exists to increase Bull Run supply by modifying existing dams to allow raising reservoir levels. Increased storage at Reservoirs 1 and 2 has been projected to

13. 4.8 BG figure based on estimated year 2050 peak season demand minus current peak season capacity. (Sources: See Appendix 4.)

provide an additional 2.5 billion gallons of storage capacity. The potential also exists to add a new reservoir to the system. A third dam would provide additional storage capacity of 19 billion gallons. The construction-related impacts of these projects include erosion (which could raise turbidity levels) and the water quality impacts of inundating areas previously above water. These impacts could affect the City of Portland's ability to continuously meet filtration avoidance criteria in state and federal regulations. Failure to meet these standards could result in a requirement to provide for filtration.

Better Water Aesthetics

The "aesthetics" of water – its clarity, taste and odor – are of concern not only to consumers, but also to the water utilities that strive to produce high quality drinking water and must respond to consumer complaints. The aesthetics of Bull Run water are generally very good. Sometimes during the late summer and fall, decomposing leaves release tannins and lignins into the Bull Run reservoirs, giving the source water the color of weak tea. While this occurrence does not present a threat to public health, it often triggers a flood of complaints from customers.

Ozone disinfection will remove color from raw source water. Direct and membrane filtration will remove color with the addition of coagulants.

Typical ozone generating equipment.

4.5 Siting

- As part of its charge, the Panel was asked to recommend a site for a treatment facility. A variety of factors must be weighed in considering the siting issue. Among these are the size and physical characteristics of the site; the implications of the site for the functioning of the water system; and land use, environmental and community issues.

- The Panel was asked to review four initial sites (Headworks, Larson's Ranch, Lusted Hill and Powell Butte) and to explore the possibility of other sites. Selection of the four initial sites was based on ownership and construction and operational requirements and costs. A majority of the Panel visited these four sites during the orientation phase of the treatment decision process (summer 2001).

- The hydraulic profile of the Bull Run system, and the compatibility of a site with the gravity-driven flow of water through the system, is a key to siting. A treatment plant must be located at the right elevation – if the elevation is too high, water will not be able to reach the plant without pumping; if it is too low, water will need to be pumped after treatment. The use of gravity as an essential screening criterion supports the Panel's values of cost-effectiveness, reliability and sustainability (in terms of energy conservation).

- To determine whether additional sites were available, the Water Bureau defined a set of criteria determined to be essential to the proper functioning of a treatment plant. These criteria include a maximum distance from the site to the existing conduits, a minimum lot size to accommodate an eventual plant capacity of 500 mgd, suitable slopes and geologic conditions, and the ability to serve a base amount of flow by gravity. The essential criteria were used to evaluate an area east of Interstate 205 and south of the

Columbia River for potential treatment plant sites. Results of this screening revealed no additional sites, and eliminated Larson's Ranch from further consideration.

- The analysis also confirmed Powell Butte, the Lusted Hill area in east Multnomah County and limited portions of the Bull Run watershed as meeting the essential criteria for treatment plant siting. (Only about 10 acres of buildable land in the Bull Run watershed meet the essential criteria, restricting this site to the smaller, non-filtration options.)

- The Panel considered land use issues at the sites meeting the essential criteria, giving special attention to the Lusted Hill site since it is outside Portland's Urban Growth Boundary. A preliminary analysis suggested that siting a facility at the Lusted Hill location would not conflict with statewide planning goals. Existing zoning is compatible with treatment plant siting at the Powell Butte and Bull Run watershed locations. The City should carefully consider and address land use impacts at all sites.

- Combinations of potential treatment methodologies and sites were reviewed in terms of their space requirements, community/environmental impacts, and operating requirements. Further analysis of these combinations showed there were no clear advantages to siting an ozone or UV plant at sites other than Headworks. These two options, along with the possibility of siting a membrane plant at Headworks or a direct or membrane filtration facility at Lusted Hill or Powell Butte, were further analyzed for cost and other considerations.

A technical memorandum regarding siting is included as Appendix 6.0.

4.6 Cost and Affordability

- The cost of a treatment facility ranges from approximately $55 million for UV disinfection at Headworks to approximately $200 million for a membrane filtration plant at Powell Butte. The table below summarizes the cost of alternative treatment technologies for a 250 mgd capacity plant at various locations.

Capital and Operating Costs of Alternatives

Treatment Process	Location	Capital Cost Plant Only (millions)[14]	Annual O&M Costs (millions)
UV Disinfection	Headworks	$55	$5.2
Ozone Disinfection	Headworks	$66	$6.2
Direct Filtration	Lusted Hill Powell Butte	$203 $179	$6.5
Membrane Filtration	Lusted Hill Powell Butte	$204 $202	$8.0

14. Cost of a 250 mgd capacity plant exclusive of additional reservoir storage, transmission expansions or distribution system storage. Costs shown in 2001 dollars.

- The total cost of a treatment project would include items beyond the plant itself, including additional reservoir storage, transmission expansions and required operations and maintenance facilities. For a 250 mgd membrane treatment at Powell Butte, these associated costs would add an estimated $43 million to the cost of treatment, bringing the total for that treatment option at that site to $245 million.

- The Panel's adopted values include a statement that the cost of treatment should be "affordable" and "represent a good value for ratepayer dollars spent". The Panel recognizes that "affordability" is a subjective concept; items that one family finds affordable may be considered luxuries by another family.

- The Panel's analysis of this issue included information from a national expert on utility affordability. Data presented showed that the median cost of water as a percent of median household income in Oregon is 0.6% - the sixth lowest in the nation. The median cost as a percentage of median income in Portland, at 0.4%, is even lower.[15]

- Another measure of affordability comes from the 1993 EPA report, "Affordability of the 1986 Amendments to Community Water Systems". This report used an affordability threshold (the upper limit for the costs of water bills as a percentage of median household income) of 2.0% to assess the financial impacts of new regulations on small drinking water systems.

- Information received by the Panel showed that the incremental increase in monthly residential water bills as a result of treatment (costs associated with plant only) would range from a little over $1.00 per month for ultraviolet light treatment to about $3.50 per month for membrane filtration. Input from two focus groups and one public meeting indicated that ratepayers would be willing to absorb the increase projected for filtration to obtain the additional increment of safety and other values afforded by these treatment options.[16]

- The Panel also received information regarding the impact of a membrane treatment facility on both small (11 ccf[17] per month) and large (20,000 ccf per month) businesses. The information showed that the average monthly bill would increase from the current $19.38 to $21.73 for a small business (using 11 ccf of water per month) and from the current $32,640 per month to $36,917 for very large, water-intensive businesses (using 20,000 ccf per month).

- The Panel felt it was important to understand the cost and rate impacts of treatment in relation to other long-term capital improvements planned by the Portland Water Bureau. Analysis of projected rate impacts showed that the average monthly residential water bill would increase from $14.60 currently to between $20.50 and $23.50 over the next 20 years to pay for membrane filtration, small supply increases, reduction of vulnerabilities in the water system, and on-going maintenance.

4.7 Alternative Delivery Mechanisms

- The Panel was asked to make recommendations regarding the financing and delivery of a treatment facility. The Panel reviewed the following alternative delivery options:

15. Estimates are based on 1990 census data. Data from the 2000 census were not available during the Panel process. Use of more recent data would yield different results, reflecting increased public expenditures to address sewer and stormwater issues.
16. The monthly impact for membrane filtration including the treatment plant and associated supply and transmission costs was estimated at about $5.00.
17. A "ccf" is one hundred cubic feet, which is considered one "unit" of water. A unit of water is also equal to 748 gallons.

- *Design-Bid-Build (DBB)* – DBB is the traditional approach to delivering projects. In DBB, the City first selects the engineer to define and develop the project bid documents. A contractor is selected to build the project based on the lowest bid.
- *General Contractor/Construction Manager (GC/CM)* – In GC/CM the City enters into two contracts, one for design services and the second for GC/CM services. The GC/CM team is responsible for working with the design team to refine design, as well as for managing the construction of the project. All construction work is competitively bid through subcontracts with public bid openings.
- *Design-Build (DB)* – In DB, the City hires a design-build team through a qualifications and price-based selection process. Typically, the City defines the existing conditions and desired outcomes, then requests a 30% design and bid price.
- *Design-Build-Maintain (DBM)* – DBM utilizes one contractor for design, construction and long-term maintenance of major equipment. Contractor selection can be similar to either DB or DBO.
- *Design-Build-Operate (DBO)* – DBO involves a single umbrella contractor for overall design, construction, and long-term operation. In DBO the City typically hires a single design-build-operate team through a two-step process: (1) short-list based on qualifications and (2) selection based on requested criteria.

- The traditional Design-Bid-Build approach is well understood and allows the City to retain a high degree of control and involvement in all aspects of project implementation. However, alternative delivery approaches offer advantages to the City:

- Alternative delivery can be used to shift risk from the City to the private contractors performing the design, construction, and even maintenance and operation of the facility. Experience with design-build suggests it will reduce costs in the design and construction phases, and therefore reduce overall project costs.
- DB/DBO/DBM could shorten the implementa tion schedule for the treatment project.
- Alternative project delivery offers the ability to meet the City's goals with respect to minority and disadvantaged business involvement, regulatory compliance, reliability, quality, cost and other aspects of project development.

Seattle's new Tolt WTP was built using a DBO approach.

- The primary disadvantage of the DB approach is that the City relinquishes some control over the project in exchange for the benefits. The City and the Water Bureau would need to carefully consider desired criteria and outcomes to ensure a successful project.

- The Panel was asked to consider which criteria are important in the selection of a specific delivery method. Almost all of the Panel members that responded felt that the ability to meet cost and schedule goals were important criteria to consider. In addition, all respondents felt that the designer and contractor must be well-qualified to perform the work. The quality of the project, its reliability, and the ease of operation and maintenance were also rated as high priorities for decision-making.

- The Panel did not give detailed consideration to alternative financing methods. However, in general the financing information presented to the Panel did not provide persuasive arguments that the benefits of private financing outweigh its higher cost relative to public financing.

Additional information on project delivery alternatives is found in Appendix 7.0.

4.8 Timetable for Regulatory Compliance

The Water Bureau estimates that it is likely to take from five to eight years to plan, design and construct a treatment facility of the size needed to meet the long-term needs of Portland and other municipalities that rely on the Bull Run. The anticipated deadline for meeting the new *Cryptosporidium* regulations is 2011.

4.9 Public Input Regarding Treatment

Over the course of its work, the Panel solicited input from the general public as well as groups and individuals with a particular interest in drinking water and the question of treatment. This input was gathered through stakeholder interviews, two randomly-selected focus groups, and several public workshops in which participants were asked about issues related to the treatment question, including their values about Bull Run, their opinions about the four treatment methodologies and their concerns about cost and affordability. In each setting, the Panel received a consistent message from this diverse range of citizens, interest groups and elected officials. This message can be summarized as follows:

- The Panel's values regarding treatment are representative of the values of the community as a whole.

- There is support for taking a long-term view when addressing problems related to such basic services as drinking water.

- People felt generally inclined to support filtration treatment options over disinfection options because of the multiple public benefits of filtration.

- In general, people are willing to pay for filtration treatment because they feel the additional benefits or value received from filtration are worth the additional cost.

- There is recognition that increased costs will fall more heavily on some than others, and support for finding ways to mitigate that impact.

5.0 Panel Recommendations

Within the described framework of assumptions, values and findings, and consistent with public input received during the process, the Bull Run Treatment Panel makes the following recommendations:

5.1 Bull Run Watershed Protection

The Panel supports continued legislative protection of the Bull Run watershed as expressed in PL 95-200 and Portland City Council Resolution 35981 (See Appendix 1.0). Treatment of Bull Run water, whether by disinfection or filtration, should not be viewed as an alternative to strong watershed protection policies. The most effective way to ensure long-term water quality and safety is through a multiple barrier strategy that begins with source water protection.

5.2 Conservation

The Panel strongly supports water conservation. The Panel believes that effective water conservation programs can help reduce the cost of, and perhaps postpone, development of new water supplies in the region. The Panel recommends that the City of Portland and other regional providers continue their efforts to review and refine existing and potential conservation programs as part of the update of the Regional Water Supply Plan. A primary goal of refining these programs should be

to make more efficient use of the currently available supply of Bull Run drinking water.

5.3 Preferred Technology

The following recommendations are based on the Panel's consideration of a great deal of data, numerous technical presentations and other information regarding the costs, benefits and risks associated with various treatment technologies. Ultimately, however, the treatment decision could not be reduced to a simple cost/benefit calculation. Instead, the Panel's recommendations evolved from a more subjective balancing of costs and benefits against the values adopted by the Panel to guide the treatment decision.

As noted, all four of the treatment technologies reviewed by the Panel will meet the requirements of the anticipated EPA rules. The filtration options also address supply and reliability, thereby supporting two of the key values embraced by the Panel. On the other hand, the Panel's values also reflect a concern for cost and affordability – and the filtration options are much more expensive than the two disinfection options.

In developing their response to the treatment question, Panel members spent considerable time weighing whether the added benefits provided by filtration justified the additional cost. Results of their collective consideration of this question are reflected in the following recommendations.

- A clear majority of the Panel believes that the benefits of treatment by filtration (direct or membranes) justify the additional costs of these technologies. The Panel therefore, recommends a filtration strategy. The Panel's rationale can be summarized as follows:

    - Filtration provides a more robust barrier to pathogens and is more adaptable to meeting potential future regulatory requirements.

    - Filtration will increase the reliability of the system by enabling Bull Run water to be delivered during times of high turbidity. Wholesale customers, in particular, place a high value on increasing system reliability through filtration.

    - By enabling drawdown of the reservoirs during the onset of fall rains, filtration will increase the total water available from the Bull Run by an estimated 2 billion gallons (approximately 10%). Currently, the Water Bureau limits the amount of water it takes from available storage in the fall to minimize the risk from significant turbidity events.

    - This increased supply will, in turn, provide one or more of the following benefits: (a) provide the City with additional capacity to meet endangered species requirements (if any), (b) decrease the need to use the wellfields as a summer augmentation source and (c) delay the need to develop other supply sources to meet increasing customer demand.

    - Filtration can improve water quality by removing organic materials that color the water in the fall. This is an aesthetic issue of particular importance to Portland's wholesale customers.[18]

    - Assuming reduced reliance on the wellfield, filtration will decrease in-plant treatment costs for industrial customers. These customers now must be able to treat varying water qualities from the Bull Run and the wellfield, which impacts operations and increases costs. Industrial customers will also benefit from improved reliability of supply to meet production requirements.

    - Filtration will make Portland's supply more reliable and consistent and thus comparable to other filtered sources in the

18. Ozone disinfection also removes color. Membrane filtration will require an additional treatment step to remove color.

region (all other surface water supply in the region is filtered). Portland's increased ability to retain its wholesale customers will spread system operations costs, thereby lowering rate increases Portland customers.

- Filtration provides Portland and the region with more flexibility to meet future water needs. The potential exists to expand Bull Run supply by raising the height of Dams 1 and 2 or building a third dam. Filtration would likely be needed during development of any of these projects to protect water quality from the effects of construction and meet federal regulatory standards.

Membrane cartridges are placed into a basin.

- The Panel considered detailed information on the advantages and disadvantages of direct filtration and membrane filtration. After weighing the information, a clear majority of the Panel recommends membrane filtration over direct filtration, because membrane filtration technology:

  - Offers the greatest flexibility to adapt to changing circumstances because of the potential to upgrade membranes without altering the basic structure or functioning of the facility.

  - Is simpler to operate, with less chance for operator error in chemical dosing and other operator-driven adjustments.

  - Has the ability to remove smaller-sized contaminants without the use of coagulating agents.

  - Generates less solid waste.

  - Requires a lesser amount and fewer types of chemicals.

  - Has a smaller "footprint", resulting in less impact on the environment and providing greater flexibility to increase capacity or add treatment to deal with future regulations.

View of a typical direct filtration plant.

- The Panel recommends that direct filtration remain under consideration as a back-up treatment technology. Direct filtration has a long track record of effective treatment of municipal water supplies, with many installations of the size needed in Portland. (One panel member preferred direct to membrane filtration.) Should theWater Bureau not be able to implement the risk management strategies discussed in Section 5.6, the Panel recommends that the City Council work with the Bureau to review the reasons for not meeting the strategies and the options then available, including the use of direct filtration. Because of the many benefits of membrane filtration, some Panel members would prefer that the City wait for further development of membrane technology instead of moving immediately to direct filtration.

- One member of the Panel recommends that the UV treatment method be installed to meet federal requirements in the short term, and that membrane filtration be held as a long-term capital goal for the Bull Run. This member embraces all the advantages of membrane filtration, and agrees with the majority that benefits beyond meeting federal requirements are worth paying a premium. However, this Panel member gives greater weight to the following: rate impacts on all customer classes; the combined rate impacts of membrane filtration and the Combined Sewer Overflow projects ramping up simultaneously; deferral of other pressing capital needs for Portland's water distribution system as a consequence of tying up bond revenue; uncertainties of Bull Run ownership; the exposure of Portland to incurring stranded costs if wholesale customers find less expensive supply options and do not participate in paying the cost of membrane filtration; and the prospect that membrane technology will further evolve and drop in cost as more water systems deploy it.

- The Panel notes that the least expensive way to achieve compliance with the anticipated regulation is by installing ozone or UV treatment. UV carries the lowest cost of the four treatment options. The Panel observes that if the City wished only to achieve regulatory compliance at the lowest cost, it would select UV treatment. (It should be noted that several Panel members believe UV treatment should not be considered under any circumstances because UV technology provides few benefits beyond *Cryptosporidium* removal and because of other uncertainties associated with this technology.)

5.4 Preferred Site

- From a water system perspective, the Panel recommends that the treatment facility be sited at Powell Butte. The Panel's rationale for recommending Powell Butte can be summarized as follows:

  - The City of Portland purchased this 578-acre property in 1925 to serve as a site for future water facilities. Powell Butte's location and elevation make it a key element in the regional water supply system. [19]

  - Powell Butte is located within Portland's urban growth boundary, a key consideration for permitting. Powell Butte's urban location has the additional benefit of providing greater opportunities to use the treatment facility to contribute to public awareness of water resource management issues and to develop public education and community recreation facilities.

  - This site offers significant cost savings compared to Lusted Hill due to the presence of the existing reservoir.

Aerial view of Powell Butte site (1995).

- The Panel recognizes that siting the treatment facility at Powell Butte will have significant impacts on the park and surrounding neighborhoods. However, the Panel believes that the advantages of this site warrant a serious effort to resolve these potential impacts.

- As the Panel neared completion of its work, some citizens expressed concerns about the

19. Water from the Bull Run Watershed flows by gravity directly to a 50-million gallon buried reservoir at the Butte, and is then distributed by gravity to Portland and the region. The Powell Butte reservoir receives the City's groundwater supply when the wellfield is in operation. Also, the major transmission pipeline to the westside wholesale customers, the 66-inch Washington County Supply Line, originates at the existing Powell Butte reservoir. The Bureau's captial plans call for the construction of additional storage reservoirs at Powell Butte.

social and environmental impacts of siting a filtration treatment facility at Powell Butte. The Panel recommends that the Water Bureau fully engage the community in future deliberations and decision-making regarding the siting of the facility.

- The Panel's support for the Powell Butte site should not be construed as support for the concept of an intertied regional supply and distribution system. There are many issues associated with such a system; addressing or making recommendations regarding these issues was not part of the charge to the Panel.

5.5 Project Delivery

- A majority of the Panel recommends that the City pursue a design/build approach to project delivery. Design/build provides advantages to the City in time and money savings and reduces the risks and uncertainties of membrane filtration at a large scale. If a design-build approach is pursued, the City and the Water Bureau must carefully and thoughtfully develop the design and operating criteria that will define the project. The City must clearly define how risk is to be allocated and the level of control that the City and Bureau will have over all aspects of the project.

- The Panel recommends that the Water Bureau and the City further evaluate other aspects of alternative delivery, including treatment plant operations.

5.6 Uncertainty and Risk Management

The Panel's recommendations are based on the best available information about drinking water quality and treatment, water supply and demand in the region, and the siting and delivery of treatment facilities. At the same time, it is important to note that the Panel's deliberations were influenced not only by what is known about alternative treatment technologies and sites, but also by what is *not* known.

The Panel's review and analysis of treatment and site options revealed four key areas of uncertainty – uncertainties about treatment technologies, uncertainties about ownership and management of the Bull Run system, siting uncertainties and questions about the cost and affordability of treatment. Each of these areas is described below, along with related strategies for minimizing or mitigating its associated risks.

Technology

The recommended treatment technology of a majority of Panel members is membrane filtration. Membrane technology has been around for a number of years, and the effectiveness of membranes in removing *Cryptosporidium* and other contaminants is well-proven. As more potential users recognize the benefits of membrane technology, and as the cost of membrane filtration drops, its application in the field of drinking water treatment will continue to expand. This is a positive development in terms of improving the safety of public drinking water supplies in the years ahead.

However, the Panel recognizes that there are certain uncertainties associated with membrane technology. Membrane filtration has not yet been applied at the scale required to meet Portland's needs. In addition, "early adopters" of membrane technology need to recognize that the membrane vendor market may be unsettled in the near term. Strategies are needed to minimize vulnerability to vendor turnover (e.g. the possibility that early users of membranes could get "stuck" with technology or filters that cannot be replaced).

The Panel recommends that the Water Bureau address the uncertainties associated with membranes as follows:

- To provide adequate cost competition, assure there are at least two acceptable suppliers of membranes that could be installed.
- Require that membrane suppliers have operating facilities that utilize the same size and configuration of component membrane modules and trains that will be utilized as building blocks in the Portland treatment plant.
- To minimize concerns regarding whether membrane filtration is effective and reliable at the scale needed by Portland, require that membrane plants with a minimum capacity of approximately 100 mgd are operating in the U.S. or internationally.
- To assure membrane performance, require membrane suppliers to guarantee performance for at least 10 years.
- To assure long-term availability of membranes, require contractual arrangements with membrane suppliers that allow Portland to manufacture replacement membranes itself if replacements are not available from the original supplier.
- With respect to uncertainty regarding evolving regulatory requirements, the Panel believes that membranes offer the greatest flexibility to adapt to changing circumstances because of the potential to upgrade membranes without altering the basic structure or functioning of the facility.
- To alleviate concerns about potential leachates from membranes, review the National Sanitation Foundation (NSF) certification process for membrane materials that membranes are currently required to meet, and require supplemental certification testing if appropriate.

Finally, the Panel notes that the risk management strategy described above could be compatible with a design-build approach to project delivery, because it will take some time to carefully evaluate the suitability of membrane technology for Portland. A design-build approach could give Portland the time to evaluate the technology and still be able to meet the anticipated implementation deadline of 2011.

Membrane modules of appropriate size and configuration should be operational before using this technology.

System Ownership and Management

Two basic concerns underlie the uncertainty some Panel members have expressed about system ownership and management. First is the concern that current discussions might lead to a fully regionalized system – that is, a system with multiple intertied sources owned and managed by a single regional entity. It is the Panel's understanding that full regionalization is not part of the current proposal and that these discussions are now focused on regional ownership and management of the Bull Run system only.

The second and larger concern is how the costs of treatment will be allocated among users of the system, and how to assure that all users will pay their "fair share" of those costs. Wholesale customers represented on the Panel have provided repeated assurances that that they – and their ratepayers – will share in the cost of treatment whether as owners or buyers of Bull Run water.

Another important principle for some Panel members is "growth pays for growth" – that is, those areas generating the growing demand should pay for

the infrastructure and expanded supply needed to meet that demand. The ability to allow for expanded supply was a key factor in the Panel's preference for filtration. Population and demand forecasts show that the need for that expanded supply will originate largely outside the City of Portland.

Determining how "growth pays for growth" is a complex undertaking. Calculating the growth-related increments of storage and distribution is relatively straightforward. However, in the case of filtration, there are multiple benefits and beneficiaries involved and a host of complicating factors. Apart from the demands generated by population growth, the system faces demands under the Endangered Species Act to release more water to enhance stream flows for fish. Climate change may result in a "double squeeze" of heightened demand and lower rainfall. These costs and constraints will need to be faced and shared by the region.

Given these multiple variables, further analysis is needed to determine whether the supply benefits of filtration are "ancillary" and cost neutral, or whether they would impose an additional increment of capacity at an additional cost not appropriately borne by Portland ratepayers. This question is particularly applicable to the analysis of costs and benefits of the largest treatment plant under consideration (400 mgd).

The City should approach this question carefully given the unresolved nature of regionalization discussions. A range of interests must be included in defining and negotiating a cost allocation formula that clearly acknowledges Portland's stake in the Bull Run while reflecting regional needs and realities.

To address the uncertainties surrounding system ownership and management, the Panel recommends the following:

- The Panel reiterates that its support for filtration is based on the assumption that the cost of treatment will be allocated fairly among Portland and other users of the Bull Run system on a cost-of-service model.

- In addition, to protect the current and future interests of all parties, the Panel recommends that the financial, ownership, cost sharing and/or contractual arrangements regarding treatment are in place before major financial commitments (i.e. construction) are made.

Aerial view of Lusted Hill Area.

Siting

The Panel recognizes that siting of public facilities is an inherently difficult process. While confident that the two sites under consideration are not "fatally flawed" from an environmental, permitting, or land-use perspective, detailed, site-specific planning and public involvement will be needed before proceeding with construction on any site selected.

- Because of these uncertainties, the Panel recommends that a Lusted Hill site remain under active consideration as an alternate to Powell Butte should neighborhood, environmental or other issues render the Powell Butte site an inappropriate location for the treatment facility.

Cost and Affordability

While in general the cost of treatment appears affordable for most ratepayers, the Panel recognizes that for some segments of the population, rising utility costs impose a burden regardless of their size. Moreover, treatment is not the only water-related capital project on the horizon for Portland. The rate impacts of treatment should be considered in the context of other planned maintenance and capital improvements, such as capping and repairing reservoirs, replacement of the water distribution system or expansion of the Bull Run system.

The Panel believes approaches (e.g. rate structures) can and should be developed and adopted that account for ratepayer needs and addresses affordability issues, and therefore recommends the following:

- The Water Bureau – and other utilities whose ratepayers will share in the cost of treatment – should evaluate current programs for low-income ratepayers, adopt changes to improve the accessibility and coverage of these programs, and work aggressively to ensure that the programs are fully utilized by eligible customers. The Panel recommends that this review occur during the implementation planning phase of this project.

- In addition, the Panel recommends that to the greatest extent possible, implementation of the treatment decision be timed to avoid overlapping with other large maintenance and capital improvement projects such as capping and repairing the reservoirs, replacement of the water distribution system or expansion of Bull Run.

5.7 Timing

- EPA's regulations regarding treatment for *Cryptosporidium* are scheduled for adoption in mid-2003. Since final rule language was not available, the Panel had to rely on language in an "agreement in principle" adopted by a stakeholder group as part of the rule-making process and an EPA "pre-proposal draft" based on that agreement. Should the final rule represent a substantially different regulatory approach or requirements, or provide different options for addressing *Cryptosporidium*, the City and Water Bureau should revisit the Panel's recommendations.

- Assuming adoption of the regulations as expected in mid-2003, the deadline for compliance with the *Cryptosporidium* regulations will be 2011. It will take five to eight years to plan, design and construct a new treatment facility. To meet the anticipated 2011 deadline for addressing the *Cryptosporidium* regulations, and to achieve the other water quality benefits of treatment, the Panel recommends that the Water Bureau begin the next phase of work related to the treatment project in 2003. The next phase of work is expected to include such tasks as community-based planning for the treatment facility, applying for necessary permits, pilot testing and additional review of alternative project delivery approaches.

A Note about the Numbers Used in this Report

The Bull Run Treatment Panel was presented with and reviewed a great deal of information during its deliberations. Some of this information was critical to the Panel's work and affected its recommendations. Key information reviewed by the Panel included regional water supply and demand projections, projected costs of treatment facilities and estimates of the impacts of various treatment technologies on both residential and business water and sewer bills.

The numbers contained in these projections and estimates came from a variety of secondary sources and are based on a wide range of underlying data and assumptions. The Panel used these numbers to compare alternative technologies and show

general trends. Development of new numbers based on more current data was outside the scope of the Panel process.

The Panel notes that some of the numbers used in this report are being revised as part of an update to the Regional Water Supply Plan.

Appendix C. Draft Site Considerations for PWB Water Treatment Facility

To: Mike Stuhr, Eddie Campbell, Chris Wanner

From: David Peters, P.E., Principal Engineer

Re: Site Considerations for Portland Water Bureau's Water Treatment Facility

Date: April 2, 2009

This memorandum discusses factors and relative costs to take into consideration when choosing a site for a filtration facility for the Bull Run water supply. A summary of the factors and costs for each site is provided on page 9 followed by a recommendation for the site that will provide the greatest benefit at the lowest cost.

Background

In 2006, the Environmental Protection Agency (EPA) issued a new drinking water rule called the Long Term 2 Surface Water Treatment Rule (LT2). The purpose of the LT2 rule is to reduce disease incidence associated with microorganisms in drinking water. One requirement of the rule is that the City of Portland must treat the water from the Bull Run River for the microorganism *Cryptosporidium*. The EPA deadline for compliance with the treatment requirement is April 1, 2012.[1]

Portland Water Bureau engineers are evaluating two methods of water filtration—direct filtration and membrane filtration (which includes either submerged or pressurized membranes)—at four possible sites: a site located on the hydraulic grade line (HGL) such as **Lusted Hill**, a site below the HGL such as the former site of **Roslyn Lake**, and two sites above the HGL such as the bureau-owned **Carpenter Lane** property or **Headworks**. A direct filtration plant would require approximately 30-40 acres. A membrane filtration facility requires less land than a direct filtration facility. For the purposes of this memorandum, filtration is assumed to be either direct filtration or submerged membrane filtration, unless pressurized membranes are specifically discussed. The decision regarding the type of filtration system to be installed is not the topic of this memo; this decision will be made at a later date.

The major factor that affects site choice is the location of the site relative to the hydraulic grade line (HGL). The HGL is the line that water follows when it flows from a higher to a lower elevation. When water flows naturally from a higher to a lower elevation it is called gravity flow. The greater the elevation difference between the starting elevation and the final elevation, the greater the gravity flow and the steeper the HGL. The existing HGL (from Headworks through the existing Lusted Hill chloramination facility to Powell Butte reservoir), provides enough gravity flow to move the water into the Portland distribution system. The closer a filtration facility site is to the existing HGL, the more the Water Bureau would be able to use gravity flow to move water through the facility and to the Portland distribution system.

The alternative to using gravity flow is to pump the water. Pumping water requires electricity. Every 10 feet of elevation that the bureau must lift the water would cost $150,000 per year in

[1] Although the EPA deadline for compliance is 2012, the Portland Water Bureau would apply to extend the deadline for two years to April 1, 2014.

additional electricity costs. Therefore, the greater the potential at a site to maximize the gravity flow, the lower the annual operations and maintenance (O&M) costs will be for the life of the facility (assumed to be 50 years).

Other factors that can affect initial capital and O&M costs and the project schedule include proximity to the existing conduit rights-of-way; the capacity of the site to accommodate process waste, including filter backwash water; current land ownership and use; the potential to accommodate future demand; the possibility of generating hydroelectric power at the plant; necessary site improvements; and the impact of the site choice on the community.

Major Factor Affecting Costs

Hydraulic Considerations

A site with a surface elevation that is on or close to the HGL is better-suited to maximizing gravity to move water than a site that is not on the HGL. Although a facility could be built at a range of elevations at any of the sites,[2] some choices would require cutting or filling to establish the facility on or near the HGL.

- At a site such as **Lusted Hill** where a filtration facility could be placed close to the HGL, little or no pumping would be required to move water through a the facility and into the Portland distribution system (see Figure 1). At this site, it is estimated that 200 million gallons a day (mgd) could be treated by gravity flow; therefore pumping would be needed only for the highest summer peak flows. Estimated costs for pumping are $2,000 to $20,000 per year for the life of the facility.

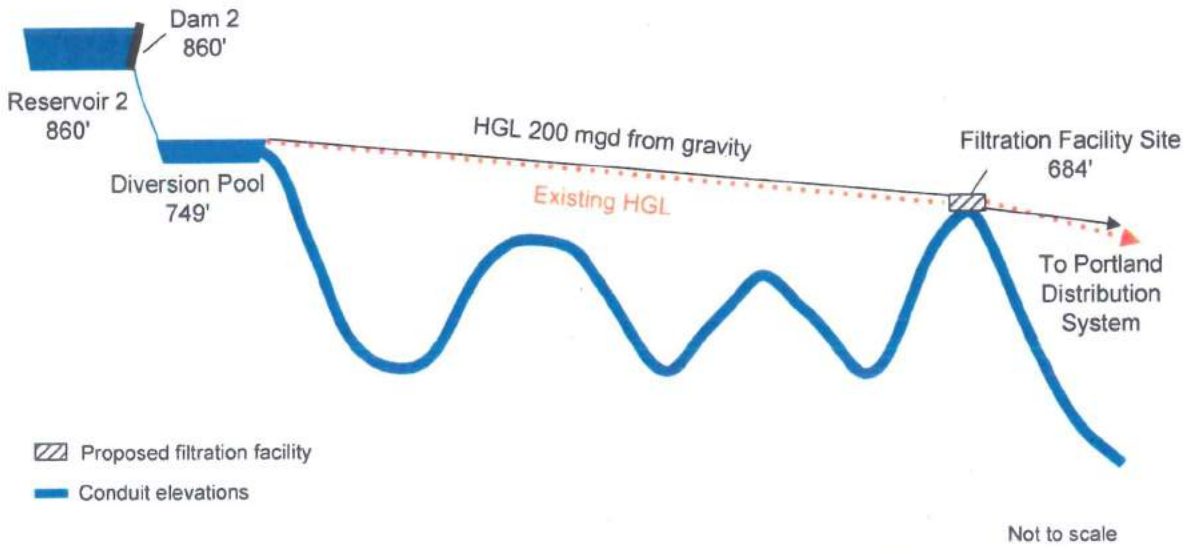


Figure 1. Direct Filtration Facility on Existing HGL—Such As Lusted Hill

[2] See the scenario description in the Filtration Hydraulics spreadsheet (Attachment 1) for examples of gravity capacity and estimated pumping at different elevations at each site.

- The existing ground elevation at a filtration site such as **Roslyn Lake** is below the HGL. If a facility were built at that elevation, pumping would always be required downstream of the facility to lift the water back up to the HGL and over Lusted Hill (see Figure 2).[3] Estimated costs for pumping are $650,000 to $1,200,000 per year for the life of the facility.

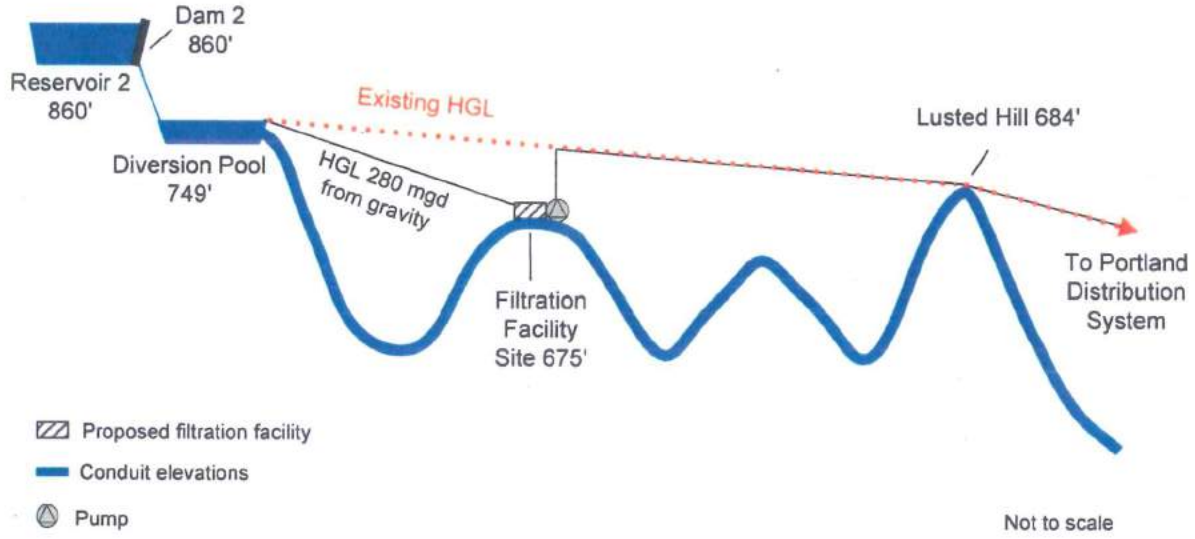


Figure 2. Direct Filtration Facility Below Existing HGL—Such As Roslyn Lake Site

- A site such as **Carpenter Lane** is above the existing HGL. Some gravity flow can be achieved at Carpenter Lane; the amount is dependent on the drop in elevation from the Diversion Pool. Figure 3 shows that a 160 mgd flow could be achieved from gravity flow. Pumping upstream of the facility would be required during the summer peak season to lift the water to Lusted Hill and connect to the conduits. Estimated costs for pumping are $30,000 to $200,000 per year for the life of the facility.

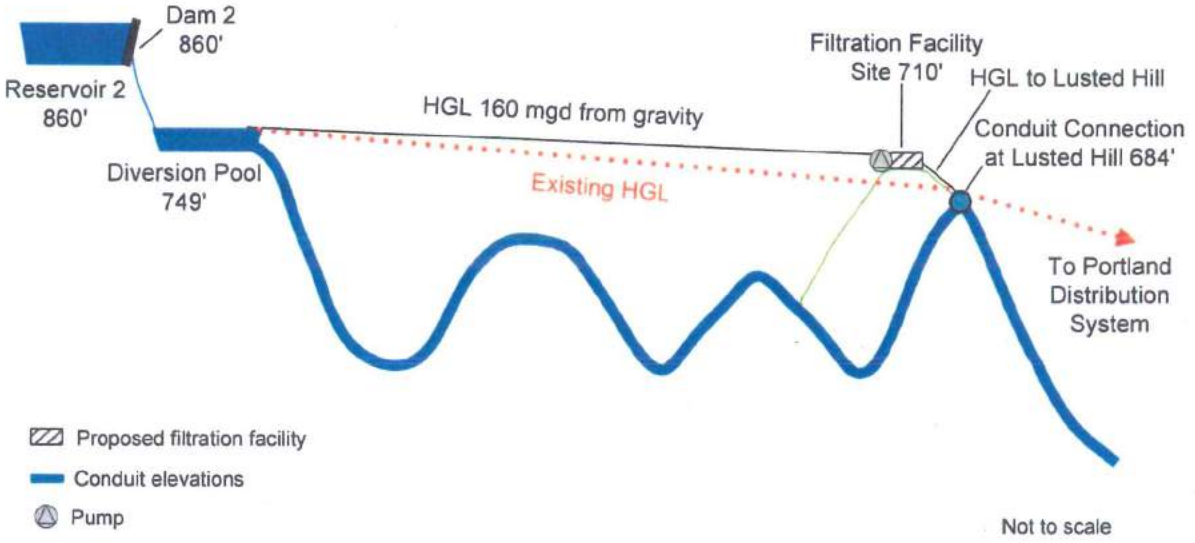


Figure 3. Direct Filtration Facility Above Existing HGL—Such As Carpenter Lane

[3] Another option would be to raise the site up to the existing HGL instead of pumping water to the existing HGL.

- A pressurized membrane facility at **Headworks** would be at the highest possible point on the existing HGL to take advantage of the gravity flow from Reservoir 2. No pumping would be required to move water to Lusted Hill and on to Portland. This option would rely on the additional water pressure available from the Reservoir 2 elevation (see Figure 4). Currently, Reservoir 2 water pressure is used to generate power through the Portland Hydroelectric Project (PHP). If this site were chosen, power generation through PHP would be reduced because the drinking water would no longer flow through the PHP powerhouse.

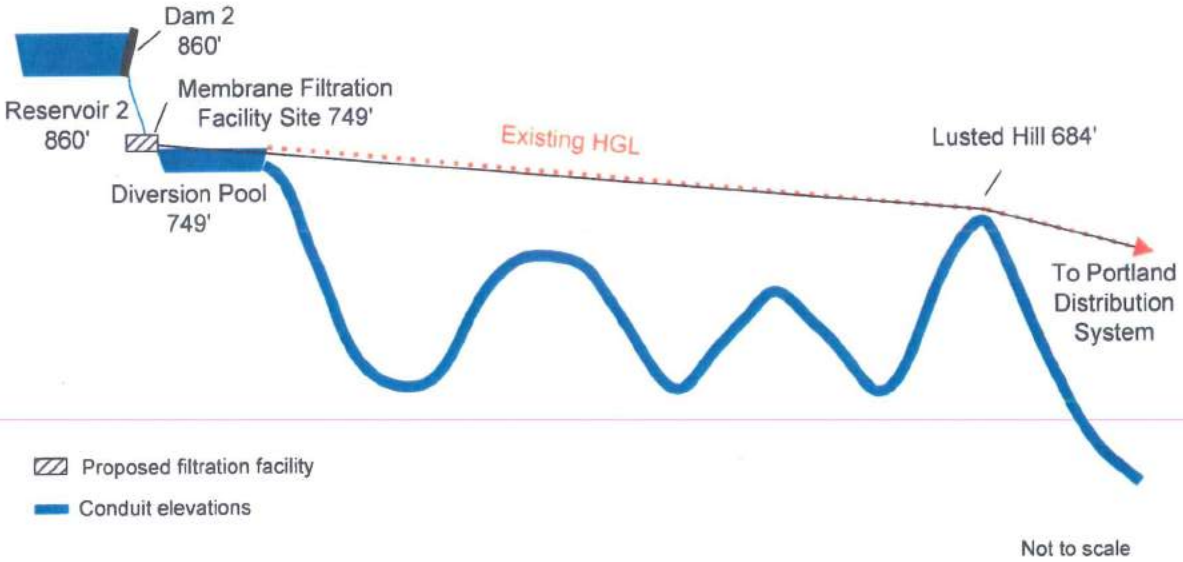


Figure 4. Membrane Filtration Facility on Existing HGL—Such As at Headworks

Other Factors Affecting Costs and Schedule

Proximity to the Conduit Rights-of-Way

Sites on or near the existing conduit rights-of-way would reduce the need for additional piping to connect to the conduits. New conduit pipeline is estimated to cost approximately $1,000 per foot.

- In some scenarios, the **Lusted Hill** site would require about 10,000 feet of additional piping to connect to the existing three conduits, Conduits 2, 3, and 4.
- A site such as **Roslyn Lake** is fairly close to two of the existing conduits; about 6,000 feet of additional piping would be needed to connect to all three conduits. This would include bringing Conduit 3 under the Sandy River twice.
- A site such as **Carpenter Lane** would require the greatest length of additional piping (13,200 feet to 21,600 feet) to connect to the existing conduits. Also, the existing conduits might need reinforcement upstream of the existing Lusted facility because the elevation of the Carpenter Lane site would add pressure to the pipes upstream of the Lusted Hill conduit connection (shown in Figure 3 as "HGL to Lusted Hill"). The increase in pressure could be as much as 60 feet (or 25 psi).

- The **Headworks** site is at the diversion point for the conduits. This option for a pressurized membrane facility would not require major extensions of large pipe.

Capacity to Accommodate Process Waste

Both membrane and direct filtration methods generate some process waste: a small amount of solids (15-55 pounds per million gallons) and filter backwash water (3-10 percent of the total volume of water).[4] The small amount of solid waste can be removed from the facility site. At peak volumes, the filter backwash water could be as much as 20 mgd. Three basic methods have been used at other facilities for discharging filter backwash water: settling, mechanical removal (with presses or centrifuges) and recycling for landscape irrigation, or discharging to a surface water source such as a stream or water body. Settling ponds or basins require space; mechanical removal requires energy; and discharge requires proximity to an acceptable surface water source.

- If additional land could be acquired at the **Lusted Hill** site (see Current Land Ownership section), the facility could handle filter backwash water through settling or mechanical removal and recycling. Discharging to a surface water source would require easements and piping to the Sandy River. The reach of the Sandy River that backwash water would be discharged to is designated as a federal Wild and Scenic River and a state Scenic Waterway; acquiring permits for an outfall may be a somewhat lengthy process, requiring coordination with several agencies.
- A site as large as **Roslyn Lake** could easily accommodate a settling pond or basin and would have sufficient power for mechanical removal of filter backwash water. In addition, piping is already in place from the abandoned Portland General Electric (PGE) powerhouse to a surface water source.
- The **Carpenter Lane** site is also large enough to accommodate a settling pond or basin and could have sufficient power for mechanical removal of filter backwash water. Discharging to a surface water source would likely require easements and piping to the Sandy River as well as a permitting process similar to that for the Lusted Hill site.
- The **Headworks** site (under consideration for a pressurized membrane facility only) is too small for a settling pond or basin or for extensive mechanical removal. Filter backwash water would be discharged to the lower Bull Run River.

Current Land Ownership and Use

Sites already owned by the City of Portland reduce the risk of failing to complete design and construction by the compliance deadline. The time frame for land-use review, permitting, and land acquisition for sites not owned by the City of Portland may be longer than the five-year time frame available to meet the final April 1, 2014 compliance deadline.

- Although the property at **Lusted Hill** is already owned by the City of Portland, the filtration plant footprint would require the acquisition of approximately 15-40 additional acres. Analyses

[4] Filter backwash water is water used to remove particles from either membrane filters or a direct filtration medium. The particles that are removed are the same particles that were present in the raw water source.

of lots to the north, west, and south indicate primarily residential improved land with some acreage zoned nonexclusive farm use. Future investigation should cover the likelihood of, and potential time frame for, acquiring property.

- The **Roslyn Lake** site is owned by PGE. The Roslyn Lake site would be large enough for a direct treatment facility. The bureau anticipates that permitting agencies already have a body of knowledge about the site that might facilitate acquiring permits. Future investigation should cover PGE's willingness to sell and confirm the status of land-use and permitting issues.
- The **Carpenter Lane** site is owned by the City of Portland. No further major land acquisition would be needed and preliminary planning for the site has been completed.
- The **Headworks** site is owned by the City of Portland. No further major land acquisition would be needed and preliminary planning for the site has been completed. Attachment 2 shows the potential permitting issues associated with constructing a pressurized membrane filtration facility at Headworks.[5]

Potential to Accommodate Future Demand

The Bull Run system's potential to accommodate future demand by gravity flow through a single treatment plant is predicated on two assumptions: the construction of Conduit 5 (along existing rights-of-way) and the future ability to divert water from Reservoir 2 rather than the Diversion Pool. The Water Bureau currently owns the right-of-way for Conduit 5; therefore, the location of a site close to the planned path for Conduit 5 would require little additional land acquisition and permitting. At an elevation of 860-832 feet above mean sea level (MSL), Reservoir 2 would provide greater water pressure to Conduit 5 than the existing Diversion Pool (at 749 above MSL). [6]

- Although the **Lusted Hill** site is relatively close to the Conduit 5 right-of-way, the site would be slightly below the Reservoir 2 modeled HGL, which means it could accommodate future demand with minimal pumping.
- The **Roslyn Lake** site is relatively far from the Conduit 5 right-of-way, and would be as much as 100 feet lower than the Reservoir 2 modeled HGL. Once the Reservoir 2 water pressure was lost at the Roslyn Lake elevation, future demand would have to be accommodated through pumping.
- The **Carpenter Lane** site is on the Conduit 5 right-of-way. The elevation of the Carpenter Lane site is on the Reservoir 2 modeled HGL, which means the site could accommodate future demand with little or no pumping.
- The use of the Reservoir 2 elevation to operate a pressurized membrane facility at **Headworks** would preclude using Conduit 5 because the elevation at the downstream end of the filtration facility would be similar to the elevation today—therefore there would be no net gain in water pressure. To accommodate future demand, water would have be to pumped or a second treatment facility would have to be constructed.

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[5] The Headworks site is too small to accommodate a direct filtration facility.

[6] Depending on the site chosen, however, the Water Bureau may opt to build a second treatment facility at a different location to treat water from Conduit 5 or the path of Conduit 5 could be changed.

Potential to Generate Power

A site below the HGL, such as **Roslyn Lake**, would have the greatest potential for power generation, because it has the greatest difference between the starting elevation and the end-point elevation, therefore the greatest water pressure.[7] Any water pressure used to generate power also reduces the gravity flow capacity.

The option of placing a pressurized membrane facility at **Headworks** and connecting it to Reservoir 2 is another possibility for power generation. The water pressure over and above what is necessary to push the water through the filtration facility could be used to generate power. It should be noted that the water pressure from Reservoir 2 used to pressurize the filter would not be available to generate power through the Portland Hydroelectric Project turbines.

In addition to hydroelectric power generation, solar generation at the **Carpenter Lane** site could be considered as an auxiliary for all options.

Necessary Site Improvements

If a filtration facility is constructed, it is assumed that all treatment facilities would be consolidated into one location. Estimated site improvements may include buildings, storage tanks, clearwells, dewatering systems, trenching or boring for conduit connections, or filling to achieve elevations necessary to minimize pumping. Future investigation should be made regarding the quality of, and capacity for, electrical power at each site.

- Depending on the land available for acquisition, additional pipeline from the **Lusted Hill** facility to the existing conduits may be lengthy and may need to be placed in a trench.
- The **Roslyn Lake** site is relatively flat, but may require significant site work.
- Although the **Carpenter Road** site is fairly flat, some deep (at least 20-foot) trenching or boring may be required to connect to the existing conduits. Further investigations should include a geotechnical analysis to confirm the feasibility of trenching or boring at the site.
- The **Headworks** site would need significant alterations to be able to fit a facility on to this site. The clearwell and dewatering systems would likely need to be constructed in Kaiser Park and other downstream areas. The Diversion Pool would need to be filled to create more buildable land. It is likely that a pressurized membrane facility at Headworks could utilize existing conduit piping.

Impact of Site Choice on the Community

The development and construction of a filtration facility of the proposed 215 mgd capacity has the potential to affect neighbors in the surrounding community. In addition to generating additional traffic during construction, the Water Bureau may need to mitigate the site to reduce the visual and noise impact of a new water treatment facility.

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[7] Raising a site that is below the existing HGL closer to the existing HGL will reduce the amount of water pressure that is available for generating hydroelectricity.

- Although a treatment facility at **Lusted Hill** is already in operation, expansion and the related land-acquisition process would be affected by land-use regulations and may affect land values in an area that is predominantly residential.
- The **Roslyn Lake** site is the largest and has the greatest potential for including features valued by the surrounding community, such as open space. The Roslyn Lake site also reduces the amount of backfeed pipeline necessary to serve upstream customers, and would provide the greatest flexibility in serving the City of Sandy.
- The **Carpenter Lane** site and easements are already owned by the City of Portland. The facility site is somewhat separate from the road, which might be considered an amenity by the community.
- The **Headworks** site would have little impact on the community except for the additional traffic into the watershed during construction.

Table 1 on the next page provides a summary of the major considerations for site selection as well as the range of estimated costs to construct and operate and maintain a facility at each of the sites under consideration.

Table 1. Considerations for Filtration Facility Site[a]

	On HGL	Below HGL	Above HGL	On HGL
Proposed Sites	Lusted Hill	Such as Roslyn Lake	Such as Carpenter Lane	Headworks
Hydraulic Considerations				
Pumping required	Minimal	All year at the current elevation	Summer	No
Estimated pipe length needed for conduit connection	10,000'	6,000'	13,200' to 21,600'	Minimal
Process Waste Accommodation	Settling or mechanical removal; discharge would require piping and permits.	Discharge would require permits.	Settling or mechanical removal; discharge would require piping and permits.	Discharge would require permits.
Current Land Ownership and Use				
Land ownership	Water Bureau owns some land but would need to acquire approximately 15-40 acres.	Portland General Electric owns entire site (~300 acres).	Water Bureau owns sufficient acreage.	Water Bureau owns all land.
Land use	Adjacent land use is mostly residential improved land with some nonexclusive farm land.	Timber District	Multiple Use Agriculture	Timber District
Potential to Accommodate Future Demand by Gravity[b]	Limiting factors	Limiting factors	Limiting factors	Could utilize maximum water pressure currently available
Potential to Generate Power	No	Yes—hydroelectric	Yes—solar[c]	Yes—hydroelectric
Necessary Site Improvements	All treatment facilities would be consolidated at the site. Clearwell and backwash facilities.	Site may require cut and fill. All treatment facilities would be consolidated at the site. Clearwell and backwash facilities.	All treatment facilities would be consolidated at the site. Clearwell and backwash facilities.	All treatment facilities would be consolidated at the site. Clearwell and backwash facilities.
Impact on Community	Facility would require a conditional use approval. Neighborhood would experience more industrial traffic.	Site size has potential to accommodate water feature or park; reduces length of backfeed pipe necessary.	Facility would require a conditional use approval. Neighborhood would experience more industrial traffic.	Facility would require a conditional use approval. Neighborhood outside watershed would experience more industrial traffic.
Scheduling Risks for Compliance Deadline	Land acquisition and permitting effort may constrain schedule.	Land acquisition and permitting effort may constrain schedule.	No land acquisition is required. Permitting effort may constrain schedule.	No land acquisition is required. Permitting effort may constrain schedule.
Total Estimated Cost to Construct (in millions of dollars)	$385—$405	$395—$415	$400—$420	<$405
Total Estimated Lifecycle Cost	$680—$730	$720—$770	$700—$750	<$730+

[a]Modeling for all site analyses was conducted under the calendar year 2008 peak-day conditions

[b]Limiting factors include proximity to proposed Conduit 5 right-of-way and site elevation relative to modeled hydraulic grade line from Reservoir 2

[c]Provided the bureau retains ownership of Carpenter Lane site, solar power generated there could provide offsets for pumping power costs at other sites.

Recommendation

The potential filtration sites discussed in this memorandum, Lusted Hill, Roslyn Lake, Carpenter Lane, and Headworks, were chosen for their position relative to the existing HGL and, to a lesser degree, their proximity to the existing conduit rights-of-way. Building a new treatment facility on the Lusted Hill site would generate the lowest lifecycle costs, require a moderate amount of new piping to connect to the conduits, and would have the least impact on the existing system. Lusted Hill is the recommended option.

As Table 1 shows, the Water Bureau would face challenges building and operating a filtration facility at any of the sites under consideration. The challenges associated with the Lusted Hill option include handling filtration backwash water, obtaining permits, and acquiring land.

Currently, the Lusted treatment facility generates a small amount of waste water that is discharged to a septic system. To accommodate as much as 20 mgd of filter backwash water during peak season, the Water Bureau would need to obtain permits to discharge the water to the Sandy River or develop an alternate form of disposal.

The Lusted Hill site as it currently exists is too small to accommodate the footprint of a direct filtration facility. Approximately 15-40 additional acres would need to be acquired in order to begin construction. Acquiring land around the existing Lusted Hill site will require permitting work and acquiring easements—tasks that can take time and entail a robust public outreach effort. The Carpenter Lane property may be an asset that can be negotiated or traded for a lot closer to the Lusted Hill facility.

It is recommended that the Water Bureau make contact with property owners in the Lusted Hill area to see whether any are interested in selling or trading properties. If there are willing sellers, then the bureau can begin to take actions on an appropriate property for the filtration facility.

Regardless of whether the bureau uses the Carpenter Lane site for a filtration facility, it is suggested that the bureau use this site for the installation of a solar-power-generation facility. If this recommendation is accepted, then the bureau should provide notice to the current land user that they would need to vacate the property in two years.

Attachment 1

Filtration Hydraulics
2/20/2009

Scenario Description	Units	Base Case	Lusted 675 215 mgd to Plant	Lusted 680	Lusted 684 Max Gravity	Carpenter 710 Inline	Carpenter 730 Inline	Roslyn 675	Roslyn 700	Roslyn 715 Max Gravity	Roslyn 700 no C3	Roslyn 715 no C3
						Scenarios						
					See Figure 1.	*See Figure 3.*		*See Figure 2*				
Diversion Pool HGL	feet	749	749	740	749	749	749	749	749	749	740	749
Plant Inlet Pool Elevation	feet	–	675	680	684	710	730	675	700	715	700	715
Clearwell Pool Elevation	feet	–	650	655	655	705	705	650	675	680	675	680
Powell Butte HGL	feet	525	525	525	525	525	525	525	525	525	525	525
Demand Settings		CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD	CY 2008 PDD
Plant Location			Lusted	Lusted	Lusted	Carpenter	Carpenter	Roslyn	Roslyn	Roslyn	Roslyn	Roslyn
Approximate ground elevation	feet		650 - 680	680 - 680	650 - 680	700 - 740	700 - 740	640 - 660	640 - 660	640 - 660	640 - 660	640 - 660
Diameter of new pipe between Conduits and plant	in		66, 58, 52	66, 58, 52	66, 58, 62	96	96	66, 58 52	66, 58, 52	66, 58, 52	66, 52	66, 52
New Pipe Length - Conduits to Plant	feet		350, 1350, 350	350, 1350, 350	350, 1350, 350	6600	6600	200, 2600, 200	200, 2600, 200	200, 2600 200	200, 200	200, 200
Diameter of new pipe between Conduits and plant	in		56, 50, 44, 24	56, 50, 44, 24	66, 50, 44, 24	96	96	66, 58, 52	66, 58, 52	66, 58, 52	66, 52	66, 52
New Pipe Length - Plant to Conduits	feet		1900, 1300, 1900, 2300	1650, 1300, 1650, 2300	1400, 1300, 1400, 2300	6600	6600	200, 2600, 200	200, 2600, 200	200, 2600 200	200, 200	200, 200
New Pipe Length - Alternate Outlet to C3	feet		–	–		5600 (96")	5600 (96")	–	–	–	–	–
New Pipe Length - Alternate Outlet C3 to C4 & C2	feet		–	–	–	2500 (72")	2500 (72")	–	–	–	–	–
Conduit interlie	#		–	–	–	2	2	–	–	–	–	–
River Crossing	#		–	–	–	–	–	2	2	2	–	–
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Using alternate outlet	mgd	–	–	–	–	211	224	–	–	–	–	–
Upstream Pump Head required to achieve 215 mgd	feet	6	0	6	6	30	50	0	0	10	–	–
Downstream Pump head required to achieve 215 mgd	feet	–	30	25	24	18	0	69	44	29	–	–
Using alternate outlet	feet	–	–	–	–	4	0	–	–	–	–	–
Potential upstream excess head recovery at 95 mgd	feet	176	56	53	48	24	4	64	39	24	34	19
Potential downstream excess head recovery at 95 mgd	feet	–	93	98	102	173	143	65	110	125	106	121
Using alternate outlet	feet	–	–	–	–	126	146	–	–	–	–	–
Potential upstream excess head recovery at 215 mgd	feet	0	0	0	0	0	0	30	5	0	–	–
Potential downstream excess head recovery at 215 mgd	feet	0	0	0	0	0	2	0	0	0	–	–
Using alternate outlet	feet	–	–	–	–	0	14	–	–	–	–	–

0.1 Environmental Permitting

Several activities associated with the construction and operation of a pressurized membrane facility at Headworks in the Bull Run watershed have been identified as potentially requiring environmental permits. Each of these actions that would trigger a permit is listed in Table 4.1, with the associated permit, permitting agency, and any secondary permitting activities that would be involved. The listed "Approval Time Frame" refers to the time it takes to obtain the permit after materials have been submitted to the permitting agency. Permitting agencies usually will not start the permitting process until the design of a facility is far enough along for impacts (to wildlife, air quality, etc.) to be fairly well known. However, early communication with permitting agencies will help agency staff become familiar with the details and potential impacts of such a large, complex facility. The City's Streamlining process provides staff the opportunity to discuss upcoming projects with agency personnel. This should be done early in the design phase.

The most significant permit that might be required for the project, in terms of the level of agency coordination, is a Clean Water Act Section 404 permit (Sec. 404 permit), obtained from the U.S. Army Corps of Engineers (USACE). A joint permit application for the 404 and Division of State Lands (DSL) permits would be required if wetlands were disturbed or if fill were placed below the ordinary high water line in order to modify an existing outfall or construct a new outfall. The approval timeframe for the Sec. 404 permit would be governed by whether the activity falls within a Nationwide Permit category or requires issuance of an "individual permit." The project is unlikely to require an environmental assessment or formal Sec. 7 ESA consultation with the National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS). Table 4 .1 reflects the longest anticipated time frames with regard to NEPA and ESA documentation and review.

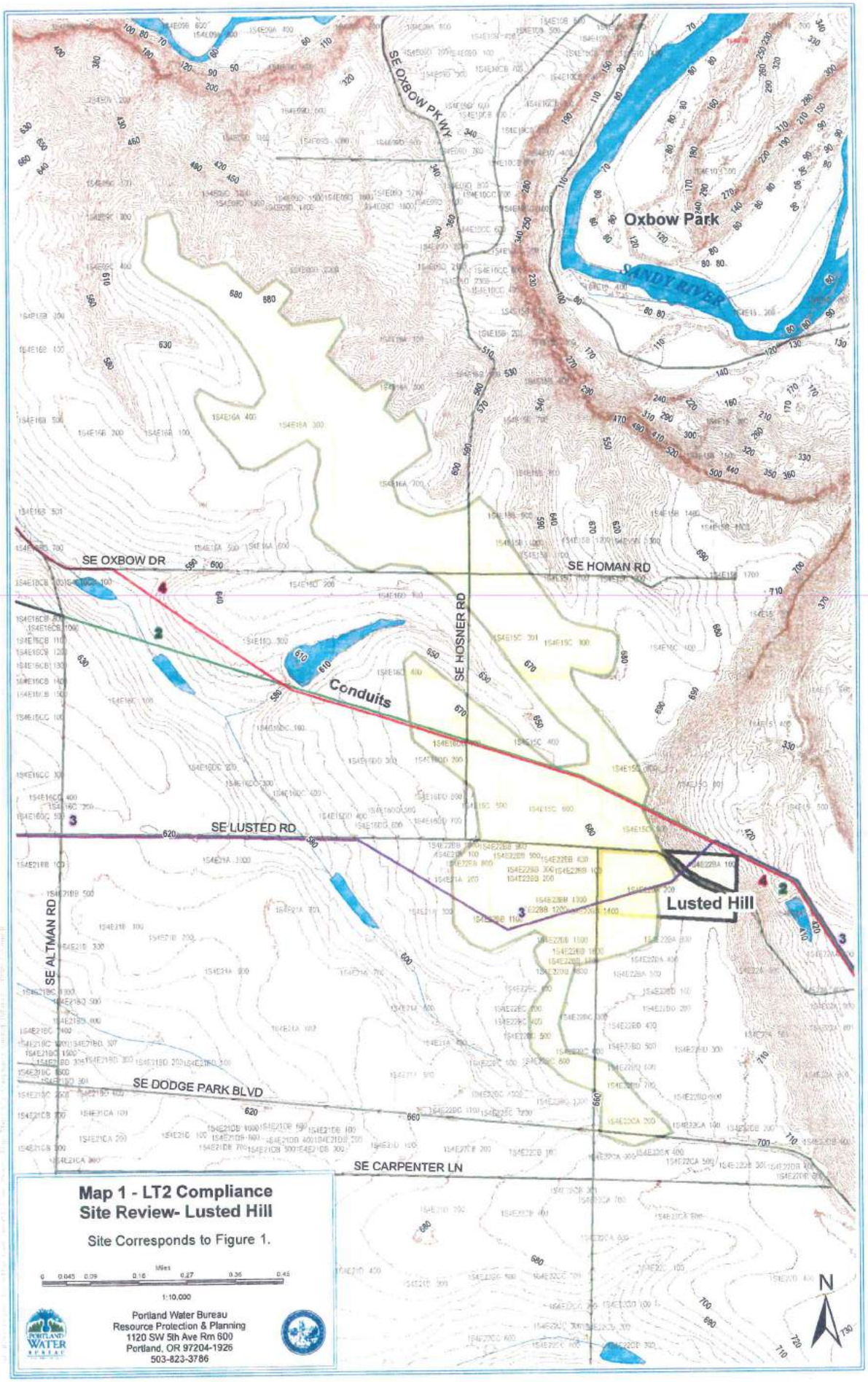
The approval timeframe for Sec. 404 Nationwide Permits is assumed to be three months, versus 9-12 months for individual permits. Nationwide Permits do not require a public notification and comment period and many of the categories, including No. 7 (Outfall Structures and Associated Intake Structures), have received pre-approval by the Oregon Department of Environmental Quality for certification with Sec. 401 of the Clean Water Act. If no disturbance to wetlands or placement of fill below the ordinary high water mark would be associated with the project, no Sec. 404 permit or secondary permits would be required.

The Bureau completed a Habitat Conservation Plan (HCP) for the Bull Run water supply system in 2008 to support its application for an Incidental Take Permit from NMFS for compliance with Sec. 10 of the ESA. The HCP did not seek coverage for terrestrial ESA-listed species from the USFWS, but includes an Implementation Plan for Spotted Owl and Bald Eagle Management which outlines a habitat evaluation and survey protocol for work being done in areas with potentially suitable habitat for these species. Although this is not a permit, it is listed as it will be considered in any permitting activities with federal agencies. An aerial photograph review of the Headworks area concluded that no suitable habitat was present that would be affected by the noise of construction or operation of the facilities. However, the recommended alternative includes activities in a location where spotted owl habitat may potentially be present – the timber stands adjacent to the fiber optic cable alignment (Road 10). Evaluations of the fiber optic cable alignment will be undertaken to determine whether further survey work is necessary

Table 4.1. Potential Permitting Requirements for a Pressurized Membrane Filtration Facility Sited In Bull Run Watershed*

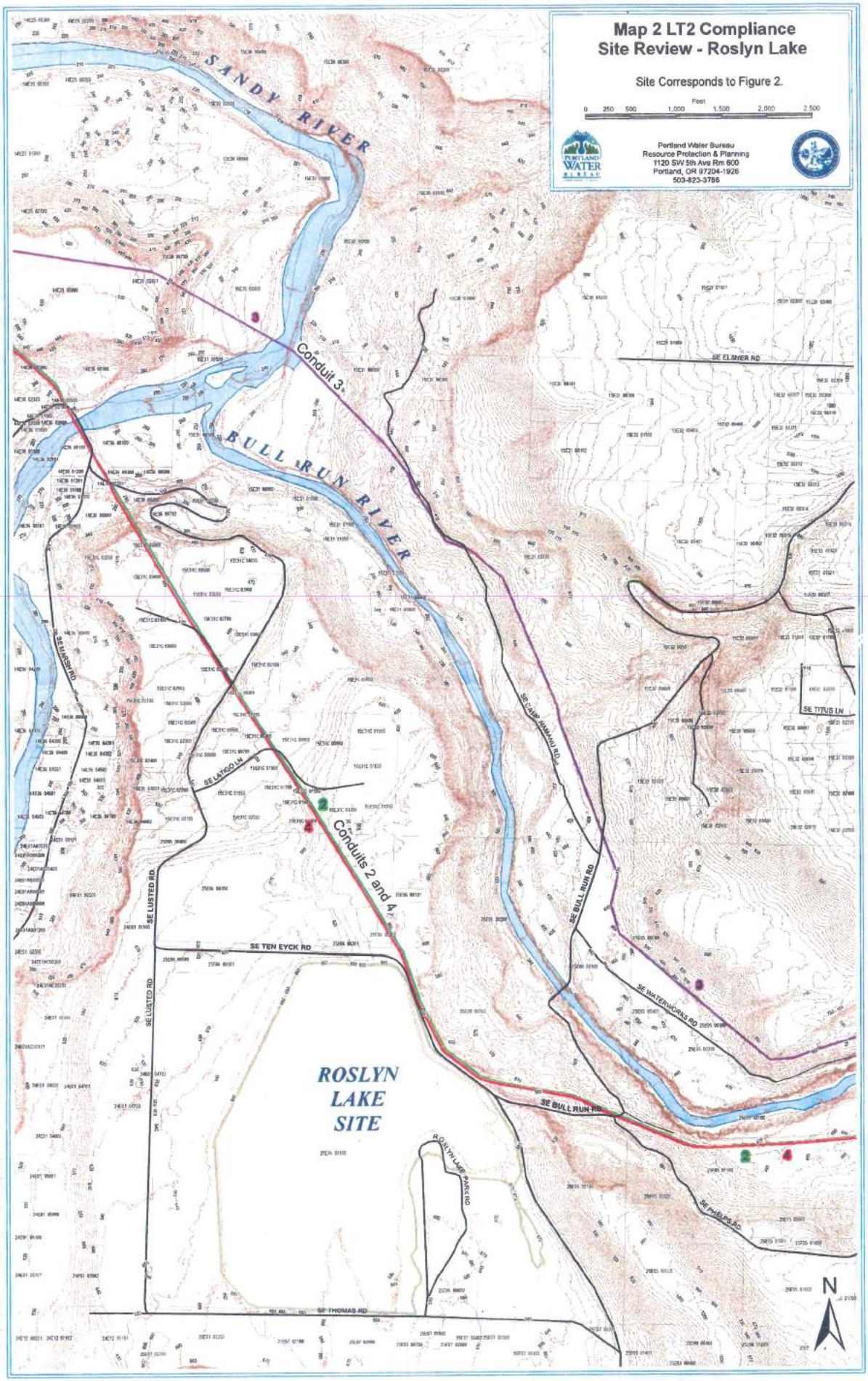
Action That May Trigger Permit	Primary: Permit	Primary: Permitting Agency	Secondary: Permit	Secondary: Permitting or Review Agency	Approval Time Frame	Notes
New outfall structure on City of Portland land that involves placement of material below ordinary high water	Modification to systemwide NPDES permit	DEQ			3 months	
	USACE 404/DSL permit	USACE, Division of State Lands	ESA Sec. 7 consultation NHPA Sec. 106 review CWA 401 certification	USFWS, NMFS SHPO DEQ	5-12 months for individual permit 3 months for Nationwide permit	USACE will most likely consider the impacts of the entire treatment plant if any 404 permit is needed (i.e. if there is a federal nexus). Some Nationwide 404 permit categories have been pre-candied by DEQ with respect to CWA 401 certification.
Construction of filtration facility and fuel storage/generator facilities for back-up power supply	Conditional Use Permit, compliance with River & Stream Conservation Area overlay zoning	Clackamas County			3-6 months	Potential to pursue rezoning of land to be compatible with PWB projects rather than obtaining a conditional use permit for individual projects
	Building permit and trade permits	Clackamas County			6-9 months	
Air quality emissions associated with backup generator	Possibly permits related to Clean Air Act	DEQ			3 months	
Land disturbance associated with filtration facility construction	1200c Construction Stormwater permit	DEQ			2-3 months	
Tree removal in riparian zone associated with construction of new outfall or modification of existing outfall at Headworks	River & Stream Conservation Area zoning permit	Clackamas County			3 months	
Noise harassment to spotted owls from construction along City of Portland land portion of roadway (buried fiber optic line)	Compliance with HCP measure W-2	USFWS			15 months to conduct habitat evaluation and nesting survey (seasonally dependent)	This is not a permit. The bureau's Habitat Conservation Plan contains an agreement to survey for owls on city land if suitable habitat exists and there is a potential to disturb owls during nesting season. No surveys or permitting required of construction activity occurs July 1- February 28.
Noise harassment to spotted owls from construction along Forest Service land portion of roadway (buried fiber optic line)	Compliance Willamette Province Spotted Owl Noise Disturbance Biological Assessment. Forest Service Special Use Permit	Forest Service	ESA Sec. 7 consultation	USFWS	15 months to conduct habitat evaluation and nesting survey (seasonally dependent)	Willamette Province Spotted Owl Noise Disturbance Biological Assessment is a programmatic ESA Sec. 7 document that contains guidance on disruption distances and seasonal operations that apply to noise disturbance on federal land. Forest Service would not require habitat surveys or nesting surveys for their land if no historical nest sites are located within ¼ mile of the project area or if construction activity occurs between July 15 and February 28. The bureau has already applied for a Special Use Permit from the Forest Service for maintenance of roads on Forest Service land, including segments of Road 10 on Forest Service land between Bull Run Watersheds Management Unit western boundary and Headworks. If historical nest sites are located within ¼ mile of the roadway, the Forest Service would amend the road Special Use Permit to include seasonal restrictions for buried cable construction for those locations.

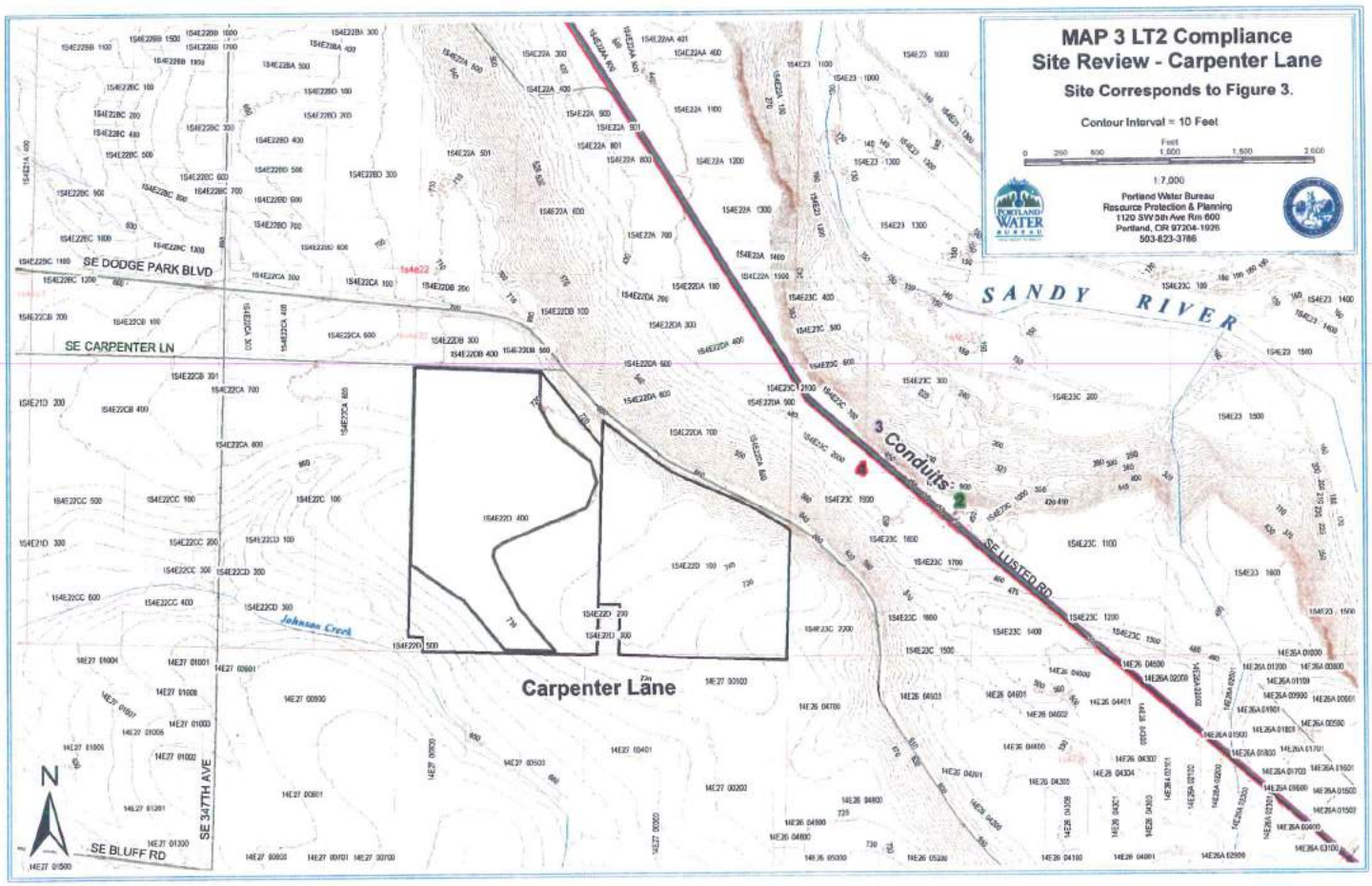
*Abbreviations
USACE—U. S. Army Corps of Engineers
DEQ—Oregon Department of Environmental Quality
DSL—Oregon Division of State Lands
ESA—Endangered Species Act
FERC—Federal Energy Regulatory Commission
NEPA—National Environmental Policy Act
NHPA (section 106)—National Historic Preservation Act, section 106 review (protection of historic properties)
NMFS—National Marine Fisheries Service
NPDES—Federal Water Pollution Control Act, section 401 permits (National Pollutant Discharge Elimination System permits)
PWB—Portland Water Bureau
SHPO—State Historic Preservation Office
USFWS—U. S. Fish & Wildlife Service
404—Federal Water Pollution Control Act (Clean Water Act), section 404 permits (Permits for dredged or fill material)



Map 1 - LT2 Compliance Site Review- Lusted Hill

Site Corresponds to Figure 1.


Map 2 LT2 Compliance
Site Review - Roslyn Lake
Site Corresponds to Figure 2.
Feet
0 250 500 1,000 1,500 2,000 2,500
Portland Water Bureau
Resource Protection & Planning
1120 SW 5th Ave Rm 600
Portland, OR 97204-1926
503-823-3786
SANDY RIVER
BULL RUN RIVER
Conduit 3
Conduits 2 and 4
SE ELSNER RD
SE TITUS LN
SE CLAIR-MAMAHI RD
SE BULL RUN RD
SE WATERWORKS RD
SE PHELPS RD
SE MARSH RD
SE LATIGO LN
SE LUSTED RD
SE TEN EYCK RD
ROSLYN LAKE PARK RD
SE THOMAS RD
ROSLYN LAKE SITE
N


MAP 3 LT2 Compliance
Site Review - Carpenter Lane
Site Corresponds to Figure 3.
Contour Interval = 10 Feet
Feet
0 250 500 1,000 1,500 2,000
1:7,000
Portland Water Bureau
Resource Protection & Planning
1120 SW 5th Ave Rm 600
Portland, OR 97204-1926
503-823-3786
SE DODGE PARK BLVD
SE CARPENTER LN
SANDY RIVER
3 Conduits
SE LUSTED RD
Carpenter Lane
Johnson Creek
SE 347TH AVE
SE BLUFF RD
N

Headworks
PWP2Rd
1000026
N11333
Dam 2
BULL RUN
RESERVOIR 2
D2Rock
D2Rock
N11470
Conduits 2 and 4
Conduit 3
Teardrp
N
Map 4 LT2 Compliance
Site Review - Headworks
Site Corresponds to Figure 4.
Contour Interval = 10 Feet
Feet
0 50 100 200 300 400 500
1:2,500
Portland Water Bureau
Resource Protection & Planning
1120 SW 5th Ave Rm 600
Portland, OR 97204-1926
503-823-3786

Appendix D. Zoning and Land Use Review Analysis for Bull Run Treatment

Zoning and Land Use Review Analysis for Bull Run Water Treatment Plant Siting

I. Overview

This report provides a *high level* review of the zoning and land use permitting requirements for six sites under consideration for a future water treatment facility for the City of Portland. The selected sites listed below are located in unincorporated Multnomah and Clackamas Counties and the City of Portland. Zoning information was collected from each jurisdiction's GIS mapping system (including Metro RLIS) and land use procedural information was derived from each jurisdiction's development code. The sites considered below are categorized by jurisdiction, not by overall developability or rank based on zoning regulations and/or land use process.

II. Sites Considered

CARPENTER LANE

Owner(s): City of Portland – Water Bureau

Location: Multnomah County – West of the Sandy River and between SE Dodge Park Blvd and Clackamas County border

Site Address: SE Carpenter Lane (not addressed)

Property ID: R342619 (1S4E22D 00400). 56.87 Acres.
R342603 (1S4E22D 00100). 36.62 Acres.

Site Area: 93.49 acres

Zoning: MUA-20 (Multiple Use Agriculture – 20)
West of Sandy River Rural Plan Area
Hydric Soils: Inside
Urban and Rural Reserves: Rural
Fire District: Multnomah County Fire Protection District #10
Watershed Name: Johnson Creek (Willamette WS)
SEC-H: Inside
SEC-WR: Inside
Slope Hazard: Inside

Environmental Resources:

- Significant Environmental Concern – Stream (or Water Resources). Applies to approximately 1.2 acres in the southwest corner of R342619 (the western taxlot).
- Significant Environmental Concern – Wildlife. Applies to approximately 4.5 acres of hillslope on the northeast margin of R342603 (the eastern taxlot).

Other Mapped Information:

- Slopes in the southwest two or three acres range from 10 to 25%.

- Slopes along the northeast margin of the site range from 25% to over 40%.
- Hydric soil is mapped over approximately ½ acre on the western boundary of the west lot and on less than 0.1 acre in the southwest corner of the west lot. There are no mapped wetlands on the site.
- Both taxlots have mapped frontage on SE Dodge Park Blvd, although it is separated from them by a steep slope.
- The west lot has frontage on SE Carpenter Lane. Carpenter Lane apparently serves seven residences between the Water Bureau properties and SE Cottrell Road.
- The south boundary of the two lots is also the Clackamas County line.

Mixed Use Agriculture (MUA 20) Zone:
The MUA 20 zone is a relatively flexible zone intended to conserve agriculture lands not suited to full-time commercial farming and encourage non-agriculture lands for other purposes, including Conditional Uses.

A water treatment/filtration facility is considered a "Community Service Use," which is a Conditional Use in the MUA-20 zone. The filtration building (if standalone) will be the primary structure. Other structures, if separate from the filtration structure, may be "accessory" structures, depending on the uses they serve.

Any tower constructed to hold radio or microwave antennae is considered an accessory structure, but also a separate use. Such towers have a specific review.

The site layout and the preliminary designs of the visible structures will be subject to a Design Review (Note: this is normally much simpler than a "Design Review" in Portland).

Review Types
Community Service Review (Section 36.6000) and **Conditional Use Review** (Section 36.6300). Community Service Uses are classified as Conditional Uses in the MUA-20 zone, and thus the CS review is a conditional use review for this proposal. In general, CS and CU reviews consider potential off-site impacts a proposal may create and can impose conditions of approval to avoid, minimize, or mitigate them. Both CS and CU reviews are Type III procedures.

In addition to the CS review triggered by this proposal, Community Service Use development standards will be reviewed at the same time.

Two specific elements of PWB's proposal are conditional uses and are subject to CS/CU reviews.

- Filtration Facility as a Community Service
- Radio and Television Transmission Tower as a Community Service (Section 36.6100).

Design Review (Section 36.7000). The County's Design Review ensures that development is "functional, safe, innovative, attractive, and compatible with the natural and man-made environment." It requires detailed site plans plus building elevations. A new filtration facility and communication tower will both require design review.

Significant Environmental Concern Review (Section 36.4500). This review has approval criteria for specific environmental factors, two of which are present on the property. This is a Type II procedure.

Because the SEC overlays cover only small portions of the property near the property boundaries, we will likely be able to keep our development out of the overlay areas and thereby meet the clear and objective standards. If not, additional steps will be required.

If pipelines must cross the SEC-habitat area to reach the facility, this will probably trigger additional requirements. The extra requirements could include a wildlife conservation plan, but this appears unlikely.

Hillside Development Review (Section 36.5500). This review is triggered when development (including ground disturbance) takes place in a hazard area as identified on the County's "Slope Hazard Map," or on lands with average slopes of 25 percent or more. This permit is reviewed under a Type II procedure.

Both properties at Carpenter Lane have hazard areas mapped along their northeast lot lines where the slope drops down to SE Dodge Park Boulevard. Work on the slope—such as installing a conduit connection to the facility—will trigger the requirement for this permit.

This permit focuses on slope stability, erosion control, and stream protection in the slope hazard area. It should be in conformance with the DEQ 1200-C stormwater and erosion control permit.

Review Procedures

Multnomah County numbers its permit review processes I through IV. Process types I and II are both administrative and do not require a hearing (unless appealed). The Type III process is initially decided by a Hearings Officer. The Type IV process is initially heard by the County's Planning Commission. Applications are heard using the highest-level procedure that applies to any of the individual reviews (such as Design Review, Community Service Review).

Because the CS and CU reviews are Type III, all the reviews discussed will be processed together through the Type III procedure, which requires a public hearing before a Hearings Officer.

LUSTED HILL

Owner(s):	City of Portland – Water Bureau
Location:	Multnomah County – West of the Sandy River and Immediately East of Lusted Hill Road
Site Address:	6704 SE Cottrell Rd
Property ID:	R342553 (1S4E22BA 00200)
Site Area:	14.55 acres
Zoning:	CFU - Commercial Forest Use (min. 80 ac.) West of Sandy River Rural Plan Area Fire District: Multnomah County Fire Protection District #10

Watershed Name: Lower Sandy WS
Hydric Soils: Inside
SEC-H: Inside
Slope Hazard: Inside

Environmental Resources:

- Significant Environmental Concern – Wildlife. Applies to the majority of the site with the exception of a small area located at the northwest corner of the property.

Other Mapped Information:

- Slopes on the majority of the property range from 0 to 10%.
- Slopes along the northeastern 4-5 acres of the site range from 25% to over 40%.
- Access to the property is from SE Cottrell Rd. SE Cottrell Road serves a number of agricultural uses in the area.
- The surrounding area is zoned MUA to the south/southwest, EFU to the north/northwest, and CFU to the east/northeast.

Commercial Forest Use (CFU) Zone

The CFU zone conserves and protects designated lands for continued commercial growing and harvesting of timber while providing for recreational opportunities and other uses which are compatible with forest use.

A water treatment filtration facility is considered a "Community Service Use," which is a Conditional Use in the CFU zone (36.2030). The site layout and the preliminary designs of the visible structures will be subject to a Design Review.

Review Types

Community Service Review (Section 36.6000) and **Conditional Use Review** (Section 36.6300). Community Service Uses are classified as Conditional Uses in the CFU zone, and thus the CS review is a conditional use review for this proposal. In general, CS and CU reviews consider potential off-site impacts a proposal may create and can impose conditions of approval to avoid, minimize, or mitigate them. Both CS and CU reviews are Type III procedures.

In addition to the CS review triggered by this proposal, Community Service Use development standards will be reviewed at the same time.

Design Review (Section 36.7000). The County's Design Review ensures that development is "functional, safe, innovative, attractive, and compatible with the natural and man-made environment." It requires detailed site plans plus building elevations. **A new filtration facility and communication tower will both require design review.**

Significant Environmental Concern Review (Section 36.4500). This review has approval criteria for specific environmental factors. This is processed as a Type II procedure.

Because the SEC-h overlay covers most of the property, any new development onsite would require a Type II SEC review.

Hillside Development Review (Section 36.5500). This review is triggered when development (including ground disturbance) takes place in a hazard area as identified on the County's "Slope Hazard Map," or on lands with average slopes of 25 percent or more. This permit is reviewed under a Type II procedure. The property has hazard areas mapped with 25% or greater slopes along the northeast lot line where the slope rises toward SE Lusted Rd. Work on the slope—such as installing a conduit connection to the facility—will trigger the requirements for this permit.

This permit focuses on slope stability, erosion control, and stream protection in the slope hazard area. It should be in conformance with the DEQ 1200-C stormwater and erosion control permit.

Review Procedures

Because the CS and CU reviews are Type III, all the reviews noted above will be processed together through the Type III procedure.

ROSYLYN LAKE

Owner(s):	Unknown
Location:	Clackamas County – Bounded by SE Lusted Rd to the west, SE Thomas Rd to the south and SE Ten Eyck Rd to the east and north
Site Address:	41401 SE Thomas Rd Sandy, OR 97055
Property ID:	00687064 (240 ac) & 05024114 (95.82 ac)
Site Area:	+/- 335 acres
Zoning:	TBR/FF10 (Timber and Farm Forest) Districts

Environmental Resources:

- Clackamas County zoning maps and its online mapping system do not identify any environmental overlays on the site; **presence of any significant habitat, riparian, or other significant environmental areas should be identified prior to site selection.**

Other Mapped Information:

- Slopes on the majority of the site appear to range from 0 to 10%.
- Both parcels are not mapped in the 100-year floodplain.
- Clackamas County and Metro mapping do not provide data on upland or riparian habitat on the site.

Timber (TBR) and Farm Forest 10-Acre (FF-10) Districts

The TBR District (ZDO 406) is intended primarily for commercial forest operations. The FF-10 District (ZDO 316) is designed to provide for the full range of agricultural and forest uses for such lands. Clackamas County's Zoning and Development Ordinance Table 406-1 lists '*water intake facilities, related treatment facilities, pumping stations, and distribution lines*' as a conditional use in the TBR zone. Uses in this category are subject to 406.05(A)(1) & (6). Table 316-1 lists '*Public Utility Facilities*' as a

conditional use in the (Farm Forest 10) FF-10 zone. Additionally, if radio communication facilities such as a tower to hold radio or microwave antennae is proposed, both the TBR and FF-10 Districts require conditional use review.

Review Types

Conditional Use Review (ZDO 1203). Conditional Use reviews are processed as a Type III review and consider potential off-site impacts a proposal may create and can impose conditions of approval to avoid, minimize, or mitigate them.

Two specific elements of PWB's proposal are conditional uses and are subject to review:

- Filtration Facility (water intake facilities, related treatment facilities)
- Radio and Television Transmission Tower

Two sets of conditional use criteria must be addressed: (1) general conditional use criteria that apply to any conditional use in Clackamas County; and (2) forest-related conditional use standards that address potential impacts to primary forest uses.

Design Review (ZDO 1102). Design Review applies to development in commercial, industrial and multifamily zoning districts. However, ZDO 1102.01 also states that the Planning Director may "require" Design Review for other uses. In past land use cases, Clackamas County planning staff advised PWB that Design Review is applicable to proposed water facilities in the Timber District. ZDO 1102.02 Criteria and Procedure describes procedures and criteria for Design Review approval. ZDO 1102.02 A. states that:

> ***A design review application may be approved pursuant to Subsection 1305.02 if the applicant provides evidence substantiating that the proposed development complies with Section 1000, the standards of the zoning district in which the subject property is located, and all other applicable provisions of this ordinance.***

PRCA/SCA Review (ZDO 704). The RSCA overlay requires a 100-foot setback from the "median high water line" of "large streams." Development and tree-cutting activities regulated by Section 704 in a Principal River Conservation Area (PRCA) are reviewed to ensure consistency with Section 704. Proposed developments on lands within and beyond 150 feet of the mean high water line shall be reviewed through a Type II application pursuant to Section 1307. For lands beyond 150 feet of the mean high water line notice is required to be sent to the US Forest Service and Bureau of Land Management.

Development and grading permits in a Stream Conservation Area (SCA) are also reviewed through a Type II application pursuant to Section 1307. (**Note – The site appears to contain a tributary of the Sandy River. It is unknow how this resource is classified and if the PRCA/SCA standards apply. Prior to site selection, all resources onsite should be identified.**

HEADWORKS

Owner(s): City of Portland – Water Bureau

Location: East Clackamas County – East Clackamas County within the Bull Run Watershed. The site is surrounded by the Mount Hood National Forest.

Site Address: 50105 SE Rock Cut Road, Corbett, OR 97019

Property ID: 00162530
Site Area: +/- 229 acres

Zoning: Timber (TBR) District
Rivers and Streams Conservation Area (RSCA) Overlay District

Environmental Resources:

- The Rivers and Streams Conservation Area (RSCA) overlay district applies to portions of the subject property. The RSCA overlay requires a 100-foot setback from the "median high water line" of "large streams" (i.e., the Bull Run Reservoir, its spillway, and the Bull Run River below the spillway), but not to the Bull Run River or the Diversion Pool above the spillway.
- Development that is located within the buffer of an unregulated stream is not subject to the River & Stream Conservation Area (RSCA) development standards of Section 704 of the County Zoning & Development Ordinance (ZDO).

Other Mapped Information:

- Slopes on the site appear to range from 0 to greater than 40% (slope data is not available through County or Metro mapping). A geotechnical study will be required for development on slopes 20% or greater.
- Both parcels are likely not mapped in the 100-year floodplain.

<u>Timber (TBR) District</u>
The TBR District (ZDO 406) is intended primarily for commercial forest operations. Clackamas County's Zoning and Development Ordinance Table 406-1 lists '*water intake facilities, related treatment facilities, pumping stations, and distribution lines*' as a conditional use in the TBR zone. Uses in this category are subject to 406.05(A)(1) & (6).

<u>Review Types</u>
Conditional Use Review (ZDO 1203). Conditional Use review are processed as a Type III review and consider potential off-site impacts a proposal may create and can impose conditions of approval to avoid, minimize, or mitigate them.

Two specific elements of PWB's proposal are conditional uses and are subject to review:

- Filtration Facility (water intake facilities, related treatment facilities)
- Radio and Television Transmission Tower

Two sets of conditional use criteria must be addressed: (1) general conditional use criteria that apply to any conditional use in Clackamas County; and (2) forest-related conditional use standards that address potential impacts to primary forest uses.

Design Review (ZDO 1102). Design Review applies to development in commercial, industrial and multifamily zoning districts. However, ZDO 1102.01 also states that the Planning Director may "require" Design Review for other uses. In past land use cases, Clackamas County planning staff advised PWB that

Design Review is applicable to proposed water facilities in the Timber District. ZDO 1102.02 Criteria and Procedure describes procedures and criteria for Design Review approval. ZDO 1102.02 A. states that:

> ***A design review application may be approved pursuant to Subsection 1305.02 if the applicant provides evidence substantiating that the proposed development complies with Section 1000, the standards of the zoning district in which the subject property is located, and all other applicable provisions of this ordinance.***

PRCA/SCA Review (ZDO 704). The RSCA overlay requires a 100-foot setback from the "median high water line" of "large streams" (i.e., the Bull Run Reservoir, its spillway, and the Bull Run River below the spillway), but not to the Bull Run River or the Diversion Pool above the spillway. Development and tree-cutting activities regulated by Section 704 in a Principal River Conservation Area (PRCA) are reviewed to ensure consistency with Section 704. Proposed developments on lands within and beyond 150 feet of the mean high water line shall be reviewed through a Type II application pursuant to Section 1307. For lands beyond 150 feet of the mean high water line notice is required to be sent to the US Forest Service and Bureau of Land Management.

Development and grading permits in a Stream Conservation Area (SCA) are also reviewed through a Type II application pursuant to Section 1307.

Protection of Natural Features (ZDO 1002). All development proposed on slopes of 20 percent or greater requires an engineering geologic study approved by the County ***to establish*** that the site is stable for the proposed development. Development on slopes up to 35% are reviewed through a Type I process; development on slopes greater than 35% are reviewed through a Type II process.

LARSON'S RANCH

Owner(s):	Unknown
Location:	East Clackamas County – Inside the Bull Run Watershed. East of SE Water Works Rd, south of SE Camp Howard Road
Site Address:	Not Addressed
Property ID:	00686760
Site Area:	+/- 226 acres
Zoning:	Timber (TBR) District

Environmental Resources:

- Clackamas County zoning maps and its online mapping system do not identify any environmental overlays on the site; **presence of any significant habitat, riparian, or other significant environmental areas should be identified prior to site selection.**

Other Mapped Information:

- The site rests on a bluff. Slopes at the north, south/southeast areas of site appear to be greater than 20-25%.

- A segment of the Bull Run River traverses the northern portion of the property.
- Access to the site is unclear and may be challenging.
- Clackamas County and Metro mapping do not provide data on upland or riparian habitat on the site.

Timber (TBR) District

The TBR District (ZDO 406) is intended primarily for commercial forest operations. Clackamas County's Zoning and Development Ordinance Table 406-1 lists '*water intake facilities, related treatment facilities, pumping stations, and distribution lines*' as a conditional use in the TBR zone. Uses in this category are subject to 406.05(A)(1) & (6).

Review Types

Conditional Use Review (ZDO 1203). Conditional Use review are processed as a Type III review and consider potential off-site impacts a proposal may create and can impose conditions of approval to avoid, minimize, or mitigate them.

Two specific elements of PWB's proposal are conditional uses and are subject to review:

- Filtration Facility (water intake facilities, related treatment facilities)
- Radio and Television Transmission Tower

Two sets of conditional use criteria must be addressed: (1) general conditional use criteria that apply to any conditional use in Clackamas County; and (2) forest-related conditional use standards that address potential impacts to primary forest uses.

Design Review (ZDO 1102). Design Review applies to development in commercial, industrial and multifamily zoning districts. However, ZDO 1102.01 also states that the Planning Director may "require" Design Review for other uses. In past land use cases, Clackamas County planning staff advised PWB that Design Review is applicable to proposed water facilities in the Timber District. ZDO 1102.02 Criteria and Procedure describes procedures and criteria for Design Review approval. ZDO 1102.02 A. states that:

> ***A design review application may be approved pursuant to Subsection 1305.02 if the applicant provides evidence substantiating that the proposed development complies with Section 1000, the standards of the zoning district in which the subject property is located, and all other applicable provisions of this ordinance.***

PRCA/SCA Review (ZDO 704). The RSCA overlay requires a 100-foot setback from the "median high water line" of "large streams." Development and tree-cutting activities regulated by Section 704 in a Principal River Conservation Area (PRCA) are reviewed to ensure consistency with Section 704. Proposed developments on lands within and beyond 150 feet of the mean high water line shall be reviewed through a Type II application pursuant to Section 1307. For lands beyond 150 feet of the mean high water line notice is required to be sent to the US Forest Service and Bureau of Land Management.

Development and grading permits in a Stream Conservation Area (SCA) are also reviewed through a Type II application pursuant to Section 1307. **(Note – The site appears to contain a tributary of the Sandy River. It is unknow how this resource is classified and if the PRCA/SCA standards apply. Prior to site selection, all resources onsite should be identified).**

Protection of Natural Features (ZDO 1002). All development proposed on slopes of 20 percent or greater requires an engineering geologic study approved by the County to establishe that the site is stable for the proposed development. Development on slopes up to 35% are reviewed through a Type I process; development on slopes greater than 35% are reviewed through a Type II process.

POWELL BUTTE

Owner(s): City of Portland – Water Bureau

Location: Southeast Portland between SE Powell Blvd and SE Foster Rd and between roughly SE 143rd and 163rd

Site Address: 16160 SE Powell Blvd

Property ID: R025703610 (multiple others)

Site Area: +/- 640 acres

Zoning: OSpc—Open Space base zone, with Environmental Conservation and Environmental Protection overlay zones. Additional zones include R10 (low density residential), and R2 (multi-dwelling residential)

Johnson Creek Basin Plan District – South Subdistrict

Powell Butte 2003 Master Plan as amended (LU 07-112412 CUMS, LU 10-169463 CUMS); Metro Title 13 High Value Habitat Areas; Scenic Resources Protection Plan

Environmental Resources:

- Environmental Conservation and Environmental Protection overlay zones

Other Mapped Information:

- The outer rim of Powell Butte consists of slopes 25% or greater and is susceptible to landslides.
- Access to the Butte is provided by means of a paved 20-foot wide driveway that extends south from SE Powell Blvd at SE 162nd Avenue.
- The Butte is surrounded largely by residential development.

<u>Overview of Zoning</u>

The site is zoned OS (open space), R10 (low density residential), and R2 (multi dwelling residential) base zones with c (environmental conservation), p (environmental protection) and a (alternative design density) overlay zones.

The Open Space base zone is intended to preserve public and private open and natural areas to provide opportunities for outdoor recreation and a contrast to the built environment, preserve scenic qualities and the capacity and water quality of the stormwater drainage system, and to protect sensitive or fragile environmental areas.

The R10 designation is one of the City's single-dwelling zones which is intended to preserve land for housing and to promote housing opportunities for individual households. The zone implements the comprehensive plan policies and designations for single-dwelling housing.

The R2 designation is one of the City's multi-dwelling zones which is intended to create and maintain higher density residential neighborhoods. The zone implements the comprehensive plan policies and designations for multi-dwelling housing.

Environmental overlay zones protect environmental resources and functional values that have been identified by the City as providing benefits to the public. The environmental regulations encourage flexibility and innovation in site planning and provide for development that is carefully designed to be sensitive to the site's protected resources. They protect the most important environmental features and resources while allowing environmentally sensitive urban development where resources are less sensitive.

The City's Scenic Resources Protection Plan maps 6 specific Scenic Viewpoints on the site, identified as Viewpoint 34-08. The Powell Butte Master Plan limits development on the site in order to protect views from these points.

The application of the environmental overlay zones is based on detailed studies that have been carried out in separate areas throughout the City. Environmental resources and functional values present in environmental zones are described in environmental inventory reports for these study areas.

The project site is mapped within the *Johnson Creek Basin Protection Plan* as Site # 29. Resources and functional values of concern on the project site, as identified by the Plan, include water, storm drainage, aesthetics, scenic, pollution and nutrient retention and removal, sediment trapping, recreation, education, and heritage. The site description includes management recommendations for protecting the forested perimeter and taking advantage of the natural attributes at Powell Butte.

The "a" overlay is intended to allow increased density that meets design compatibility requirements. It focuses development on vacant sites, preserves existing housing stock, and encourages new development that is compatible with the surrounding residential neighborhood. This proposal is not using any of the provisions of the "a" overlay.

<u>Review Types</u>

Major Amendment to a Conditional Use Master Plan (CUMP)

Powell Butte operates under a Conditional Use Master Plan. The Powell Butte CUMP implements the planned water system and park amenities and provides an overall framework for the future of Powell Butte. The Master Plan also sets forth land use and approval criteria for a variety of development, uses, or actions allowed by the master plan. The master plan notes that "any uses not allowed" by the master plan such as new filtration facility and any associated development would require a major amendment to the approved master plan (Type III process). Expansions of the master plan boundary would also be processed through a Type III process.

Conditional Use Review (Section 33.815). Basic Utilities are classified as Conditional Uses OS zone, and thus a conditional use review for this proposal would be required. CU reviews are processed as a Type III review. Additionally, Rail Lines and Utility Corridors are conditional uses in the OS zone.

The required conditional use reviews triggered by this proposal would be processed as part of the Major Amendment to the Conditional Use Master Plan.

Environmental Review (Section 33.430). Environmental review would be required for any development within environmental zones on the site including the new filtration facility, accessory structures and buildings, or new conduits or utility lines. The proposed projects must comply with the approval criteria established by the 2003 Master Plan and any subsequent relevant master plan amendments.

Adjustment Review (Section 33.805). The master plan establishes a number of development standards that apply to permitted uses within the master plan. When the proposed development does not comply with the clear and objective standards in the plan, an Adjustment must be approved. For example, potential adjustments may arise if minimum building setbacks cannot be met, prescribed utility corridors exceed the maximum disturbance area allowed by the CUMP, or tree preservation/removal exceeds limitations under the CUMP.

Review Procedures

The Type III process is initially decided by a Hearings Officer. Applications are heard using the highest-level procedure that applies to any of the individual reviews. An appeal of a Hearings Officer decision would be considered by Portland City Council and is then appealable to LUBA.

III. Discussion and Conclusion

This assessment provides a general zoning and land use review analysis of six sites currently under consideration for a water filtration facility. A more comprehensive analysis should be considered as part of the decision process if a specific site is determined to be more desirable based on developed site selection criteria.

Of the six selected sites, Powell Butte would likely be the most difficult to secure land use approvals for development. This is because the land use process would require a Major Amendment to the Powell Butte Conditional Use Master Plan and would trigger a subset of other land use reviews including conditional use, environmental, and likely adjustment review to accommodate the impacts of development in the park and to the surrounding area. Additionally, larger Powell Butte land use reviews (Reservoirs and 2003 CUMP) in the past have been appealed to the State Land Use Board of Appeals (LUBA) by the neighborhood association and other public members, creating additional monetary costs, approval delays, and political scrutiny for the project and for PWB.

The other five potential sites are located outside of the Urban Growth Boundary (UGB) and are rural in nature. The timing and difficulty of the land use review process would likely be driven by PWB's success in demonstrating minimal impact to forest and farm uses/operations in each immediate area as well as to any existing residential uses. Because all five sites in the rural area will require Conditional Use Review and likely environmental review, additional factors that will need to be considered include (but not limited to) provision of utility service (sewer, water etc.), access to the site, impact on the transportation system because of additional generated trips to the site, potential transportation system improvements (e.g., right-of-way dedication, road or site distance improvements, etc.), and any onsite environmental disturbance that would occur as a result of development.

Addendum

Owner(s): Bottomley Evergreens of Oregon - % Martha Bottomley

Location: Multnomah County – West of the Sandy River and Immediately north of Lusted Road

Site Address: 34519 SE Lusted Rd

Property ID: R341823 (14.32 ac), R341822 (4.32 ac), R341821 (19.86 ac)

Site Area: **+/- 38.50 ac**

Zoning: **EFU – Exclusive Farm Use**
West of Sandy River Rural Plan Area (MCC Chapter 36)
Fire District: Multnomah County Fire Protection District #10
Watershed: Lower Sandy WS
SEC – Water Resources (R341821 only)
Hydric Soils are mapped on portions of R341821 & R341823 (a segment of Beaver Creek bisects R341821 and terminates on R341823) .

Other Mapped Information:

- Slopes on the majority of the property range from 0 to 10%.
- Soils consist of 10c (Cornelius Silt Loam), 27b (Mershon Silt Loam), and 57 (Wollent Silt Loam) – all high value farm land soil types.
- Access to the property would be from SE Lusted Rd or SE Hosner Rd.
- The surrounding area is zoned MUA to the south/southwest, EFU to the north/northwest, and CFU to the east/northeast.

<u>Exclusive Farm Use (EFU) Zone</u>

The Exclusive Farm Use District preserves and maintains agricultural lands for farm use consistent with existing and future needs for agricultural products, forests and open spaces.

A water treatment/filtration facility is not specifically listed as an allowed use, a 'Review Use' (use requiring at least Type II review), or Conditional Use in the EFU zone. Rather, MCC 36.2625 (A) provides that **"Utility facilities necessary for public service….."** are "Review Uses." This means that the proposed water treatment facility can be administratively reviewed (decision by Planning Director) and would not require a hearing unless appealed.

MCC 36.2675 (A) supports **ORS 215.275 (Uses Permitted in Exclusive Farm Use Zones in Nonmarginal Lands Counties)** by requiring an alternative site analysis, whereby a thorough analysis of all reasonable, non-EFU sites are considered along with the reasons for rejection. ORS 215.275 is implemented by OAR 660-033-0130(16) and it provides the following approval criteria (**'Necessity Test'**) that must be addressed as part of a land use application:

OAR 660-033-0130
(16)(a) A utility facility is necessary for public service if the facility must be sited in an exclusive farm use zone in order to provide the service. ***To demonstrate that a utility facility is necessary, an applicant must show that reasonable alternatives have been considered and that the facility must be sited in an exclusive farm use zone*** *due to one or more of the following factors:*
(A) Technical and engineering feasibility;
(B) The proposed facility is locationally dependent. A utility facility is locationally dependent if it must cross land in one or more areas zoned for exclusive farm use in order to achieve a reasonably direct route or to meet unique geographical needs that cannot be satisfied on other lands;
(C) Lack of available urban and nonresource lands;
(D) Availability of existing rights of way;
(E) Public health and safety; and
(F) Other requirements of state and federal agencies.

(b) Costs associated with any of the factors listed in subsection (16)(a) of this rule may be considered, but cost alone may not be the only consideration in determining that a utility facility is necessary for public service. Land costs shall not be included when considering alternative locations for substantially similar utility facilities and the siting of utility facilities that are not substantially similar.

(c) The owner of a utility facility approved under this section shall be responsible for restoring, as nearly as possible, to its former condition any agricultural land and associated improvements that are damaged or otherwise disturbed by the siting, maintenance, repair or reconstruction of the facility. Nothing in this subsection shall prevent the owner of the utility facility from requiring a bond or other security from a contractor or otherwise imposing on a contractor the responsibility for restoration.

(d) The governing body of the county or its designee shall impose clear and objective conditions on an application for utility facility siting to mitigate and minimize the impacts of the proposed facility, if any, on surrounding lands devoted to farm use in order to prevent a significant change in accepted farm practices or a significant increase in the cost of farm practices on surrounding farmlands.

Review Types
Administrative Decision by Planning Director (Type II Review unless appealed to Hearings Officer) for review of the proposed water treatment facility and compliance with the zoning code.

Design Review (Section 36.7000). **A new filtration facility will require design review.** The County's Design Review ensures that development is "functional, safe, innovative, attractive, and compatible with the natural and man-made environment." Design Review is processed as a Type II review.

Significant Environmental Concern Review (Section 36.4500). Because the SEC-Water Resources overlay covers a small swath of the northern taxlot, any new development within the SEC overlay would require a Type II SEC review.

Conclusion
Although it appears that siting a water treatment plant on this site would only require a Type II land use review, it may be advisable to elevate the application to a Type III if there is a likely possibility for an

appeal. In consideration of this site, PWB will need to make a strong finding in its land use application that the water treatment facility must be sited in an EFU zone pursuant to ORS 215.275. In a previous case, LUBA (the Land Use Board of Appeals) explained that *"at the core of the necessity test is the requirement that the local government determine that the utility facility cannot feasibly be located on non-EFU land, which in turn requires that the local government consider reasonable alternatives to siting the facility on EFU-zoned land."* ***Central Klamath County Community Action Team v. Klamath County, LUBA No. 2001-043 (2001)***. PWB will need to provide a robust alternatives analysis that adequately demonstrates why this facility must be located on this site in lieu of other non-EFU sites currently under consideration.

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PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Technical Memo

Date:	September 18, 2018
Project:	Bull Run Filtration Project 699275.01.03
To:	Portland Water Bureau Filtration Decision Team
Copy to:	HDR, Barney &Worth
Prepared by:	Lee Odell, Dan Speicher
Approved by:	Kelly Irving
Subject:	**Filtration Plant Technology Alternatives**

1 Introduction

The purpose of this technical memorandum is to provide an alternatives analysis of filtration technologies that were considered for the treatment technology decision.

Information was provided to the project decision team over a series of several workshops. The information provided to the team included:

- A review of raw water quality data collected by PWB over the past 10 years. This information included important information used to select treatment for surface waters like turbidity, algae counts, color, manganese as well as microbiological testing results, and other parameters. This information is included in Appendix A.
- A summary of previous filtration pilot testing efforts conducted by PWB. These efforts included a significant amount of granular media filtration testing and two shorter efforts with low pressure membrane filtration technologies. This information is included in Appendix B.
- A listing of 167 large (> 50 million gallons per day) surface water treatment plants in North America and the type of filtration technology they each use. This information is included in Appendix C.

Additional information provided to the project team on the capabilities of treatment technologies, and on the capital and operations and maintenance costs and related impacts and benefits of facilities, are described in this technical memorandum.

2 Description of Filtration Technologies

The USEPA recognizes several filtration strategies for compliance with the Surface Water Treatment Rules, including the latest Long-term 2 (LT2) Enhanced Surface Water Treatment Rule that sets out treatment requirements for *Cryptosporidium* removal and inactivation. These technologies include:

- Granular media filtration (includes conventional and direct filtration)
- Membrane filtration
- Slow sand filtration
- Cartridge and bag filtration, and
- Diatomaceous filtration

Of these filtration technologies, there are no known large (greater than 50 million gallons per day [mgd]) cartridge, bag, or diatomaceous earth filtration facilities. Therefore, the team proposed to focus the evaluation on the remaining three technologies. Each of the three technologies is described below.

2.1 Granular Media Filtration

Granular media filtration is the most commonly used technology for large surface water plants in the U.S. There are two basic types of granular media filters in use for potable water treatment: Rapid granular media filters and biologically active filters.

2.1.1 Rapid Granular Media Filtration

Most conventional surface water treatment plants use rapid granular media filters after coagulation and often clarification processes to produce filtered water. This is referred to as Conventional Filtration throughout this memorandum. Most granular media designs use sand, anthracite, granular activated carbon (GAC), or combinations of media types. Typical design filter loading rates for modern filters are 6 to 8 gallons per minute per square foot (gpm/sq. ft.) but can range from 3 to 12 gpm/sq. ft. of filter area.

Dual media filters are the most common filters found at water treatment plants today. Most designs are anthracite/sand or GAC/sand. The dual media design is typically a shallow bed with 18 to 24 inches of anthracite or GAC followed by 12 inches of sand. Media sizes can vary, but the most common media size for the sand part of the filter is 0.5 mm (effective size), while the anthracite and GAC can range from 0.8 to 1.2 mm (effective size). Dual media filters provide excellent finished water quality. The smaller sand media provides a barrier to particle breakthrough, and more efficient filter runs.

2.1.2 Biologically Active Filtration (BAF)

BAF filters are used to provide additional removal of organics resulting in better disinfection byproduct (DBP) control and a biologically stable filter effluent. The filter design is generally the same as a rapid media filter with large media and deep beds to promote biofilm growth. Biological growth can be supported on GAC and anthracite. GAC is most amenable to biological growth because of the rougher surface characteristics than the other granular media types. The filters are usually preceded by ozonation to convert many of the large organic molecules into smaller organic molecules that are readily assimilable by microbiological activity in the filter. Ozone also introduces large amounts of oxygen to the water, creating excellent aerobic conditions for microbial growth on the filter media. A biological filter system may also include additions of nutrients to encourage more biological growth and hydrogen peroxide to manage the growth. To sustain the biofilms, biological filters are typically backwashed with unchlorinated water.

Advantages to BAF include:

- Production of a biologically stable filter effluent that reduces regrowth in the distribution system
- Removal of organic precursors to DBPs
- Reduction in the disinfectant demand of the filter effluent, thereby reducing the amount of disinfectant required in the finished water and possibly reducing DBPs
- Removal of ozonated DBPs (bromates)

2.2 Membrane Filtration

With increasingly stringent requirements for better drinking water quality and reduction in use of disinfectants because of health concerns, the drinking water industry has investigated alternative processes to conventional treatment. Membrane filtration is gaining popularity in the U.S. The long-term

experience with membranes in large surface water treatment applications is limited, but there are a few plants with capacities of 50 to 120 mgd in North America.

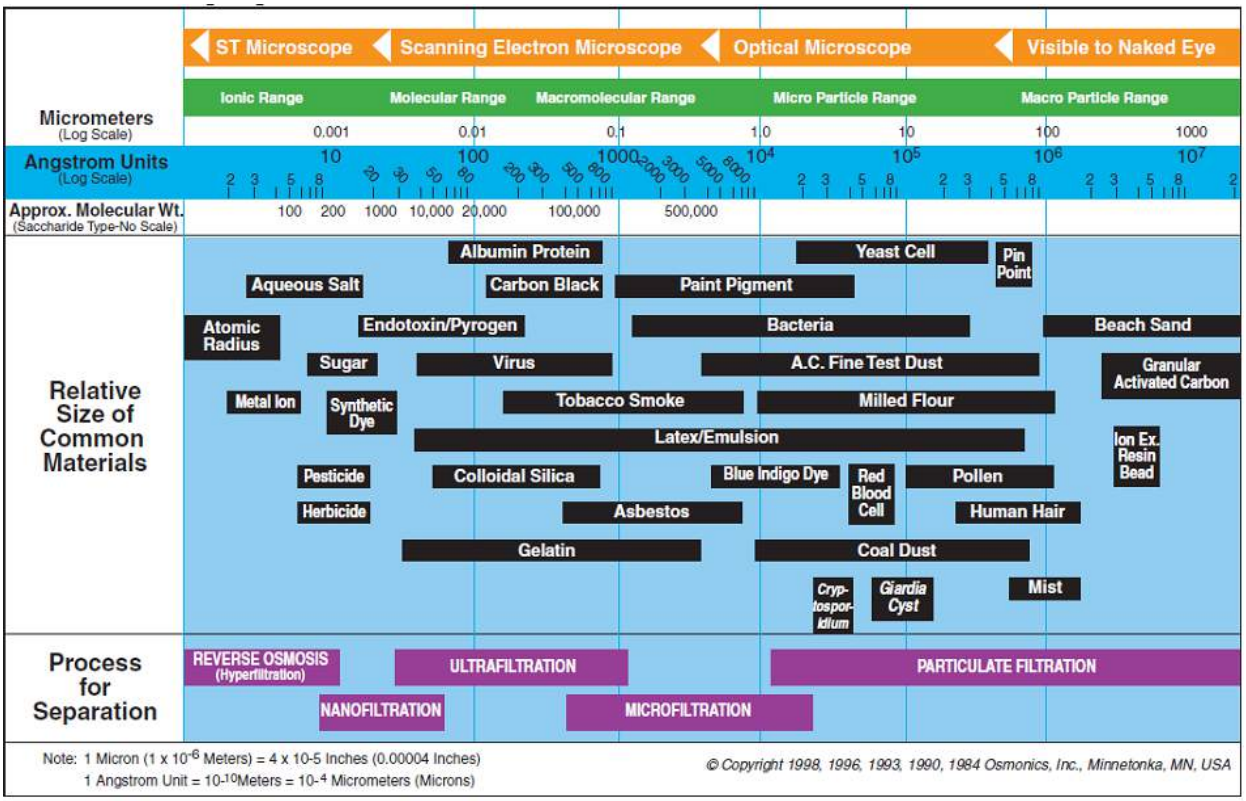
Membrane filtration can be separated into four basic categories—reverse osmosis, nanofiltration, ultrafiltration, and microfiltration.

Reverse osmosis (RO) and nanofiltration (NF) are used to remove dissolved inorganic compounds such as sodium, calcium, and magnesium ions, or dissolved organic compounds such as humic and fulvic acids that make up the primary source of DBP precursors. They operate at transmembrane pressures of about 80 to 1,200 psi, depending upon the source water quality and degree of separation required. Some uses for RO and NF include desalination of seawater and membrane softening, respectively. Ultrafiltration (UF) and microfiltration (MF), on the other hand, cannot remove dissolved materials, and are limited to removal of particles. UF membranes have a nominal pore size of between 0.003 and 0.03 micrometer (µm), whereas MF membranes have a nominal pore size of between 0.05 and 0.5 µm.

MF membranes, because of the pore size, are most effective at removal of turbidity, bacteria and oocysts such as *Giardia* and *Cryptosporidium*, while UF membranes have the added feature of removing not only turbidity, bacteria, and *Giardia* and *Cryptosporidium,* but also viruses. NF membranes remove particles but also can remove most DBP precursors and some dissolved salts. RO membranes remove everything the other membranes do, plus almost all dissolved salts. Figure 1 shows the particle size removal capacity of each type of membrane.

The cost of installing and operating RO or NF systems make this process cost-prohibitive for a surface water like the Bull Run. MF is the typical membrane filtration technology for this type of surface water.

Figure 1. Membrane Pore Sizes



The earliest commercially available UF and MF membrane systems designed to filter/sterilize liquids are known as pressure-driven, hollow-fiber membranes. The liquid is passed either from the outside to the

inside of the fibers (called the lumen) of the hollow fiber (outside-in) or from the lumen to the outside of the fiber (inside-out). The hollow fibers are installed in vessels, which provide support for the pressure necessary to drive the liquid through the membrane pores. This type of filter is commercially available from many suppliers. These units use water, air, or air/water backwash systems.

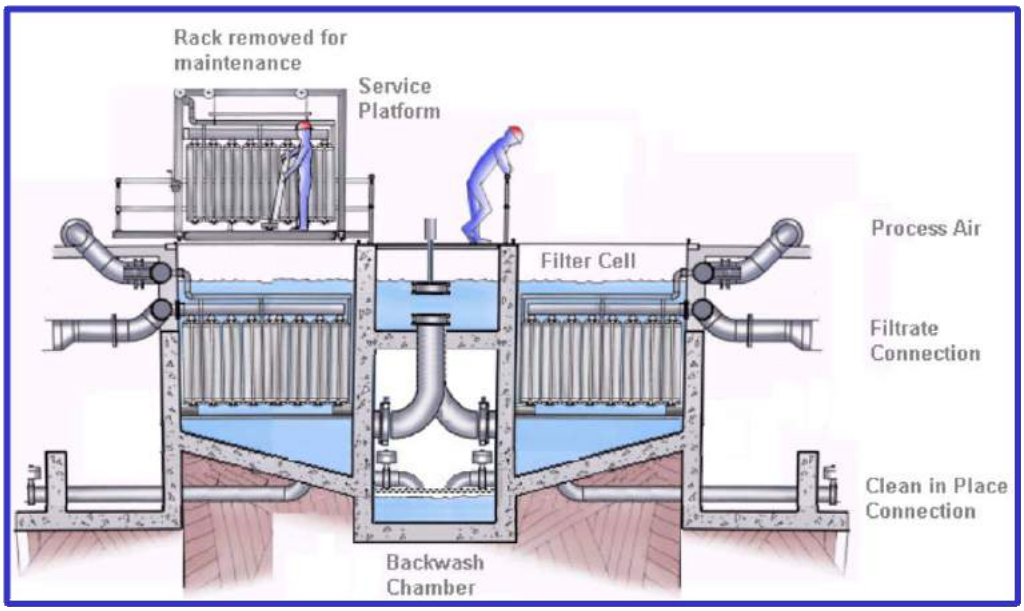
Immersed membranes have been used in the largest membrane surface water treatment plant applications. In this process, hollow fiber membranes are installed (immersed) in a raw water vessel and a small vacuum is applied to their downstream side. This process is more energy efficient and can result in a smaller footprint than pressure-driven configurations. Immersed membranes are available from Zenon (UF) and Memcor (MF). With the Zenon ZeeWeed® Process, air is introduced at the bottom of the membrane feed vessel, which creates turbulence in the tank effectively scrubbing the solids from the membrane surface. Memcor uses air only in the backwash of its immersed membranes.

The advantage of a solids separation barrier with a known diameter makes MF or UF a feasible technology for control of microbes and provides effective filtration while achieving reasonable recovery of the product water. Product water recovery for MF and UF membranes ranges from 85 to 95% and can be even higher in some cases.

An example pressurized microfiltration system is shown in Figure 2. An immersed membrane configuration is shown in Figure 3.

Figure 2. Pressurized Microfiltration System *(Courtesy of Pall Corporation)*

Figure 3. Immersed Microfiltration System *(Courtesy of Evoqua)*



Advantages of membranes compared to granular media filtration include increased particle removal, reliably consitent treated water quality and often improved pathogen removal. The disidvantages include the necessity of adding pretreatment for removal of materials smaller than the pore size. For example, coagulation is needed to remove dissolved organic matter prior to microfiltration or ultrafiltration. Membrane cleaning and replacement are also significant operational activities. Disposal or treatment and recycling for membrane concentrate can be more significant than for granular media filter backwash wastes, and capital and operating costs for membranes are often higher than for granular media filters.

2.3 Slow Sand Filtration

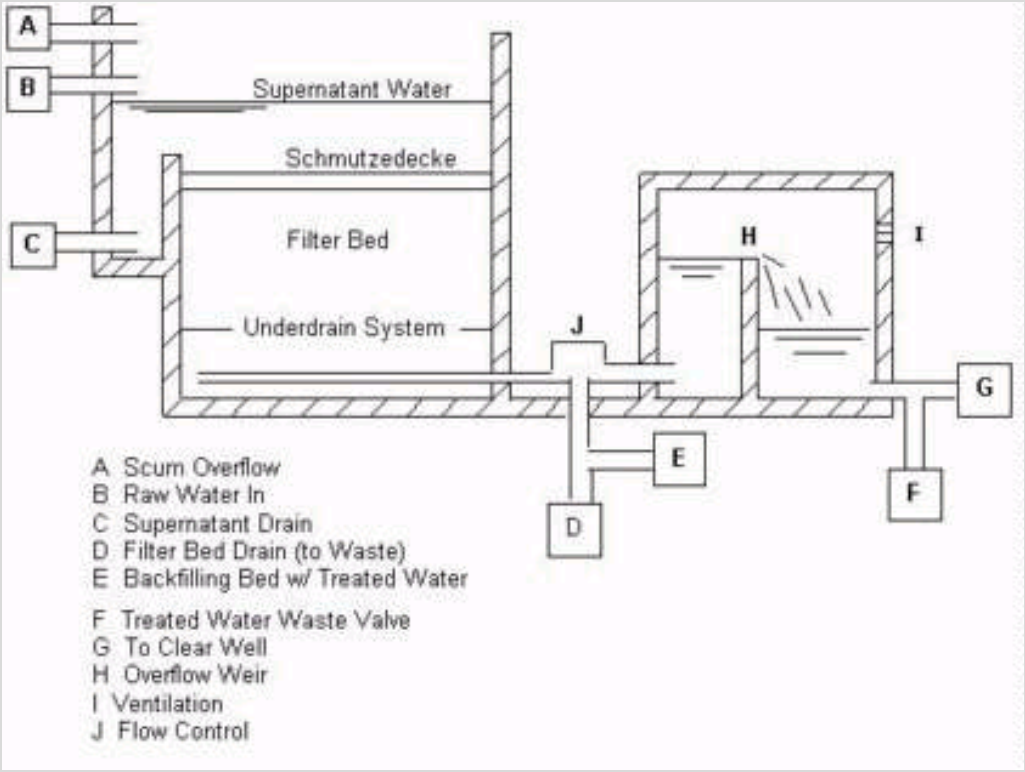
As the name suggests, slow sand filtration utilizes a sand filter operated at a low filtration loading rate, typically 50 to 100 gallons per day (gpd) per square foot of filter area. The one large slow sand plant in North America, Salem, Oregon's Geren Island Water Treatment Plant (WTP), has a design loading rate of 72 gpd per square foot.

Slow sand filters are typically characterized by certain design components: the supernatant (water above the filter sand), filter sand varying in depth, the underdrain medium (typically consisting of graded gravel), and a set of control devices.

In a mature sand bed, a thin upper sand layer called a schmutzdecke forms. The schmutzdecke consists of biologically active microorganisms that break down organic matter while suspended inorganic matter is removed by straining. The primary purpose of the schmutzdecke is turbidity removal, and while it is a microbiologically active layer, it has a limited ability to remove DBP precursors, taste and odor (T&O) causing compounds, and algal toxins.

A schematic of a slow sand filter is presented in Figure 4. This example used concrete basins.

Figure 4. Slow Sand Filter Schematic



Because of their low filtration rate, slow sand filters require a relatively large surface area. Slow sand filters may be configured as earthen or concrete basins (Figure 5), with concrete basins tending to be significantly more expensive. However, the only slow sand filter facility designed to withstand a Cascadia Subduction Zone seismic event is in the City of Camas, WA. Constructed in 2016, the Camas' slow sand facility was built using concrete basins specifically because geologic conductions and structural design requirements to meet the expected seismic impacts could not be met by using earthen berms at that site (CH2M, 2016).

Figure 5. Slow Sand Filter Beds, Geren Island, Salem, OR *(Photo Credit USGS)*

Slow sand filters can be differentiated from standard granular media filters by the following characteristics:

- Use of biological mechanisms as well as physical/chemical mechanisms for removal of particulates and pathogens (although granular media filtration can be modified to include biological filtration, too).
- Use of smaller sand particles.
- Required replacement of the surface media layer rather than backwashing for removal of solids trapped by the filter.
- Much longer run times between cleanings.
- Required ripening period, e.g. re-establishment of biological mechanisms (schmutzdecke), at the beginning of each run.

Maintenance of a slow sand filter involves two periodic tasks:

- Removal of the top 0.25 to 0.5 inches of the sand bed when headloss becomes excessive.
- Replacement of the sand when repeated scrapings have reduced the bed depth to approximately one-half of the initial depth.

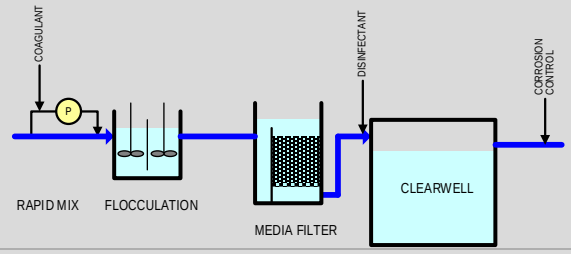
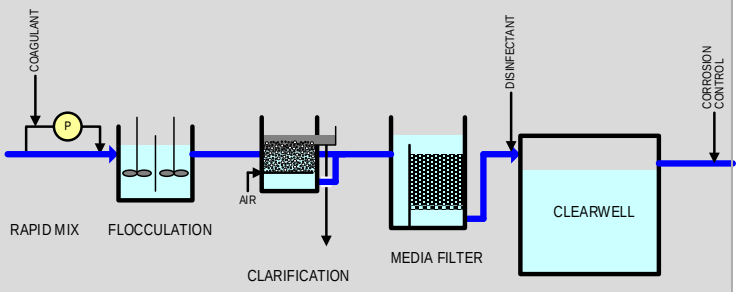
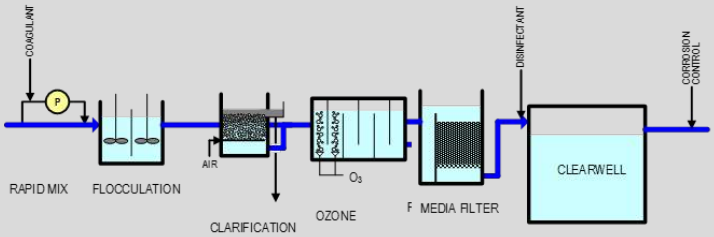
Following removal of filter bed material, re-establishment of the schmutzdecke may take several days or even weeks. Proper application of slow sand filtration requires pilot testing to confirm the design and operating parameters required to reliably meet water quality objectives for a given site. Typically, pretreatment is not extensively used with slow sand filters. There is a concern that extended use of clarification prior to slow sand filtration would remove the bacterial food sources and nutrients required for effective treatment.

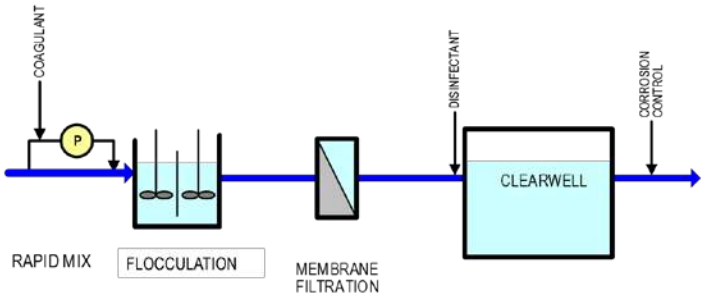
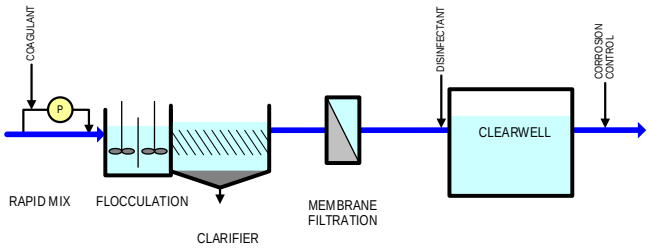
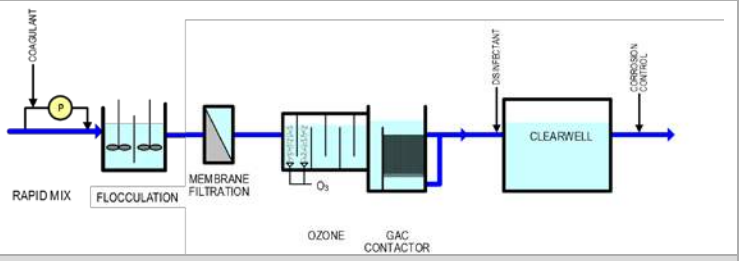
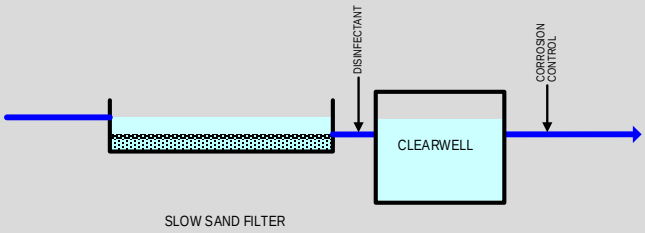
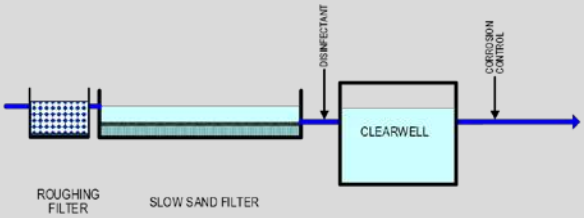
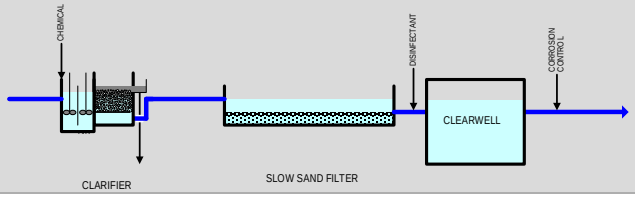
3 Filtration Technology Screening

At this stage in the decision-making process, prior to selecting the WTP designer, this screening evaluation provides basic information about filtration technology performance to determine which filtration technology should be carried forward in the decision process. Screening is not intended to describe the final configuration of the technologies selected, but rather to provide a basis for evaluating the expected performance of each type of filtration.

For each of the three filtration technologies being evaluated, there are many ways to configure the treatment plant. For example, a low-pressure membrane plant will not remove dissolved organic chemicals, so it may result in higher levels of disinfection by-products compared to a media filter. A media filter requires coagulant chemicals and rapid mixing to meet the regulatory requirements. Coagulants could also be added to the membrane plant, if desired, to lower disinfection by-products or just to reduce membrane fouling. To aid in the discussion, three general configurations are provided for each filtration technology, as shown in Table 1.

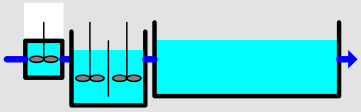
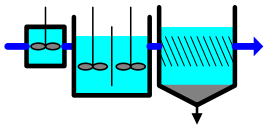
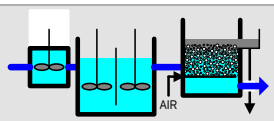
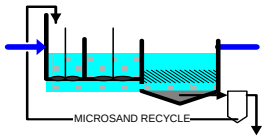
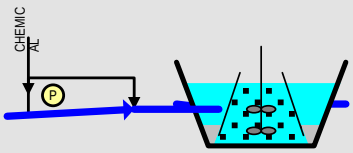
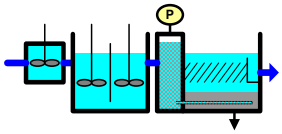
Table 1. General Configurations of Filtration Technologies

#	Filtration Technology	Treatment Goal of Configuration	Example Process Flow Diagram
1	**Granular media filtration (Direct Filtration)**	Basic configuration: rapid mix, coagulation/floccula-tion, filter, backwash, disinfection, corrosion control	
1A	Add clarification (Conventional Filtration)	Removal of elevated turbidity, algae, and TOC	
1B	Biological granular media filtration	Improved removal of dissolved organic chemicals, improved aesthetics	

#	Filtration Technology	Treatment Goal of Configuration	Example Process Flow Diagram
2	**Membrane filtration**	Basic configuration: rapid mix, coagulation/flocculation, membrane, backwash, clean in place, disinfection, corrosion control	
2A	Add clarification	Removal of elevated turbidity, diatoms, algae, and TOC	
2B	Add post filter ozone and biological contactor	Removal of dissolved organic chemicals, improved aesthetics	
3	**Slow sand filtration**	Basic configuration: slow sand filter, disinfection, corrosion control	
3A	Add Roughing Filter	Removal of elevated turbidity, algae, and TOC	
3B	Add Clarification	Removal of elevated turbidity, algae, and TOC	

There are many types of pretreatment technologies that could be used. Examples are shown in Table 2.

Table 2. Clarification Alternatives

Pretreatment Alternative	Process Schematic	How it Works
Conventional sedimentation		Settleable particles are formed and allowed to settle to the bottom of the basin
Plate or tube settling		Tubes or plates are used to reduce settling distance and footprint
Dissolved air flotation (DAF)		Super-saturated oxygen is used to float particles to surface
Sand-ballasted clarification		Micro-sand intercepts particles and carries them to the bottom; sand is recycled after separating
Upflow clarifier		Particles flow from the center through the bottom of the basin and out the top, passing through a blanket of sludge.
Pulsed sludge blanket clarification, SuperPulsator™		Vacuum pumps pulse water through a solids contactor

Post treatment could include methods to improve pathogen removal, like ultra-violet (UV) light or advanced oxidation, or it could include post filter ozonation and biological contactors. These technologies have been widely used in the drinking water industry.

It is not the intent of this evaluation to identify the pre- and post-treatment technology that would be used with each filtration technology. The intent is to identify if pre- or post-treatment measures may be used to achieve the required desired benefits of filtration and to develop capital and operating costs so that decision-makers can fairly evaluate the alternatives.

3.1 Filtration Benefits

Potential benefits of filtration are as follows:

- Provide pathogen removal for *Cryptosporidium, Giardia*, bacteria and viruses
- Produce biologically stable water
- Reduce disinfection by-products
- Increase supply reliability
- Reduce (not eliminate) distribution system flushing, and lower turbidity levels
- Reduce iron and manganese concentrations
- Improve water quality stability, and lower lead and copper levels (optimized corrosion control would still be required)
- Effectively treat an algae event
- Reduce water quality impacts due to warmer weather
- Reduce organic discoloration events
- Improve ability to respond to changes in regulations
- Increase ability to meet several critical service levels
- Treat a sustained elevated turbidity event
- Reduce customer cost of home water filtering or treatment

The consultant team met with Bureau staff and identified the list of filtration benefits as those that would have measurable impact on evaluating the differences among the filtration technologies being considered. These filtration benefits are based on the filtration benefits described by the Bureau to the City Council in the August 1, 2017, memo to Council identifying the probable benefits of filtration over UV treatment.

3.2 Granular Media Filtration Screening

These benefits were used to conduct an initial alternatives analysis of the treatment technologies. The screening evaluation of granular media filtration against the filtration benefits is shown in Table 3 and further explained in the following text. The results of the screening show that with the addition of clarification, granular media filtration can achieve a good or excellent rating in each of the benefit categories. Without clarification, granular media filtration cannot withstand an extended elevated turbidity event of greater than 10 NTU.

Table 3. Granular Media Filtration Screening

Treatment Process	Granular Media Filtration			
Benefits	**Granular Media Filter (Direct Filtration)**	**Add Clarification (Conventional Filtration)**	**Biological Granular Media Filtration**	**Notes/references**
Provide pathogen removal for *Cryptosporidium, Giardia*, bacteria and viruses (3.2.1)	Excellent	Excellent	Excellent	USEPA, 2010 (LT2 Toolbox)
Produce a biologically stable water (3.2.2)	Good	Good	Excellent	AOC reduction, CH2M TM 4.1

Treatment Process	Granular Media Filtration			
Benefits	**Granular Media Filter (Direct Filtration)**	**Add Clarification (Conventional Filtration)**	**Biological Granular Media Filtration**	**Notes/references**
Reduce DBPs (3.2.3)	Good	Good	Excellent	THM and HAA reduction
Increase supply reliability (3.2.4)	Good	Excellent	Excellent	Turbidity events, AWWA ASCE, 2012
Reduce distribution system flushing, lower turbidity levels (3.2.5)	Excellent	Excellent	Excellent	USEPA, 2010 (LT2 Toolbox)
Reduce iron and manganese (3.2.6)	Good	Good	Excellent	AWWA ASCE, 2012
Improve WQ stability, lower lead and copper levels (3.2.7)	Excellent	Excellent	Excellent	Assumes optimal corrosion control for all options
Effectively treat an algae event (3.2.8)	Good	Excellent	Excellent	Production, T&O, cyanotoxins
Reduce water quality impacts due to warmer weather (3.2.9)	Good	Good	Excellent	Increases algal blooms, T&O, cyanotoxins
Reduce organic discoloration events (3.2.10)	Good	Good to Excellent	Excellent	Tannins and lignins, AWWA ASCE, 2012
Improve ability to respond to changes in regulations (3.2.11)	Good	Excellent	Excellent	Removal of contaminants of emerging concern
Increase ability to meet several critical service levels (3.2.12)	Good	Excellent	Excellent	Color, manganese, sediment
Treat a sustained elevated turbidity event (3.2.13)	Poor	Excellent	Excellent	AWWA ASCE, 2012
Reduce customer cost of water treatment (3.2.14)	Good	Excellent	Excellent	Consistent water quality with low color, T&O

3.2.1. Provide pathogen removal for cryptosporidium, giardia, bacteria and viruses

Direct Filtration: Granular media filtration can achieve > 2 log removal credits (2 log removal credit is equal to 99% removal) for *Cryptosporidium*, at least 2 log removal credits for *Giardia* and at least 1 log (90%) removal credit for viruses.

With Clarification: If clarification is added prior to the filters, an additional 0.5 log removal credit for *Giardia* and additional 1 log removal credit for viruses can be achieved.

With Ozone/Biological Filtration: Ozone is an effective disinfectant for pathogens; however, Oregon does not allow disinfection credit for ozone applied prior to filtration, although a variance may be possible.

3.2.2. Produce a biologically stable water

Direct Filtration: Granular media filtration with coagulation can typically achieve at least 20% reduction of total organic carbon (TOC), a portion of which can contribute to biological regrowth in the distribution system. Coagulation involves adding polymers to the water to clump small particles together into larger aggregates that are more easily removed.

With Clarification: No additional improvement expected.

With Ozone/Biological Filtration: If ozone is added prior to the filters, it will produce elevated levels of assimilable organic carbon (AOC). If the ozone is followed by a biologically active filter, the reduction of AOC and TOC is usually significantly increased over granular media filtration alone. In Portland's pilot testing, UV 254, which is a surrogate measure of dissolved inorganic carbon, was reduced 57% to 84% with ozone and biological filtration, compared to approximately 24% reduction with coagulation and filtration alone.

3.2.3. Reduce disinfection by-products

Direct Filtration: With direct filtration, reductions in trihalomethanes (THMS) and haloacetic acids (HAAs) would be expected to reflect reductions in TOC of approximately 20%.

With Clarification: Results would be similar to direct filtration.

With Ozone/Biological Filtration: Portland's pilot testing of Bull Run water found that ozone reduced total THM formation by 40 to 50% and haloacetic acids (HAAs) by 50 to 70% over un-ozonated Bull Run water. Subsequent pilot testing using granular media filtration was all done using pre-ozonated water. Additional reductions were achieved with both GAC and anthracite filter medias.

3.2.4. Increase supply reliability

Direct Filtration: Increased supply reliability would be achieved if the Bull Run water supply could remain online through normal turbidity events, e.g., less than 10 NTU for 1-3 days of duration. All the granular media filtration options provide an improved supply reliability over the unfiltered status. With direct filtration, the system should be able to operate routinely with turbidity up to 10 NTU and for short periods with turbidity up to 20 NTU.

With Clarification: With clarification, elevated turbidities up to 500 NTU can be treated. Reduced plant output may be experienced at higher turbidity levels.

With Ozone/Biological Filtration: No additional improvement over clarification.

3.2.5. Reduce distribution system flushing, and lower turbidity levels

Direct Filtration: Reduction in distribution system flushing would be a result of lower sediment load being sent to the distribution system. During pilot testing, turbidity was routinely maintained below 0.1 NTU in granular media filtered water. A full-scale granular media filtration plant would be expected to have a filtered water turbidity well below 0.1 NTU.

With Clarification: Results would be similar to direct filtration.

With Ozone/Biological Filtration: Results would be similar to direct filtration.

3.2.6. Reduce iron and manganese concentrations

Direct Filtration: In granular media filtration facilities that maintain a chlorine residual across their filters, it is very common for oxides to form on the surface of the filter media. These oxides can form in as little as a few weeks and, once established, help remove iron and manganese from the influent water supply. Granular media filtration plants are very capable of producing water with iron and manganese levels below 0.05 mg/L and 0.02 mg/L, respectively. During Bull Run pilot testing, iron and manganese in the raw water were low – ranging from 0.03 to 0.04 mg/L for iron and 0.003 to 0.009 mg/L for manganese. Results are less predictable in filters that do not maintain a chlorine residual across the media bed.

With Clarification: Results would be similar to direct filtration.

With Ozone/Biological Filtration: With ozone followed by biological filtration, ozone can effectively oxidize iron and manganese prior to the filters, so results would be similar to direct filtration where a chlorine residual is maintained across the filters. However, too much ozone can oxidize manganese to permanganate, which could pass through the filters.

3.2.7. Improve water quality stability, and lower lead and copper levels

Direct Filtration: Filtration will provide a reduction in both DOC and particulate metals loading to the system and is therefore anticipated to provide a reduction in lead release observed at customer taps (Black & Veatch, 2014). Optimized corrosion control would still be required.

With Clarification: Results would be similar to direct filtration.

With Ozone/Biological Filtration: This option would also reduce nitrification. Nitrification can contribute to lead leaching.

3.2.8. Effectively treat an algae event

Direct Filtration: A few studies have examined the effect of granular media filtration on algae and algal toxins. In one, rapid sand filtration achieved 14-30% removal of Microcystis aeruginosa cells (Drikas et al.,1997). Another study showed 14% removal of cyanobacterial cells in rapid sand filtration (Lepisto et al., 1996). A third study demonstrated 42% removal of cyanobacteria cells in rapid sand filtration using GAC media (Lambert et al., 1996). However, researchers have expressed concerns over cell lysis and toxin release during filtration (Mouchet and Bonnélye, 1998).

With Clarification: Large blooms can be treated with coagulants or powdered activated carbon to prevent filter clogging and remove geosmin, 2-Methylisoborneol (MIB) and algal toxins. Typically, if significant algal blooms occur, they require clarification to prevent filter clogging.

With Ozone/Biological Filtration: In addition to clarification removal, ozone is very effective at oxidizing geosmin, MIB and algal toxins. When an algae bloom breaks down, the cells can release cyanotoxins and taste and odor (T&O) causing compounds such as geosmin and MIB.

Clarification with ozonation are needed to effectively remove these dissolved organic compounds.

3.2.9. Reduce water quality impacts due to warmer weather

Direct Filtration: The discussion provided concerning algal events also applies to warmer weather impacts on water treatment technology. In addition, warmer water produces disinfection by products in the presence of free chlorine at a faster rate compared to cooler water. Filtration reduces the amount free chlorine contact time required for primary disinfection which will result in lower disinfection by products during warm weather periods.

With Clarification: Large algal blooms can be treated with coagulants or powdered activated carbon to prevent filter clogging and remove geosmin, MIB and algal toxins.

With Ozone/Biological Filtration: In addition to clarification removal, ozone is very effective at removing taste and odor causing compounds and algal toxins.

3.2.10. Reduce organic discoloration events

Direct Filtration: The Bull Run has highly colored raw water, averaging 11 color units, and levels as high as 75 color units have been noted. Granular media filtration with effective coagulation should be successful in achieving an average color of below 5 color units. At peak color levels without clarification, the filters may be overloaded with particles due to high coagulant doses.

With Clarification: Clarification would allow color removal even during peak raw water color periods.

With Ozone/Biological Filtration: In addition to clarification removal, ozone is also very effective at oxidizing color causing compounds such as tannin and lignins and could reduce the amount of coagulant needed during a color event.

3.2.11. Improve ability to respond to changes in regulations

Direct Filtration: A granular media filter provides flexibility in being able to meet potential future regulatory issues. There are a number of potential regulations that could impact PWB in the future, including those that would require: changes to pathogen monitoring and testing methods; changes to distribution water quality that address DBPs, heterotrophic plate counts, lead, copper, nitrite and nitrate, and manganese to prevent scaling; and regulations addressing algal toxins, nitrosamines and other contaminants of emerging concern. While a direct filtration plant can address many of these issues, some may require more robust multiple barrier approaches including clarification, ozone or advanced oxidation, and biological filtration.

With Clarification: Clarification would provide more flexibility for addressing future regulations than direct filtration.

With Ozone/Biological Filtration: Ozone and biological filtration would provide the most flexibility for addressing future regulations.

3.2.12. Increase ability to meet several critical service levels

Direct Filtration: Critical service level issues include several water quality issues such as distribution system disinfectant residuals, coliform, taste and odor, and manganese, among others. Granular media filtration would provide benefits.

With Clarification: Clarification would provide improved performance over direct filtration.

With Ozone/Biological Filtration: Ozone and biological filtration would provide the best performance.

3.2.13. Treat a sustained elevated turbidity event

Direct Filtration: While direct filtration can treat short-term turbidity spikes of 10 or 20 NTU, these events will require frequent backwashing and could reduce the overall capacity or overwhelm the residuals handling systems. A sustained elevated turbidity event (over 10 NTU) would require the addition of clarification for granular media filtration.

With Clarification: Clarification would provide improved performance over direct filtration and could treat turbidities up to 500 NTU.

With Ozone/Biological Filtration: No additional improvement over clarification.

3.2.14. Reduce customer cost of water treatment

Direct Filtration: Customers could reduce their need for in-home or business water treatment facilities with granular media filtration. Granular media filtration would provide a consistently lower sediment load and more aesthetically pleasing water.

With Clarification: Clarification would provide improved performance over direct filtration in that it could stay online during extended turbidity events.

With Ozone/Biological Filtration: Ozone and biological filtration would provide the best performance in terms of customer cost.

3.3 Membrane Filtration Screening

The membrane filtration screening results are summarized in Table 4 and described in detail in the following text. The basic configuration of prescreening, flocculation and microfiltration membrane followed by disinfection and corrosion control was able to achieve a good or excellent rating in all the filtration benefit categories. The ratings assume that coagulation chemicals would be required in all cases to achieve the benefits desired.

Table 4. Membrane Filtration Screening

Treatment Process	Microfiltration Membrane Filtration			
Benefits	Membrane Filtration	Add clarification	Add post filter ozone and biological contactors	Notes/references
Provide pathogen removal for *Cryptosporidium, Giardia*, bacteria and viruses (3.3.1)	Excellent	Excellent	Excellent	USEPA, 2005
Produce a biologically stable water (3.3.2)	Good	Good	Excellent	AOC reduction, CH2M TM 4.1
Reduce DBPs (3.3.3)	Good	Good	Excellent	THM and HAA reduction
Increase supply reliability (3.3.4)	Excellent	Excellent	Excellent	Turbidity events, AWWA ASCE, 2012
Reduce distribution system flushing, lower turbidity levels (3.3.5)	Excellent	Excellent	Excellent	USEPA, 2010 (LT2 Toolbox)

Treatment Process	Microfiltration Membrane Filtration			
Benefits	Membrane Filtration	Add clarification	Add post filter ozone and biological contactors	Notes/references
Reduce iron and manganese (3.3.6)	Good	Good	Good	AWWA ASCE, 2012
Improve WQ stability, lower lead and copper levels (3.3.7)	Excellent	Excellent	Excellent	Assumes optimal corrosion control for all options
Effectively treat an algae event (3.3.8)	Good	Good	Excellent	Production, T&O, cyanotoxins
Reduce water quality impacts due to warmer weather (3.3.9)	Good	Good	Excellent	Increases algal blooms, T&O, cyanotoxins
Reduce organic discoloration events (3.3.10)	Good	Good to Excellent	Excellent	Tannins and lignins, AWWA ASCE, 2012
Improve ability to respond to changes in regulations (3.3.11)	Good	Excellent	Excellent	Removal of contaminants of emerging concern
Increase ability to meet several critical service levels (3.3.12)	Good	Good	Good	Color, manganese, sediment
Treat a sustained elevated turbidity event (3.3.13)	Excellent	Excellent	Excellent	AWWA ASCE, 2012
Reduce customer cost of water treatment (3.3.14)	Good	Excellent	Excellent	Consistent water quality with low color, T&O

3.3.1 Provide pathogen removal for *Cryptosporidium*, *Giardia*, bacteria and viruses

Membrane Filtration: Microfiltration membrane plants can achieve >2-log removal credits for *Cryptosporidium* and > 3 log removal credits for G*iardia,* but no removal credit for viruses. Systems are required to provide an additional 1-log of disinfection for *Giardia* and 4-log disinfection for viruses. 4-log of virus credit can be achieved with a free chlorine contact time of approximately 9 to 12 mg/L*min, which is easily attainable in a pipe or clear well after filtration without adding any additional infrastructure or equipment.

With Clarification: No additional credit.

With Ozone/Biological Contactors: No additional credit.

3.3.2 Produce a biologically stable water

Membrane Filtration: Microfiltration membrane pores are too large to remove dissolved organic compounds. With coagulation chemicals like those used for granular media filtration, TOC reduction should be expected to be similar.

With Clarification: Some organic removal would be achieved prior to the membranes, typically 20%.

With Ozone/Biological Contactors: Results would be very similar to granular media filtration with ozone and biological filtration. One big difference between microfiltration and granular media filtration is that ozone and a biological contactor are provided after the membrane to achieve biological reduction of the AOC produced during ozonation.

3.3.3 Reduce disinfection by-products

Membrane Filtration: Reduction of DBPs in PWB's membrane pilot testing showed 13 to 34% reduction of THMs and 1 to 49% reduction of HAAs using an ultrafiltration membrane with a coagulant. Microfiltration membrane plants in the pacific northwest have shown 20% to 40% TOC reduction and are expected to have similar reduction in DBPs.

With Clarification: Some organic DBP precursor removal would be achieved prior to the membranes, typically 20%.

With Ozone/Biological Contactors: The addition of ozone/biological contactors would improve DBP reduction to 40 to 70%.

3.3.4 Increase supply reliability

Membrane Filtration: Increased supply reliability would be achieved if the Bull Run water supply could remain online through normal turbidity events. All membrane options could stay online during turbidity events. Without clarification, increased turbidity above 10 NTU could reduce the plant output.

With Clarification: The plant could stay online during extended elevated turbidity periods. Clarification performance would be the same as with a granular media filtration plant.

With Ozone/Biological Contactors: Ozone/GAC contactors would increase reliability during turbidity events.

3.3.5 Reduce distribution system flushing and lower turbidity levels

Membrane Filtration: Reduction in distribution system flushing would result from lower sediment load being sent to the distribution system. A full-scale membrane filtration plant would be expected to have a filtered water turbidity below 0.05 NTU.

With Clarification: Similar to membrane filtration alone.

With Ozone/Biological Contactors: Similar to membrane filtration alone, although this option would reduce distribution system biological activity.

3.3.6 Reduce iron and manganese concentrations

Membrane Filtration: Iron is easy to oxidize with exposure to dissolved oxygen or other oxidants and can be normally removed with microfiltration membranes. Manganese is more difficult and tends to foul the membranes.

With Clarification: Enhanced cleaning or other pre-treatment measures to address manganese fouling would be needed seasonally.

With Ozone/Biological Contactors: No additional removal.

3.3.7 Improve water quality stability, and lower lead and copper levels

Membrane Filtration: Filtration will provide a reduction in both DOC and particulate metals loading to the system and is therefore anticipated to provide a reduction in lead release observed at customer taps. Optimized corrosion control would still be required.

With Clarification: Results similar to membrane filtration alone.

With Ozone/Biological Contactors: Optimal treatment. This option would also reduce nitrification. Nitrification can contribute to lead leaching.

3.3.8 Effectively treat an algae event

Membrane Filtration: Flat-sheet studies of UF and MF membranes have shown high efficiency of removal (> 98%) of whole cells of toxic M. aeruginosa with minimal cell damage (Chow et al., 1997b). However, MF membranes will not remove dissolved organic compounds, including cyanotoxins, MIB and geosmin that can be released in a dying algal bloom.

With Clarification: Clarification would allow the plant to maintain peak capacity during algal blooms, but would not address taste, odor or toxins.

With Ozone/Biological Contactors: Would provide effective removal of taste- and odor-causing compounds and algal toxins and allow the plant to maintain peak capacity during algal blooms.

3.3.9 Reduce water quality impacts due to warmer weather.

Membrane Filtration: The discussion provided concerning algal events also applies to warmer weather impacts on water treatment technology. In addition, warmer water produces disinfection by products in the presence of free chlorine at a faster rate compared to cooler water. Filtration reduces the amount free chlorine contact time required for primary disinfection which will result in lower disinfection by products during warm weather periods.

With Clarification: Clarification would allow the plant to maintain peak capacity during algal blooms.

With Ozone/Biological Contactors: Would provide effective removal of taste and odor causing compounds and algal toxins.

3.3.10 Reduce organic discoloration events

Membrane Filtration: Color removal with microfiltration membranes is expected to be similar to granular media filtration.

With Clarification: Clarification would improve color removal during high raw water color events.

With Ozone/Biological Contactors: Would provide effective removal of color year-round.

3.3.11 Improve ability to respond to changes in regulations

Membrane Filtration: A microfiltration membrane provides flexibility in being able to meet potential future regulatory issues. There are many potential regulations that could impact PWB in the future, including requirements to: change pathogen monitoring and testing methods; change distribution water quality contents of DBPs, lead, copper, nitrite and nitrate, and manganese, and heterotrophic plate counts; and regulations addressing algal toxins, nitrosamines and other contaminants of emerging concern.

With Clarification: While a membrane filtration plant can address many of these issues, some may require more robust multiple-barrier approaches, including clarification.

With Ozone/Biological Contactors: These additional barriers would provide the most flexibility for addressing future regulations.

3.3.12 Increase ability to meet several critical service levels

Membrane Filtration: Critical service level issues include several water quality issues such as distribution system disinfectant residuals, coliform, taste and odor, and manganese, among others. Membrane filtration would provide benefits.

With Clarification: Improved performance over just coagulation.

With Ozone/Biological Contactors: Improved performance would be provided with ozone/biological contactors.

3.3.13 Treat a sustained elevated turbidity event

Membrane Filtration: A sustained elevated turbidity event (over 10 NTU) would not require the addition of clarification for membrane filtration, but the plant would operate at a higher pressure or reduced production level.

With Clarification: Clarification would increase plant efficiency and capacity during these events and would not experience reduced production until turbidity exceeded 10 NTU.

With Ozone/Biological Contactors: No additional improvement over clarification.

3.3.14 Reduce customer cost of water treatment

Membrane Filtration: Customers could reduce their need for in-home or business water treatment facilities with membrane filtration. Membrane filtration would provide more consistent water quality.

With Clarification: Clarification would increase plant efficiency and capacity during water quality events.

With Ozone/Biological Contactors: Would address color, taste and odor issues.

3.4 Slow Sand Filtration Screening

The results of the slow sand filtration screening are shown in Table 5 and discussed in detail in the following text. None of the treatment configurations for slow sand filtration provide a good or excellent rating for all the filtration benefits.

Table 5. Slow Sand Filtration Screening

Treatment Process	Slow Sand Filtration			
Benefits	**Slow sand filtration**	**Add roughing filter**	**Add clarification**	**Notes/References**
Provide pathogen removal for *Cryptosporidium, Giardia*, bacteria and viruses (3.4.1)	Good	Good	Good	USEPA, 2005
Produce a biologically stable water (3.4.2)	Good	Good	Good	AOC reduction, CH2M TM 4.1
Reduce DBPs (3.4.3)	Good	Good	Good	THM and HAA reduction
Increase supply reliability (3.4.4)	Good	Good	Excellent	Turbidity events, AWWA ASCE, 2012

Treatment Process	Slow Sand Filtration			
Benefits	**Slow sand filtration**	**Add roughing filter**	**Add clarification**	**Notes/References**
Reduce distribution system flushing, lower turbidity levels (3.4.5)	Poor to Good	Poor to Good	Poor to Good	USEPA, 2010 (LT2 Toolbox)
Reduce iron and manganese (3.4.6)	Poor	Poor	Poor	AWWA ASCE, 2012
Improve WQ stability, lower lead and copper levels (3.4.7)	Excellent	Excellent	Excellent	Assumes optimal corrosion control for all options
Effectively treat an algae event (3.4.8)	Poor	Poor	Poor to Good	Production, T&O, cyanotoxins
Reduce water quality impacts due to warmer weather (3.4.9)	Poor	Poor	Poor to Good	Increases algal blooms, T&O, cyanotoxins
Reduce organic discoloration events (3.4.10)	Good	Good	Good to Excellent	Tannins and lignin's, AWWA ASCE, 2012
Improve ability to respond to changes in regulations (3.4.11)	Poor to Good	Poor to Good	Good	Removal of contaminants of emerging concern
Increase ability to meet several critical service levels (3.4.12)	Poor to Good	Good	Good	Color, manganese, sediment
Treat a sustained elevated turbidity event (3.4.13)	Poor to Good	Good	Unknown	AWWA ASCE, 2012
Reduce customer cost of water treatment (3.4.14)	Good	Good	Good	Consistent water quality with low color, T&O

3.4.1 Provide pathogen removal for cryptosporidium, giardia, bacteria and viruses

Slow Sand Filter: Slow sand filtration plants can achieve > 2 log removal credits for *Cryptosporidium*, 2 log removal credits for *Giardia,* and 2 log removal credits for viruses. Systems are required to provide at least 1 log of disinfection for *Giardia* and 2 logs of disinfection for viruses. However, the performance of slow sand filters can be highly variable. Fogel, et. al., 1993, found 93% removal of *Giardia* cysts in a two-year study of a full-scale operating slow sand plant, but only an average of 48% removal of *Cryptosporidium* cysts, with detections in 46% of the filtered water samples.

With Roughing Filter: A roughing filter is a pretreatment process specifically designed for slow sand plants, consisting of several layers of gravel. Its purpose is to reduce influent turbidity spikes for short term turbidity events. A roughing filter would not provide any additional pathogen removal credit.

With Clarification: Because slow sand filters require a fair amount of organic material in the raw water to maintain biological activity within the schmutzdecke, clarification would be used only for limited durations of a few days during turbidity or algae events and would not provide any additional pathogen removal credit. The formation of the schmutzdecke in slow sand filters is the primary pathogen removal mechanisms, while in granular media biological filters, pathogen removal is obtained through the filter bed depth.

3.4.2 Produce a biologically stable water

Slow Sand Filter: The slow sand process is a largely microbiological process, and it will consume some of the readily available portion of the dissolved organic carbon referred to as assimilable organic carbon or AOC. Typically, about 10% of the raw water TOC is in the form of AOC. Removal of AOC in a biological filter prevents this material from entering the distribution system and becoming food for biofilm in the distribution system piping system.

Dissolved organic carbon (DOC) removal in slow sand filters is variable and may range from 10 to 25% (Collins., 1989; Fox et. al., 1987). About 90% of the remaining TOC in the effluent samples is dissolved (USEPA, Microbial and Disinfection Byproduct Rules Simultaneous Compliance Guidance Manual, 1999).

With Roughing Filter: No additional benefit.

With Clarification: Clarification would be used only for limited durations of a few days during turbidity or algae events, since it would remove much of the food source for the schmutzdecke and would provide limited benefit.

3.4.3 Reduce disinfection by-products

Slow Sand Filter: Reduction of DBPs in slow sand plants is typically 20-30% (Collins, 1998).

With Roughing Filter: A roughing filter would provide no additional benefit, since it is used primarily for the removal of suspended solids

With Clarification: Clarification would be used only for limited durations of a few days during turbidity or algae events, thus it would not provide an ongoing reduction of disinfection by product precursors.

3.4.4 Increase supply reliability

Slow Sand Filter: Increased supply reliability would be achieved if the Bull Run water supply could remain online through normal turbidity events. Slow sand plants are recommended only for waters with raw water turbidity less than 10 NTU, which includes most but not all regular normal turbidity events.

With Roughing Filter: Roughing filters can treat some short-term turbidity spikes and may remove 50% to 90% of influent turbidity (Wegelin, et.al., 1998).

With Clarification: Since clarification removes the organics needed for a healthy schmutzdecke clarification would be used only for limited durations of a few days during turbidity events but would be effective during these periods of use.

3.4.5 Reduce distribution system flushing, and lower turbidity levels

Slow Sand Filter: Reduction in turbidity with slow sand plants can be highly variable. For CT (concentration X time) credit, effluent turbidity must be less than 1 NTU in 95% of monthly samples with no samples over 5 NTU. Typically, slow sand plants will achieve at least 50% removal (Leland, 1991). Some plants may experience higher effluent turbidity than influent turbidity during periods of low raw water turbidity (CH2M, 2014).

With Roughing Filter: A roughing filter would provide no additional benefit.

With Clarification: Clarification would provide no additional benefit.

3.4.6 Reduce iron and manganese concentrations

Slow Sand Filter: Slow sand filtration can provide removal of manganese and iron. Both are dependent on maintaining an oxidizing condition within the filter, but removal of up to 67% of manganese is possible (Collins, 1998). However, since it is a biological process, manganese release can occur during periods of low dissolved oxygen or other changing water quality conditions.

With Roughing Filter: A roughing filter would provide no additional benefit.

With Clarification: Since clarification would be used only for a few days at a time, it would not be effective for iron and manganese control.

3.4.7 Improve water quality stability, and lower lead and copper levels

Slow Sand Filter: Filtration will provide a reduction in both DOC and particulate metals loading to the system and is therefore anticipated to provide a reduction in lead release observed at customer taps.

With Roughing Filter: A roughing filter would not add benefits for lead and copper removal.

With Clarification: Since clarification would only be used infrequently, it would not provide additional benefits beyond filtration alone.

3.4.8 Effectively treat an algae event

Slow Sand Filter: Algal blooms can clog slow sand filters. Because they take several days or longer to clean and ripen prior to putting the filters back on line, clogging events can have a significant impact on the ability of a plant to meet demand. Slow sand filters are also susceptible to taste and odor events and cyanobacteria detections in filtered water during or at the end of an algal bloom. In addition, slow sand filters are not well suited to addressing cyanobacteria toxins.

With Roughing Filter: A roughing filter may provide some benefit for algae removal, similar to turbidity reduction, of 30 to 50%.

With Clarification: Since clarification removes the necessary food supply for the slow sand filters it would be used only for limited durations of a few days during turbidity or algae events but would provide effective treatment during these periods.

3.4.9 Reduce water quality impacts due to warmer weather

Slow Sand Filter: The discussion provided concerning algal events also applies to warmer weather impacts on water treatment technology. In addition, warmer water produces disinfection by products in the presence of free chlorine at a faster rate compared to cooler water. Filtration reduces the amount free chlorine contact time required for primary disinfection which will result in lower disinfection by products during warm weather periods.

With Roughing Filter: A roughing filter may provide some benefit for algae removal, similar to turbidity reduction, of 30 to 50%.

With Clarification: Since clarification would be used only for limited durations of a few days during turbidity or algae events, its benefit would only occur during these periods. If the algal bloom died off and released algal toxins and taste-and odor-causing compounds, clarification would require the addition of powdered activated carbon to effectively remove these compounds.

3.4.10 Reduce organic discoloration events

Slow Sand Filter: Some color removal is generally seen with slow sand filtration; however, the Oregon Health Authority recommends slow sand filters be used with raw water color of less than 5 color units. Elevated color could occur with a slow sand plant on Bull Run.

With Roughing Filter: A roughing filter would provide no additional benefit.

With Clarification: As discussed previously, clarification would be used only for limited durations of a few days during turbidity or algae events and would not typically be used for color events.

3.4.11 Improve ability to respond to changes in regulations

Slow Sand Filter: A slow sand filtration plant provides some flexibility in being able to meet potential future regulatory issues. There are many potential regulations that could impact PWB in the future, including requirements to: change pathogen monitoring and testing methods; change distribution water quality content of DBPs, lead, copper, nitrite and nitrate, and manganese, and change to heterotrophic plate counts; and regulations addressing algal toxins, nitrosamines and other contaminants of emerging concern. A slow sand plant can provide some benefit for many of these issues but may require a more robust multiple treatment barrier approach.

With Roughing Filter: A roughing filter would provide no additional benefit.

With Clarification: Clarification would be used only for limited durations of a few days during turbidity or algae events and would provide little additional benefit.

3.4.12 Increase ability to meet several critical service levels

Slow Sand Filter: Critical service level issues include several water quality issues such as distribution system disinfectant residuals, coliform, taste and odor, and manganese, among others. Slow sand filtration will provide benefits for many of these issues.

With Roughing Filter: A roughing filter would provide little additional benefit.

With Clarification: Clarification would be used only for limited durations of a few days during turbidity or algae events and would provide benefits only during times of use.

3.4.13 Treat a sustained elevated turbidity event

Slow Sand Filter: A sustained elevated turbidity event (over 10 NTU) would require the addition of clarification for slow sand filtration; however, clarification prior to slow sand filtration is rarely used and often only as a short-term measure to address a turbidity or algal event.

With Roughing Filter: A roughing filter would reduce turbidity somewhat (see 3.4.5) but would only allow treatment of long-term events with turbidities of 10 to 20 NTU.

With Clarification: Clarification would be used only for limited durations of a few days during turbidity or algae events but would provide effective treatment during these periods.

3.4.14 Reduce customer cost of water treatment

Slow Sand Filter: Customers could reduce their need for in-home or business water treatment facilities with a slow sand filter. The slow sand filter would allow more consistent use of Bull Run water; however, aesthetic issues may still exist.

With Roughing Filter: A roughing filter would provide no additional benefit.

With Clarification: Clarification would be used only for limited durations of a few days during turbidity or algae events and would provide limited additional benefit.

3.5 Summary of Filtration Screening

Table 6 presents a side-by-side comparison of the filtration technologies considered in this alternatives analysis. The granular media filtration alternative with clarification and the basic membrane filtration alternative are the simple forms of the two technologies that provide good or excellent benefits in each of the categories.

Slow sand does not provide a good or excellent rating in all the benefits, no matter which level of treatment is used. In addition, it has limited ability to remove some dissolved organic materials including algal toxins and cannot treat a sustained turbidity event without clarification. There are no known slow sand filters using clarification on a sustained long-term basis and there is a concern that it may degrade the performance of the filter by limiting food and nutrients. In addition, the only slow sand filter that has been designed to withstand a Cascadia Subduction Zone seismic event required the use of concrete basins, which will significantly increase the cost of slow sand filtration.

Slow sand filters are also poor at removing color. It is recommended that influent color for slow sand be less than 5 color units (Oregon Health Authority, 2018). Also, it is noted that slow sand plants are subject to both algal clogging events as well as taste, odor and algal toxin events. The extended “do not drink” event related to algal toxins in Salem in June 2018 should be a strong reminder that slow sand plants are not well suited to addressing cyanotoxins and have treatment limitations in waters potentially subject to algal blooms.

Therefore, it is recommended that the following two alternatives be evaluated for potential filtration technology to use on the Bull Run supply:

- Granular media filtration with clarification, and
- Membrane filtration (microfiltration).

The granular media filtration process flow diagram is shown in Figure 6. The proposed membrane filtration process flow diagram is shown in Figure 7.

Table 6. Comparison of Filtration Technologies

Treatment Process	Granular Media Filtration			Membrane filtration			Slow Sand Filtration		
Benefits	Granular Media Filtration (Direct Filtration	Add clarifi-cation (Conventional filtration)	Biological granular media filtration	Membrane filtration	Add clarifi-cation	Add post filter ozone and biological contactors	Slow sand filtration	Add roughing filter	Add clarifi-cation
Provide pathogen removal for cryptosporidium, giardia, bacteria and viruses	++	++	++	++	++	++	+	+	+
Produce a biologically stable water	+	+	++	+	+	++	+	+	+
Reduce DBPs	+	+	++	+	+	++	+	+	+
Increase supply reliability	+	++	++	++	++	++	+	+	++
Reduce distribution system flushing, lower turbidity levels	++	++	++	++	++	++	- to +	- to +	- to +
Reduce iron and manganese	+	+	++	+	+	+	-	-	-
Improve WQ stability, lower lead and copper levels	++	++	++	++	++	++	++	++	++
Effectively treat an algae event	+	++	++	+	+	++	-	-	- to +
Reduce water quality impacts due to warmer weather	+	+	++	+	+	++	-	-	- to +
Reduce organic discoloration events	+	+ to ++	++	+	+ to ++	++	+	+	+ to ++
Improve ability to respond to changes in regulations	+	++	++	+	++	++	- to +	- to +	+
Increase ability to meet critical service levels	+	++	++	+	+	+	- to +	+	+
Treat a sustained elevated turbidity event	-	++	++	++	++	++	- to +	+	?
Reduce customer cost of water treatment	+	++	++	+	++	++	+	+	+

Ratings Key - ++ = excellent, += good, - = poor

Figure 6. Granular Media Filtration Process Flow Diagram

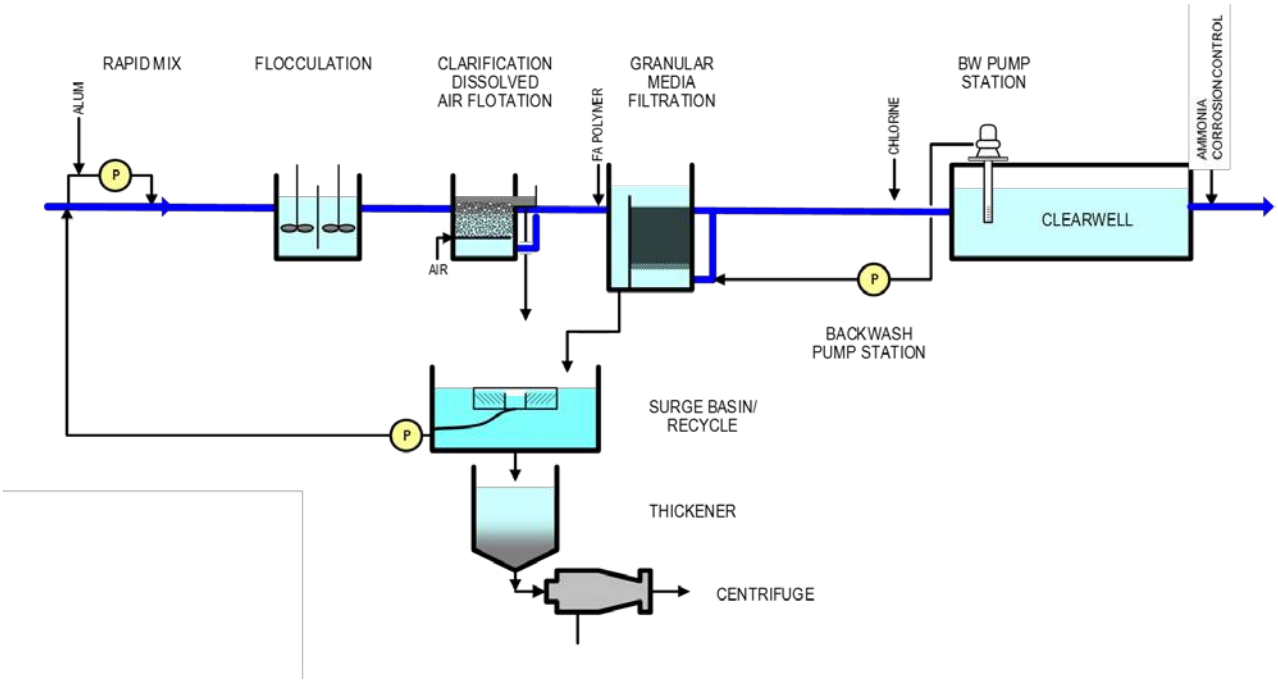
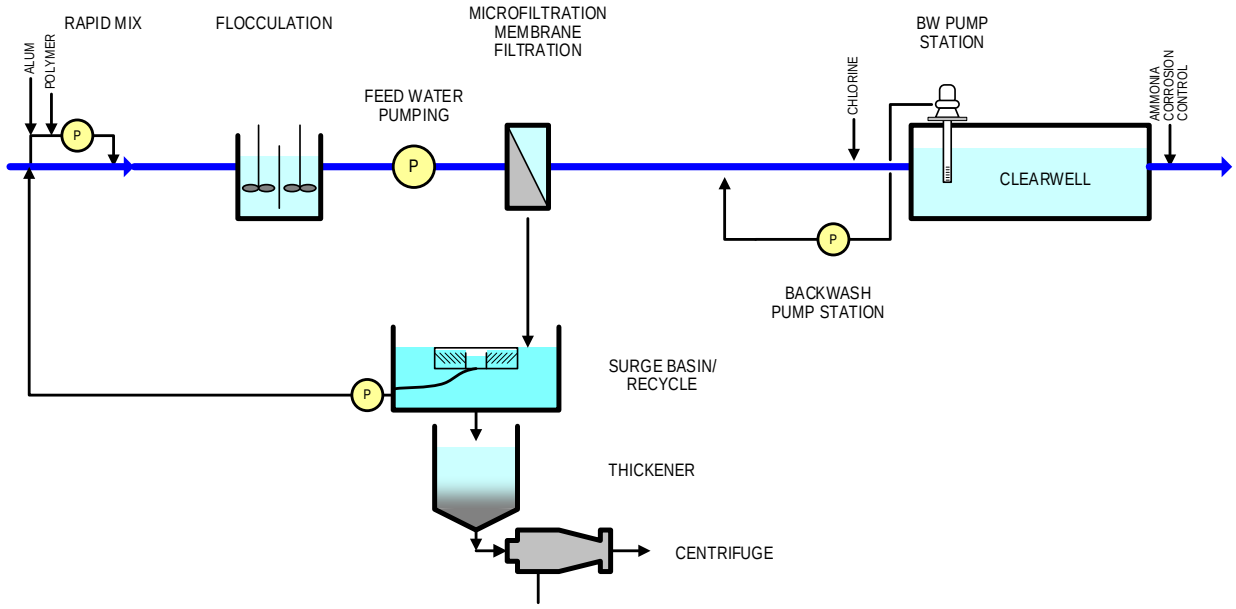


Figure 7. Microfiltration Membrane Process Flow Diagram



4 Decision Framework and Criteria

The two remaining alternatives were evaluated using the program's adopted Decision Framework. The framework consists of eight values, each having several criteria to evaluate each alternative. Table 7 lists the values and criteria.

While all the values are applied to each alternative, not every criterion is applicable for the capacity decision. For example, the criteria "On- and off-site ownership" is not applicable because the treatment technology selection is not dependent upon the ownership of the parcel. Table 7 also lists the criteria specifically included and excluded from the technology evaluation and the rationale associated with that inclusion or exclusion.

Table 7. Decision Framework and Criteria Used for Technology Evaluation

Value	Criteria	Inclusion Rationale	Exclusion Rational
Public Health and Water Quality (4.2)	Existing microbiological regulations	Included; treatment technology is directly measured by microbiological removal	
	Organics/inorganics regulations	Included; treatment technology can be measured by its efficacy of iron and manganese removal	
	Emerging water quality regulations	Included; ability to treat contaminants of emerging concern (CECs) is related to treatment technology	
	Consistent water quality	Included; treatment technologies perform differently in consistency of water quality	
	Chemical impacts	Included; disinfection byproducts differ per treatment technologies	
Resiliency/ Reliability (4.3)	Earthquake	Included; technologies may differ in their response to a seismic event	
	Catastrophic water quality event	Included; days of recovery following a catastrophic event may differ	
	Routine water quality event	Included; online percentage may differ	
Community interest (4.4)	Local impacts	Included; transport of materials and chemicals will differ	
	Consistency in taste and appearance	Included; performance can differ	
	Chemical concerns	Included; performance of pathogen removal may differ	

Value	Criteria	Inclusion Rationale	Exclusion Rational
Cost Benefit (4.5)	Cost of construction	Included; cost profiles are different	
	Operating costs	Included; operating costs differ among technologies	
Future Needs (4.6)	Capacity	Included; expansion potential differs	
	Future water quality	Included; CEC treatment can be differentiated	
	Available gravity capacity	Included; use of gravity flow will influence performance and costs	
Environmental Impacts (4.7)	Electricity usage	Included as it is a direct function of treatment technology	
	Residuals produced	Included; production of residuals differs depending on treatment technology	
	Construction and operations fuel consumption	Included; fuel consumption is a direct function of treatment technology	
Integration (4.8)	WTP labor	Included; amount of required labor may differ	
	Safety and operations	Included; chemical use differs with treatment technology	
	Corrosion control integration	Included; selection of treatment technology may influence the application and integration of corrosion control	
	Other infrastructure ramifications		Excluded; treatment technology does not influence other system components
	Distribution system water quality	Included; elimination of suspended solids may differ; may reduce flushing	
Implementation (4.9)	Ease of construction	Included; differing treatment facilities may influence schedule differently	
	Implementation complexity	Included; differing treatment facilities may influence schedule differently	
	Land use permits		Excluded; type of treatment is not influenced by land use permitting
	On- and off-site ownership		Excluded as ownership is related to siting only and not treatment technology

4.1. Evaluation of Screened Alternatives

The two alternatives carried forward from the screening of alternatives:

- Granular Media Filtration with Clarification (Conventional Filtration), and
- Membrane Filtration (microfiltration)

Table 8 provides the initial ratings for each of the criteria identified in the March 2018 workshop using the technology scales also developed during that workshop. The initial ratings are explained below.

Two types of performance scales are used to present the performance of the two alternatives across the 25 included criteria. The first is a quantitative scale based upon the natural performance of the specific criterion. Examples include cost of construction (millions of dollars) and electricity usage (kilowatt hours per year). These natural scales are simply used to demonstrate the performance of the different alternatives. For natural scales, the values are relative to each other in the table, but are concerted to either a 1 (best) or 0 (worst) within the decision scoring model. In the Public Health and Water Quality Value, related to the Emerging Water Quality Regulations, a natural scale was used based on the technologies' ability to partially remove a broad base of emerging contaminants, even though many of these contaminates are not expected to be found in the Bull Run source water.

The criteria that do not have a natural scale require the use of a constructed scale. A constructed scale considers a combination of materials and involves some professional judgement. For the criteria requiring a constructed scale, a 0 to 10 numbering system is used. The best performance is represented by a 10, the worst performance represented by a 0. Examples of criteria utilizing this constructed scale include 'consistency in taste and appearance' and 'perception of safety.'

Table 8. Summary of Ratings for Screened Water Treatment Technologies

Value	Value Statement	Criteria	Technology Scales	Granular Media Filtration with Clarification	Membrane Filtration
Public Health and Water Quality (4.2)	Provide drinking water that is safe and consistent	Existing Microbiological Regulations	Log removal	7	10
		Emerging Water Quality Regulations	Ability to treat CECs	30%*	30%*
		Organics and Inorganics Removal	SMCLs	7	3
		Consistent Water Quality	Consistency of water treatment	7	5
		Chemical Impacts	Disinfection byproducts formation	8	5

Value	Value Statement	Criteria	Technology Scales	Granular Media Filtration with Clarification	Membrane Filtration
Resiliency/ Reliability (4.3)	Facility maximizes likelihood of continued water provision, even after a fire or disaster	Earthquake	Ability to recovery	10	10
		Catastrophic WQ Event (forest fire, landslide)	Days of recovery	7	5
		Routine WQ Events (elevated turbidity, algae bloom)	Online capacity during event	10	7
Community Interests (4.4)	Integrate community interests in the decision-making process	Local Impacts	Neighbors impacted, expressed as truck trips	143,000	82,500
		Consistency in Taste and Appearance	Scaling	10	7
		Perception of Safety	Chemicals in customers' taps	7	5
Cost Benefit (4.5)	Getting the most benefit for the dollar	Cost of Construction	Capital cost $	$318 million	$413 million
		Operating Costs	Operating $	$13 million	$20 million
Meet Future Needs (4.6)	Maximizes ability to make adjustments in future	Capacity	Expansion potential	10	5
		Future Water Quality	CEC treatment percentage	30%	30%
		Available Gravity Capacity	mgd	130	0
Environmental Impacts (4.7)	Minimize environmental impacts	Electricity Usage	kWh/year	13 million	47 million
		Residuals Produced	Volume produced	3,630	1,900
		Construction and Operations Fuel Consumption	# truck trips + operations fuel consumption	322,000	237,000
Integration (4.8)	Optimize operability & integration with PWB's	WTP Labor	Required FTEs	12	12
		Chemical Use	Tons/year	5,770	3,290
		Corrosion Control Integration	Ability to install optimal treatment	10	10

Value	Value Statement	Criteria	Technology Scales	Granular Media Filtration with Clarification	Membrane Filtration
	systems & practices	Other infrastructure Ramifications	Impacts on other infrastructure	N/A	N/A
		Distribution System WQ	Elimination of suspended solids	10	10
Implementation (4.9)	Increases ability to implement and meet compliance schedule	Ease of Construction	Risk to schedule	8	10
		Implementation Complexity	Risk to schedule	10	5
		Land Use Permits	Risk to schedule	N/A	N/A
		On and off-site Ownership	N/A	N/A	N/A

* Based on the technology's ability to remove a broad base of emerging contaminants, regardless of whether they are likely to be found in Bull Run.

All the criteria that are included in the treatment alternatives are characterized below. Each has a description of the scale used to present alternative performance, characterizes the basis for the valuation and repeats the performance results summarized in Table 8.

4.2 Public Health and Water Quality

4.2.1 Existing Micro-Biological Regulations

Performance Scale: The constructed scale of 0-10 was used to rate the performance of this criterion. This constructed scale is used to incorporate a number of elements of microbiological regulations into one index of performance.

Basis for Valuation: Microbiological performance is rated on pathogen removal. Conventional filtration can receive 2.5 logs of credit for G*iardia*, greater than 2 logs of credit for C*ryptosporidium*, and 2 logs of credit for virus removal.

Membrane filtration can receive greater than 3 logs of credit for *Giardia* removal, greater than 2 logs of removal credit for *Cryptosporidium* removal, but no credit for viruses.

Membranes were rated higher because even though membranes receive no credit for virus removal, viruses can be addressed with the addition of chlorine. Virus disinfection requires a very low CT value for chlorine -- 9 to 12 mg/L - minutes, compared to the large values required for *Cryptosporidium* and *Giardia* disinfection.

Performance Results:

- Granular media filtration with clarification: 7 out of a possible 10
- Membrane filtration: 10 out of a possible 10

4.2.2 Emerging Water Quality Regulations

Performance Scale: This criterion was evaluated based on the alternatives' ability to remove contaminants of emerging concern (CECs) such as algal toxins, nitrosamine precursors or even

pharmaceutical chemicals. A quantitative scale of the ability to remove contaminants of emerging concern is applied.

Basis for Valuation: There are no known CECs in the Bull Run Water Supply, as most of these compounds are man-made and would not likely be present in the protected watershed. The ability to remove a broad spectrum of CECs was used as a surrogate for potential future regulations, since these could include future disinfection byproducts, other algal toxins or unknown compounds.

Coagulation and clarification as part of the conventional filtration plant are expected to remove approximately 30% of a broad base of CECs, based on evaluations conducted by Snyder, and Westerhoff, (2008). Microfiltration membranes do not remove these small dissolved organic compounds; however, with coagulants added, they would likely perform similar to clarification.

Performance Results:

- Granular media filtration with Clarification: 30% Reduction
- Membrane Filtration: 30% Reduction

4.2.3 Organics and Inorganics Removal

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion. This constructed scale is used to incorporate a number of elements including the removal of iron and manganese and AOC reduction into one index of performance.

Basis for Valuation: Granular media filtration provides excellent removal of iron and manganese, and clarification will remove color even at its peak levels. Membrane filtration may not be effective for manganese removal without extended preoxidation and pH adjustment and the membranes may be subject to fouling from manganese.

Granular media filtration outperforms membrane for AOC reduction. In addition, AOC removal can be optimized with granular media filtration by pre-ozonating, while MF membranes will not remove dissolved organic material and cannot be used with ozone unless post filter biological contactors are added to remove AOC.

Performance Results:

- Granular media filtration with Clarification: 7 out of a possible 10
- Membrane Filtration: 3 out of a possible 10

4.2.4 Consistency of Water Quality

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion. This constructed scale was used to incorporate a number of elements and professional judgement.

Basis for Valuation: Granular media filtration was ranked slightly higher than membranes in consistency of water quality. Membranes may have higher potential for distribution biological activity which can affect scales. Membranes can also have higher manganese levels which can form scale and attract other metals.

Performance Results:

- Granular media filtration with Clarification: 7 out of a possible 10
- Membrane Filtration: 5 out of a possible 10

4.2.5 Chemical Impacts

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: Disinfection byproduct formation potential was used to evaluate the technologies in this criterion. Based on the results of PWB's previous pilot testing, granular media filtration had lower DBP levels than the microfiltration and ultrafiltration membranes tested.

Performance Results:

- Granular media filtration with Clarification: 8 out of a possible 10
- Membrane Filtration: 5 out of a possible 10

4.3 Resiliency/Reliability

4.3.1 Earthquake

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: Both water treatment technologies can be designed to withstand a Cascadia Subduction seismic event and should be available immediately after an event.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 10 out of a possible 10

4.3.2 Catastrophic WQ Event (forest fire, landslide)

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion, based on the number of days of recovery it would take to return to service.

Basis for Valuation: The principal water quality impacts of a forest fire or catastrophic landslide would be highly elevated turbidity and dissolved organic material. Both technologies would be able to treat the water, but the membranes would likely have a significantly reduced capacity without clarification, therefore it would take longer to return to full capacity after the event.

Performance Results:

- Granular media filtration with Clarification: 7 out of a possible 10
- Membrane Filtration: 5 out of a possible 10

4.3.3 Routine WQ Events (elevated turbidity, algae bloom)

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion, based on the technologies on-line capacity during the event.

Basis for Valuation: Both technologies can treat elevated turbidity and algal bloom events. If algal blooms result in taste and odor events or algal toxin release, powdered activated carbon could be added to both. Membranes are rated slightly lower, because the capacity is expected to decrease during an event. In the granular media filtration plant, clarification would allow the filters to operate at full capacity, prior to the filters.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 7 out of a possible 10

4.4 Community Interests

4.4.1 Local Impacts

Performance Scale: Local impacts are evaluated based on the number of truck trips to occur over a 25-year period to transport materials and chemicals. A natural scale of the number of truck trips is applied.

Basis for Valuation: Neighbors impacted were evaluated based on lifecycle truck trips for each technology. The granular media filtration plant would require 123,000 truck trips during construction and approximately 800 truck trips per year, while the membrane plant would require 60,000 truck trips during construction and approximately 900 truck trips per year.

Performance Results:

- Granular media filtration with Clarification: 143,000 truck trips over 25-year live cycle of the water treatment plant.
- Membrane Filtration: 82,500 truck trips over 25-year live cycle of the water treatment plant.

4.4.2 Consistency in Taste and Appearance

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion, based on the potential for disruption of distribution pipeline scales.

Basis for Valuation: Granular media filtration was ranked slightly higher than membranes in consistency in taste and appearance. Membranes may have higher potential for distribution biological activity which can affect scales. Membranes can also have higher manganese levels which can form scale and attract other metals.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 7 out of a possible 10

4.4.3 Perception of Safety

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion, based on the concentrations of chemicals in customers tap water.

Basis for Valuation: Ratings were provided based on the quantity of chemicals used in treatment and the effluent water quality produced by the treatment systems. Granular media filtration was rated a 7, and membranes were rated a 5, based on their ability to remove dissolved organic matter and provide lower disinfection by-products.

Performance Results:

- Granular media filtration with Clarification: 7 out of a possible 10
- Membrane Filtration: 5 out of a possible 10

4.5 Cost Benefit

4.5.1 Cost of Construction

Performance Scale: A quantitative scale of construction costs is applied.

Basis for Valuation: The capital cost of granular media filtration with clarification is estimated at $318 million. The capital cost of membrane filtration is estimated at $413 million. CH2M Technical Memorandum 4.5 provides details on costs, design and operation of each water treatment technology.

Performance Results:

- Granular media filtration with Clarification: $318 Million
- Membrane Filtration: $413 Million

4.5.2 Operating Costs

Performance Scale: A natural scale of operating costs is applied.

Basis for Valuation: The annual O&M cost of granular media filtration is estimated at $13 million. The annual O&M cost of membrane filtration is estimated at $20 million.

Performance Results:

- Granular media filtration with Clarification: $13 Million
- Membrane Filtration: $20 Million

4.6 Meet Future Needs

4.6.1 Capacity

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: This rating was based on the ability to expand the plants in the future. Granular media filtration was rated higher, because the filter loading rate could likely be increased after design to obtain additional capacity, whereas, membranes would require additional equipment.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 5 out of a possible 10

4.6.2 Future Water Quality

Performance Scale: A quantitative scale of contaminants of emerging concern treatment percentage is applied.

Basis for Valuation: This rating was based on the ability of the technology to remove CECs. Granular media filtration is expected to remove several types of CECs through coagulation and clarification. Membranes with coagulation are expected to have similar levels of removal.

Performance Results:

- Granular media filtration with Clarification: 30% Reduction
- Membrane Filtration: 30% Reduction

4.6.3 Available Gravity Capacity

Performance Scale: A quantitative scale of mgd available by gravity is applied.

Basis for Valuation: The granular media filtration plant is estimated to be able to provide 130 mgd of gravity flow at the Carpenter Lane site (depending on piping size, configuration, and elevation), whereas membranes would require pumping for the entire plant capacity.

Performance Results:

- Granular media filtration with Clarification: 130 mgd for the Carpenter Lane site
- Membrane Filtration: 0 mgd

4.7 Environmental Impacts

4.7.1 Electricity Usage

Performance Scale: A quantitative scale of kilowatt hours (kWh) used per year is applied.

Basis for Valuation: Appendix E provides details on costs, design and operation of each water treatment technology. The annual power required of granular media filtration is estimated at 13 million KW-hours per year. The power requirement of membrane filtration is estimated at 47 million kilowatt-hours per year.

Performance Results:

- Granular media filtration with Clarification: 13 million kWh per year
- Membrane Filtration: 47 million kWh per year

4.7.2 Residuals Produced

Performance Scale: A quantitative scale of the volume in dry tons of residuals produced per year is applied.

Basis for Valuation: Section 7 provides details on costs, design and operation of each water treatment technology. The annual residuals produced with granular media filtration is estimated at 3,360 try tons. The annual residuals with membrane filtration is estimated at 1,900 dry tons.

Performance Results:

- Granular media filtration with Clarification: 3,630 dry tons per year
- Membrane Filtration: 1,900 dry tons per year

4.7.3 Construction and Operations Fuel Consumption

Performance Scale: A quantitative scale of the volume in gallons of consumed over 25 years is applied.

Basis for Valuation: Section 7 provides details on costs, design and operation of each water treatment technology. The life-cycle fuel consumption for granular media filtration is estimated at 322, 000 gallons of diesel. The life-cycle fuel consumption with membrane filtration is estimated at 237,000 gallons.

Performance Results:

- Granular media filtration with Clarification: 322,000 gallons
- Membrane Filtration: 237,000 gallons

4.8 Integration

4.8.1 Water Treatment Plant Labor

Performance Scale: A quantitative scale of the required FTEs is applied.

Basis for Valuation: Section 7 provides details on costs, design and operation of each water treatment technology. Both plants are expected to have the same staffing requirements.

Performance Results:

- Granular media filtration with Clarification: 12 FTEs
- Membrane Filtration: 12 FTEs

4.8.2 Chemical Use

Performance Scale: A quantitative scale of tons of chemicals consumed per year is applied.

Basis for Valuation: Section 7 provides details on costs, design and operation of each water treatment technology. The annual chemical use for granular media filtration is estimated at 5,770 tons. The annual chemical use with membrane filtration is estimated at 3,290 tons.

Performance Results:

- Granular media filtration with Clarification: 5,770 tons
- Membrane Filtration: 3,290 tons

4.8.3 Corrosion Control Integration

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: Filtration will remove dissolved organic matter and suspended solids that will contribute to lower lead levels. Both technologies are expected to include optimal corrosion control treatment in a similar fashion.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 10 out of a possible 10

4.8.4 Distribution System WQ

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: Both technologies are expected to reduce suspended solids entering the distribution system to similar levels.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 10 out of a possible 10

4.9 Implementation

4.9.1 Ease of Construction

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: The membrane filtration technology is expected to be somewhat easier to construct, since clarification facilities are not required.

Performance Results:

- Granular media filtration with Clarification: 8 out of a possible 10
- Membrane Filtration: 10 out of a possible 10

4.9.2 Implementation Complexity

Performance Scale: The constructed scale of 0-10 was used to present the performance of this criterion.

Basis for Valuation: Membranes are expected to be more difficult to implement because of the high degree of mechanical equipment and instrumentation included in the technology.

Performance Results:

- Granular media filtration with Clarification: 10 out of a possible 10
- Membrane Filtration: 5 out of a possible 10

5 Cost Estimating

Cost estimates and evaluation criteria metrics are presented in Table 9 for the two filtration technologies for a 160 mgd plant. This section provides a summary of the cost details presented in Appendix E to this technical memorandum.

Values provided are for a typical granular media and membrane filtration WTP and do not specifically represent data or cost of a facility for the Bull Run Supply. The information is solely for comparative purposes. Decisions about the actual makeup of the filtration plant will be made by PWB after selection of a designer and program manager.

Table 9. Filtration Technology Estimated Costs and Measures for Water Treatment Plant

Item	Filtration Technologies at 160 mgd Capacity	
	Granular Media with Clarification	Membrane Filtration
Construction cost	$318,200,000	$413,450,000
Annual operations and maintenance	$12,520,000	$19,980,000
25-year life-cycle cost	$556,770,000	$794,410,000
Cost per CCF delivered*	$0.61	$0.87
Electrical usage (megawatt-hours per year)	12,600	46,950
Residuals (cubic yards per year)	3,630	1,900
Truck trips during construction	115,390	54,670
Truck trips per year	450	810
Fuel consumption during construction (gallons)	259,300	122,850
Fuel consumption (gallons per year)	2,520	4,570
Chemicals (dry tons per year)	5,770	3,290

*CCF is hundred cubic feet. Includes construction costs and annual operations and maintenance costs.

5.1 Capital Cost Estimates

The cost estimating guidance presented in Appendix E was developed by an Excel-based conceptual parametric estimating system (CPES). This guidance supports development of a Class 5 cost estimate, as defined by the Association for the Advancement of Cost Engineering International (see Attachment A for more information). A Class 5 cost estimate is provided with very little project definition (0-2%) and is used for concept screening.

The costs described in this technical memorandum are developed for granular media filtration with clarification, and membrane filtration without clarification. Neither of the alternatives include costs for conveyance of water to the site. Granular media filtration does not include raw water pumping facilities, which is a requirement for the membrane alternative. The cost estimates also do not include operations or an administration building. The purpose of the cost estimate is to compare the filtration technologies, not to provide a cost estimate of the full treatment project.

5.1.1 Granular Media Filtration

The granular media filtration process flow diagram is shown in Figure 8. Table 10 presents the capital cost elements included in the granular media filtration alternative. Dissolved air flotation was chosen as the clarification process for this cost model, but several other clarification types exist. The final decision on the treatment train will be developed after PWB selects the program manager and design teams for the project.

Figure 8. Direct Granular Media Filtration Process Flow Diagram

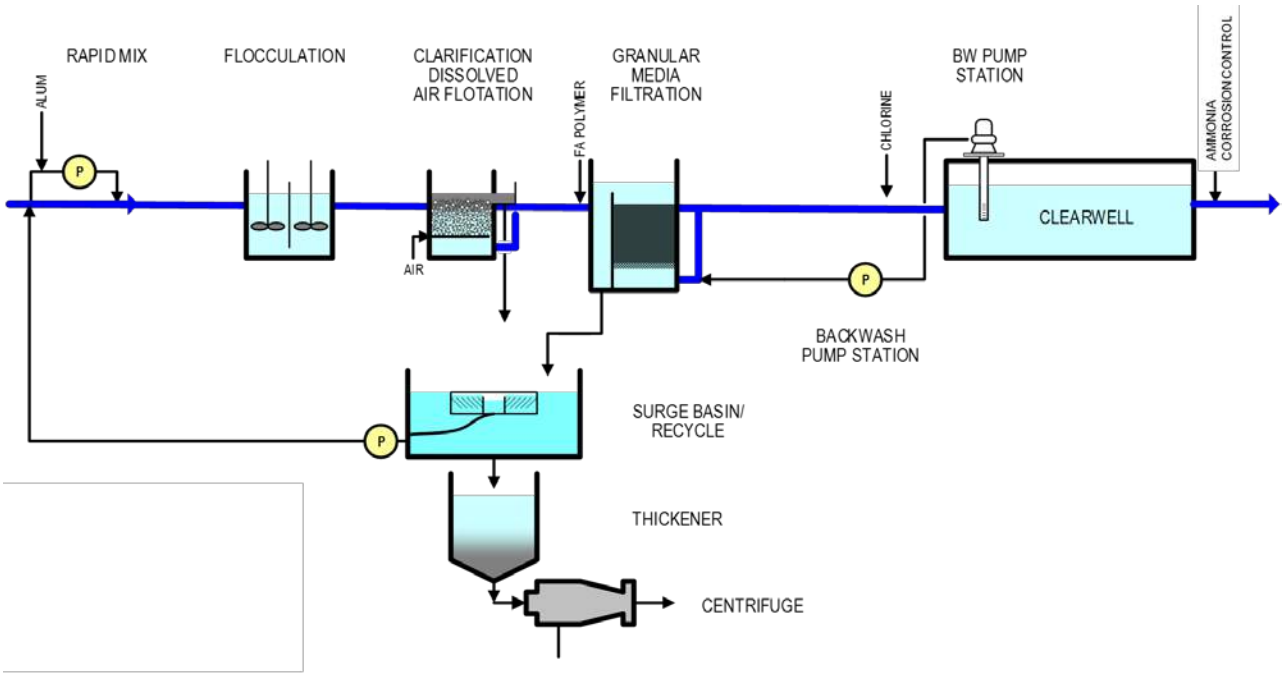


Table 10. Capital Cost Elements for Granular Media Filtration Plant

Project Element	Value
Capacity	160 mgd
Rapid mix, type, No. trains	Turbine, 4
Flocculation, type, HRT min, No. trains	HPW, 30, 8
Clarification Type, No. of trains	Dissolved Air Flotation, 4
Coagulant, type, average dose (mg/L)	Alum, 5
Coagulant aid polymer, type, average dose (mg/L)	Liquid, 0.75
Filter aid polymer type, average dose (mg/L)	Liquid, 0.1
Media filter type	Sand/Anthracite
Media filter size (square feet)/No.	926/22
Media filter depth (sand/anthracite in inches)	12/60
Disinfection type, average dose (mg/L)	OSHG, 3
Clear well volume (MG)	16.0
Backwash pump station capacity (mgd)	33
Corrosion control chemicals, average	NA_2CO_3 ,25

Table 10. Capital Cost Elements for Granular Media Filtration Plant

Project Element	Value
dose (mg/L)	CO_2, 5
Surge basin volume (MG)	11.6
Sludge thickener (MG)	0.90
Sludge holding (MG)	0.6
Dewatering	Centrifuge

Alum = aluminum sulfate; HRT = hydraulic residence time; HPW = horizontal paddle wheel; lb/day = pounds per day; MG = million gallons; mg/L = milligrams per liter; mgd = million gallons per day; NA_2CO_3 = soda ash; CO_2 = carbon dioxide, OSHG = onsite sodium hypochlorite generation.

5.1.2 Membrane Filtration

Figure 9 shows the process schematic for membrane filtration used in the cost estimate. Feed water pumping is provided for each membrane train. Table 11 shows the design criteria for the membrane filtration plant.

Figure 9. Microfiltration Membrane Process Flow Diagram

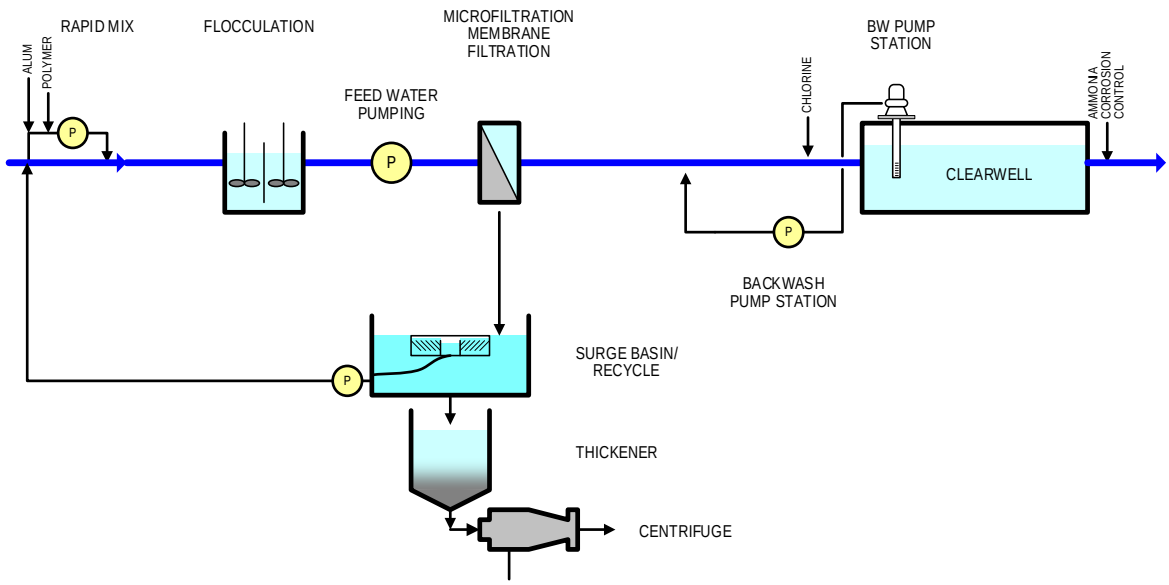


Table 11. Capital Cost Elements for Membrane Filtration Plant

Project Element	Value
Capacity	160 mgd
Rapid mix, type, No. trains	Turbine, 4
Flocculation, type, HRT min, No. trains	HPW, 30, 8
Coagulant, type, average dose (mg/L)	Alum, 5
Coagulant aid polymer, type, average dose (mg/L)	Liquid, 0.75
Membrane type	Pressure Modules, Microfiltration

Table 11. Capital Cost Elements for Membrane Filtration Plant

Project Element	Value
Membrane Subsystems, No.	6
Membrane trains per subsystem	9 on line, 1 standby
Maximum Instantaneous Flux Rate, gfd	58
Permeate recovery, %	97%
Disinfection type, average dose (mg/L)	OSHG, 3
Clear well volume (MG)	16.0
Feedwater pumping design TDH, ft	102
Corrosion control chemicals, average dose (mg/L)	NA_2CO_3 ,25 CO_2, 5
Surge basin volume (MG)	11.6
Sludge thickener (MG)	0.90
Sludge holding (MG)	0.6
Dewatering	Centrifuge

Alum = aluminum sulfate; HRT = hydraulic residence time; HPW = horizontal paddle wheel; lb/day = pounds per day; MG = million gallons; mg/L = milligrams per liter; mgd = million gallons per day; NA_2CO_3 = soda ash; CO_2 = carbon dioxide; OSHG = onsite sodium hypochlorite generation.

5.2 Cost Estimating Allowances

Table 12 presents the site-wide allowances included within the water infrastructure component construction cost curves developed from CPES for WTPs, as these facilities include additional supporting infrastructure to enable the group of unit processes to perform in a secure environment. These allowances are based on actual constructed projects and experience for the cost of site grading, roadways, site secondary power distribution, site instrumentation and control signal transmission, and yard piping to interconnect the unit processes as a percentage of the total facility unit process component construction cost.

Table 12. Site-wide Allowances for Water Treatment Plant

Project Component	Allowance
Site grading, roadways, stormwater management	5%
Site electrical distribution (less primary & standby power provisions)	4%
Site yard piping	7.5%
Site I&C/SCADA network	5%
Total site-wide allowance	**21.5%**

I&C = instrumentation and control; SCADA = supervisory control and data acquisition.

5.2.1 Contractor Allowances

Construction contractor allowances include contractor overhead, markup, mobilization, bonds, and insurance. Table 13 presents the percentage of costs related to each of these additional construction costs. These allowances are based on CH2M Constructors, Inc., experience for traditional design-bid-build delivery projects. These allowances will vary by project type and market conditions at the time of bidding. For this guide and resulting conceptual cost estimating tool, the total of 22.5% is a reasonable assumption.

Table 13. Construction Contractor Allowances

Allowance & Governing Subtotal	Cost Percentage
Overhead/general conditions allowance applied to project component cost subtotal	14%
Profit	5%
Mobilization/bonds/insurance allowance applied to project component subtotal	3.5%
Total contractor allowance	**22.5%**

5.2.2 Project Contingency

A 40% contingency is applied to the sum of the project component costs and contractor allowances to account for incomplete definition and design.

The following items are not assumed nor explicitly accounted for in the project component costs at this stage of conceptual cost estimating:

- Rock excavation
- Tunneling or boring
- Pile foundations
- Seismic foundations
- Shoring
- Soil contamination
- Dewatering conditions
- Environmental mitigation
- Weather impacts
- Depth of structures
- Local building code restrictions
- Coatings or finishes
- Building or architectural preferences
- Client material preferences
- Client equipment preferences
- Existing utilities interference
- System-wide I&C automation integration
- Primary electrical power source transmission and transformation
- Access and maintenance roadways

5.2.3 Construction Truck Trips and Fuel Consumption

The construction truck volumes were assumed to be 10 cubic yards for construction and residuals hauling. Average distance was estimated at 20 miles per trip. Fuel consumption was estimated at 8.9 miles per gallon.

5.3 Annual O&M Cost Estimate Preparation

Annual O&M cost includes the following elements:

- Labor
- Chemicals
- Power
- Residuals disposal

Chemicals, power, and ultimate residuals disposal are based on user input of both average annual day and maximum day design flow capacity, so the chemical usage, residuals production, and total connected horsepower, which are each sized for maximum day, can be proportionally reduced to represent average annual usage. Labor, as well as repair and maintenance materials, are considered fixed costs unrelated to flow rate.

5.3.1 Labor

Table 14 presents the assumed base staffing requirements and hourly rates for a WTP based on a wide range of staffing philosophies across water utilities world-wide. This results in a total WTP labor force equal to 13 full time equivalent (FTE) positions.

Table 14. Project Component Staffing Requirements and Rates

Project Component Staffing	Staffing Rates
One superintendent 8 hours per day, 5 days per week	$50/hour
Two operators onsite always	$30/hour
Two maintenance workers 8 hours per day, 7 days per week	$30/hour
One clerical worker 8 hours per day, 5 days per week	$20/hour
One lab worker 8 hours per day, 5 days per week	$20/hour

5.3.2 Chemicals

Table 15 presents the chemicals, average annual dose assumptions, and chemical unit costs associated with each WTP type, resulting in a total chemical cost per million gallons by WTP type. Chemical hauling distance is estimated at 50 miles.

Table 15. Project Component Staffing Requirements & Rates

Chemical	Unit Cost ($/dry ton)	Average Surface WTP Dose (mg/L)
Sodium hypochlorite	$1,500	3.0
Sodium hydroxide	$600	10
Aluminum sulfate	$450	5
Polymer	$2,500	0.75/0.1

5.3.3 Power

Power cost is based on a unit power rate of $0.0605 per kilowatt-hour.

5.3.4 Residuals Handling and Disposal

Residuals handling will include 100% liquid recycle with solids drying and disposal at a landfill. Hauling distance is estimated at 20 miles; disposal costs are estimated at $50 per cubic yard.

6 Evaluation

The PWB Filtration Team, including representatives of the Executive Team, met on June 20, 2018, to review the performance of the technology alternatives and reach a conclusion upon the preferred technology alternative. The decision model incorporated the values, criteria, and performance evaluation of the two technology alternatives. Throughout the evaluation and review, the team reminded itself that the decision model does not make the decision, the team does. This context assured that the decision model and the evaluation of alternatives were designed to inform the technical team and the Executive Committee, not make the decision for the team.

Three weighting scenarios were carried through the process to reflect the different perspectives of the PWB team members. The three weighting scenarios were:

1. Team Weighted (TW) – The PWB Filtration Team weights produced on March 27, 2018.
2. Equal Weights (EQ) – Equal weights among the eight values.
3. Split (SP) – A 60/40 split weighting where 40% of the weight remained with Public Health Water Quality (25%) and Reliability (15%) as identified in the team weighted scenario, and the remaining 60% was distributed equally among the other six values.

These weighting scenarios were carried through the evaluation process to demonstrate weighting sensitivity. The summary of these weights and their associated impacts on scoring are shown in Table 16.

Table 16: Weighting Scenarios Evaluation

ID#	Evaluation Criteria	TW	EQ	SP
1	**Public Health and Water Quality**	25	12.5	25
1.1	Log Removal	6.22	2.5	5
1.2	Ability to treat CECs	4.56	2.5	5
1.3	Aesthetics Goals: SMCLs	5.66	2.5	5
1.4	Scale-stability: Consistency	4.5	2.5	5
1.5	Chemical Impacts: Disinfection byproducts	4.06	2.5	5
2	**Resiliency/Reliability**	15	12.5	15
2.1	Earthquake: Days of Recovery	3.4	4.167	5
2.2	Catastrophic WQ Event: Days of Recovery	5.3	4.167	5
2.3	Routing WQ Events: Online %age	6.3	4.167	5
3	**Community Interests**	9	12.5	10
3.1	Local Impacts: Neighbors impacted	1.9	4.167	3.333
3.2	Consistency in Taste/Apearance: Scaling	4.2	4.167	3.333
3.3	Perception of Safety	2.9	4.167	3.333
4	**Cost Benefit**	12	12.5	10
4.1	Cost of Construction	5.4	6.25	5
4.2	Operating Costs	6.6	6.25	5
5	**Future Needs**	10	12.5	10
5.1	Capacity: Expansion potential	3.4	4.167	3.333
5.2	Future WQ: CEC treatment %age	3.2	4.167	3.333
5.3	Available Gravity Capacity: MGD	3.4	4.167	3.333
6	**Environmental Impacts**	7	12.5	10
6.1	Electricity Usage: Kilowatts per year	2.3	4.167	3.333
6.2	Residuals Produced: Volume	2.7	4.167	3.333
6.3	Fuel Consumption: Truck Trips	2	4.167	3.333
7	**Integration**	12	12.5	10
7.1	WTP Labor: FTEs	2.225	3.125	2.5
7.2	Chemical Use: Tons/Year	4.315	3.125	2.5
7.3	Corrosion Control Integration	2.629	3.125	2.5
7.4	System WQ: Suspended Solids	2.831	3.125	2.5
8	**Implementation**	10	12.5	10
8.1	Ease of Construction: Risk to schedule	4.2	6.25	5
8.2	Implementation Complexity: Risk to schedule	5.8	6.25	5

The performance ratings of the alternatives found in Table 8, and the weighting of the values and criteria found in Table 16 above, are the inputs for the evaluation of the site alternatives. The normalized performance rating multiplied by the weight and added across values and criteria produces a value score. Table 17 demonstrates these calculations.

Table 17. Value Score Calculations

A	B	C	D	E	F	G	H	I	J	K	L
	Weight %	Raw Ratings				Normalized Ratings		Value Scores (weight times normalized rating times 100)			
Value/ Criteria No.	TW	Minimum	Maximum	Conventional Filtration	Membrane Filtration	Conventional Filtration	Membrane Filtration	Conventional Filtration	Membrane Filtration	Value/Criterion	Assigned Weight (TW)
1.1	6.2%	7	10	7	10	0	1	0.0	6.2	**Public Health and Water Quality/**Log Removal	6.2
1.2	4.6%	30	30	30	30	0	0	0.0	0.0	**Public Health and Water Quality/**Ability to treat CEC's	4.6
1.3	5.7%	3	7	7	3	1	0	5.7	0.0	**Public Health and Water Quality/**Aesthetics Goals	5.7
1.4	4.5%	5	7	7	5	1	0	4.5	0.0	**Public Health and Water Quality/**Scale-stability	4.5
1.5	4.1%	5	8	8	5	1	0	4.1	0.0	**Public Health and Water Quality/**Chemical Impacts	4.1
2.1	3.4%	10	10	10	10	0	0	0.0	0.0	**Resiliency/Reliability/**Earthquake	3.4
2.2	5.3%	5	7	7	5	1	0	5.3	0.0	**Resiliency/Reliability/**Catastrophic WQ Event	5.3
2.3	6.3%	7	10	10	7	1	0	6.3	0.0	**Resiliency/Reliability/**Routing WQ Events	6.3
3.1	1.9%	143	82.5	143	82.5	0	1	0.0	1.9	**Community Interests/**Local Impacts	1.9
3.2	4.2%	7	10	10	7	1	0	4.2	0.0	**Community Interests/**Consistency in Taste Appearance	4.2
3.3	2.9%	5	7	7	5	1	0	2.9	0.0	**Community Interests/**Perception of Safety	2.9
4.1	5.4%	413	318	318	413	1	0	5.4	0.0	**Cost Benefit/**Cost of Construction	5.4
4.2	6.6%	20	13	13	20	1	0	6.6	0.0	**Cost Benefit/**Operating Costs	6.6
5.1	3.4%	5	10	10	5	1	0	3.4	0.0	**Future Needs/**Capacity	3.4
5.2	3.2%	30	30	30	30	0	0	0.0	0.0	**Future Needs/**Future WQ	3.2
5.3	3.4%	0	130	130	0	1	0	3.4	0.0	**Future Needs/**Available Gravity Capacity	3.4
6.1	2.3%	47	13	13	47	1	0	2.3	0.0	**Environmental Impacts/**Electricity Usage	2.3
6.2	2.7%	3630	1900	3630	1900	0	1	0.0	2.7	**Environmental Impacts/**Residuals Produced	2.7
6.3	2.0%	322	237	322	237	0	1	0.0	2.0	**Environmental Impacts/**Fuel Consumption	2
7.1	2.2%	12	12	12	12	0	0	0.0	0.0	**Integration/**WTP Labor	2.2
7.2	4.3%	5770	3290	5770	3290	0	1	0.0	4.3	**Integration/**Chemical Use	4.3
7.3	2.6%	10	10	10	10	0	0	0.0	0.0	**Integration/**Corrosion Control	2.6
7.4	2.8%	10	10	10	10	0	0	0.0	0.0	**Integration/**System WQ	2.8
8.1	4.2%	8	10	8	10	0	1	0.0	4.2	**Implementation/**Ease of Construction	4.2
8.2	5.8%	5	10	10	5	1	0	5.8	0.0	**Implementation/**Implementation Complexity	5.8
							Total Value Scores (sum of all values/criteria value scores):	59.8	21.3		

Columns K and L in Table 17 list the values and criteria and their associated weights. In the calculation in Table 17, the weights that are showcased are those associated with the Team weighting scheme (TW) in Table 16. Column B of Table 17 displays the weight percentage of each value/criterion. This weight percentage is the number that is carried through the evaluation calculation.

Columns E and F summarize the performance ratings of each capacity alternative. These are the same numbers that are presented in Table 8 and further characterized in Sections 4.2 through 4.9. Columns C and D reflect the minimum and maximum performance ratings among the alternatives. Columns G and H are the normalized performance ratings of the three alternatives. Normalization (calculating performance in a 0 to 1 scale) is done for all performance scales to allow for common application in the evaluation. Regardless of the scale used to demonstrate performance of the alternatives (e.g., performance scale of site acres for Community Interests/Local Impacts), normalization produces a 0 for the worst performer and a 1 for the best performer within each value/criterion.

Columns I and J in Table 17 are the calculated values scores for each value/criterion. This is the multiplication of the weight (Column B) times the Normalized Rating (Column G or H) times 100 (the 100 is just to make the result a more manageable number). As an example, the 6.2% of Column B in row 1.1, reflecting the weight of Public Health and Water Quality/Log Removal is multiplied by the 1 in Column H, reflecting the normalized performance rating of membrane filtration, then multiplied by 100 to produce the 6.2 result in Column J. The calculations within each cell of Columns I and J reflect the contribution of value the respective alternative receives from the specific value/criteria. The summation of these contributions down Column I or J produces the total value score for each capacity alternative. Value scores for each value/criterion for each alternative are added to produce a total value score. These total values scores demonstrate, relatively, how well the alternatives perform against the values and criteria. The higher the number, the better the relative performance.

Figures 10, 11, and 12 demonstrate the performance of the two technology alternatives within the three difference weighting scenarios. The numbers below each stacked bar present the summation of the value score. Each color of the stacked bar represents the contribution the alternative received from each value. Each value has criteria that are used to gauge the performance of the alternatives. The size of the colored bar is determined by multiplying the performance score of the alternative by the weight of the specific criterion (as shown in Table 17). The results of the criteria scores are then added to produce the total contribution per value, and then summed across all values and criteria to produce the total value score for each alternative. The higher the total score, the higher the collective performance of the alternative against the values.

Figure 10: Team Weighting Value Scores

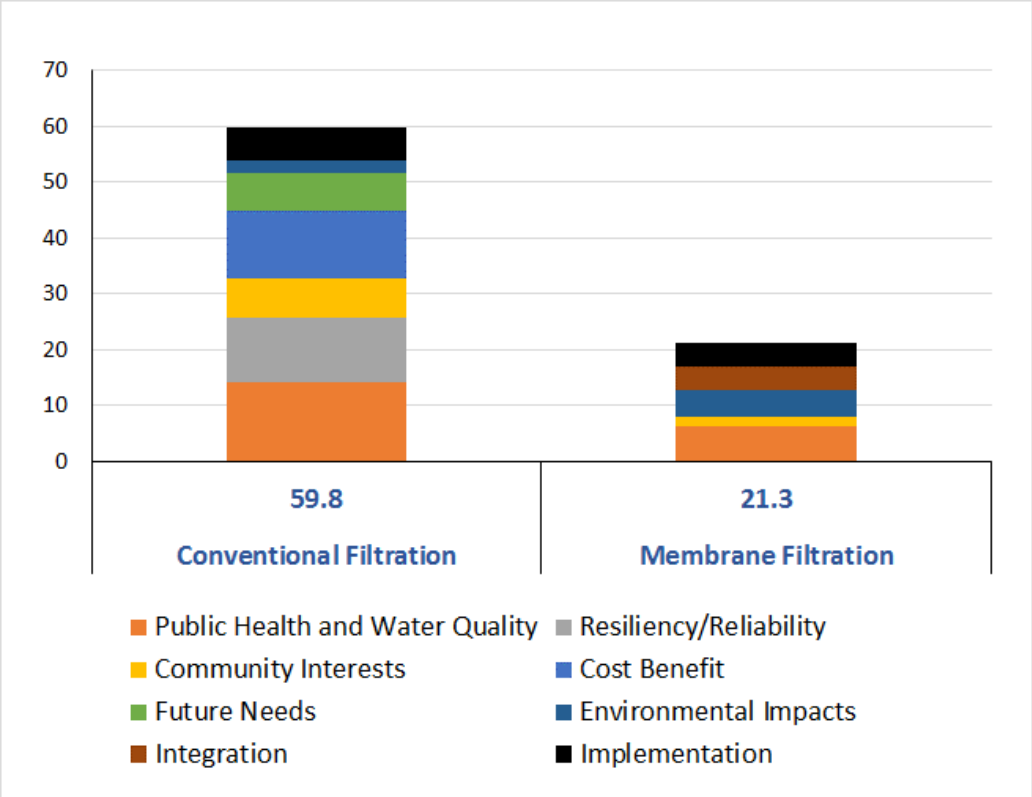


Figure 11: Equal Weighting Value Scores

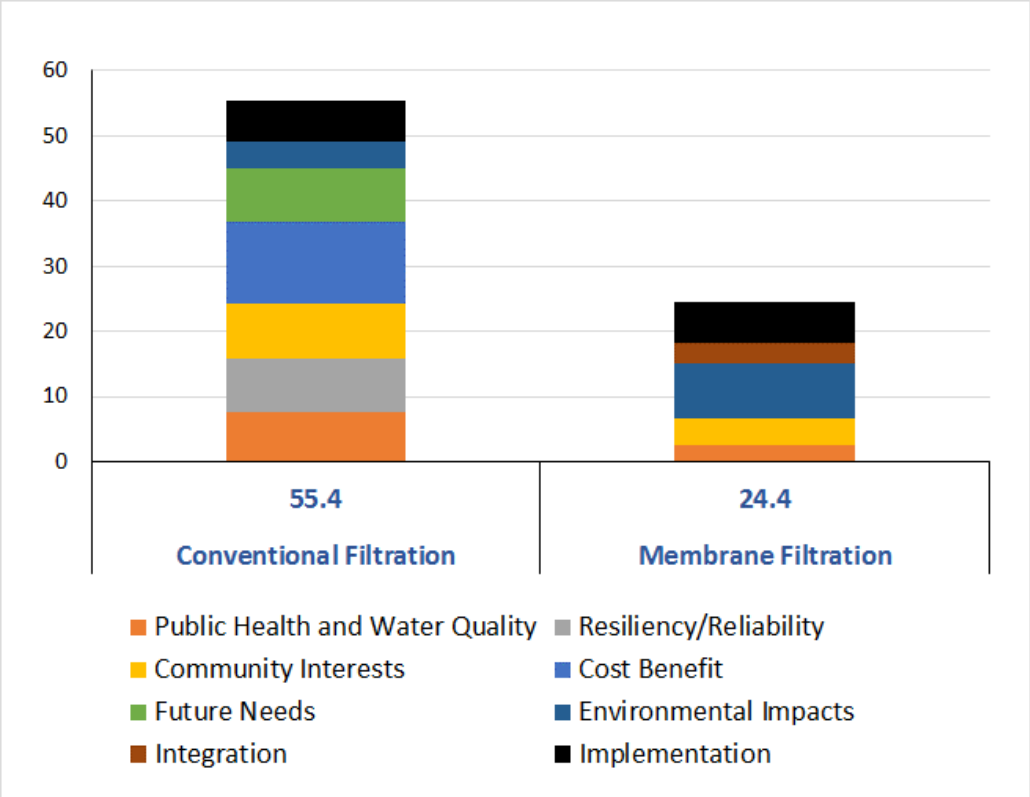
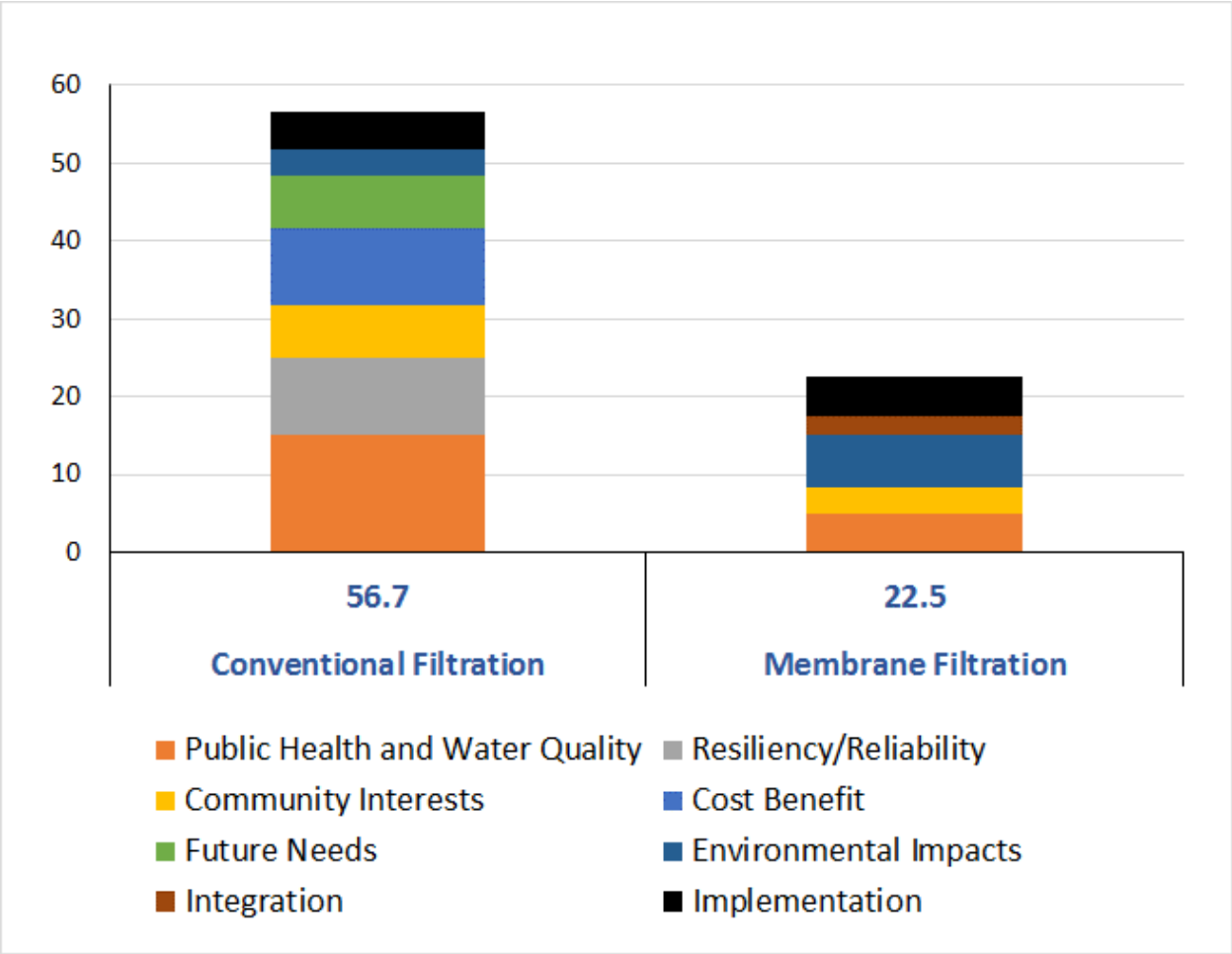


Figure 12: 60/40 Split Weighting Value Scores



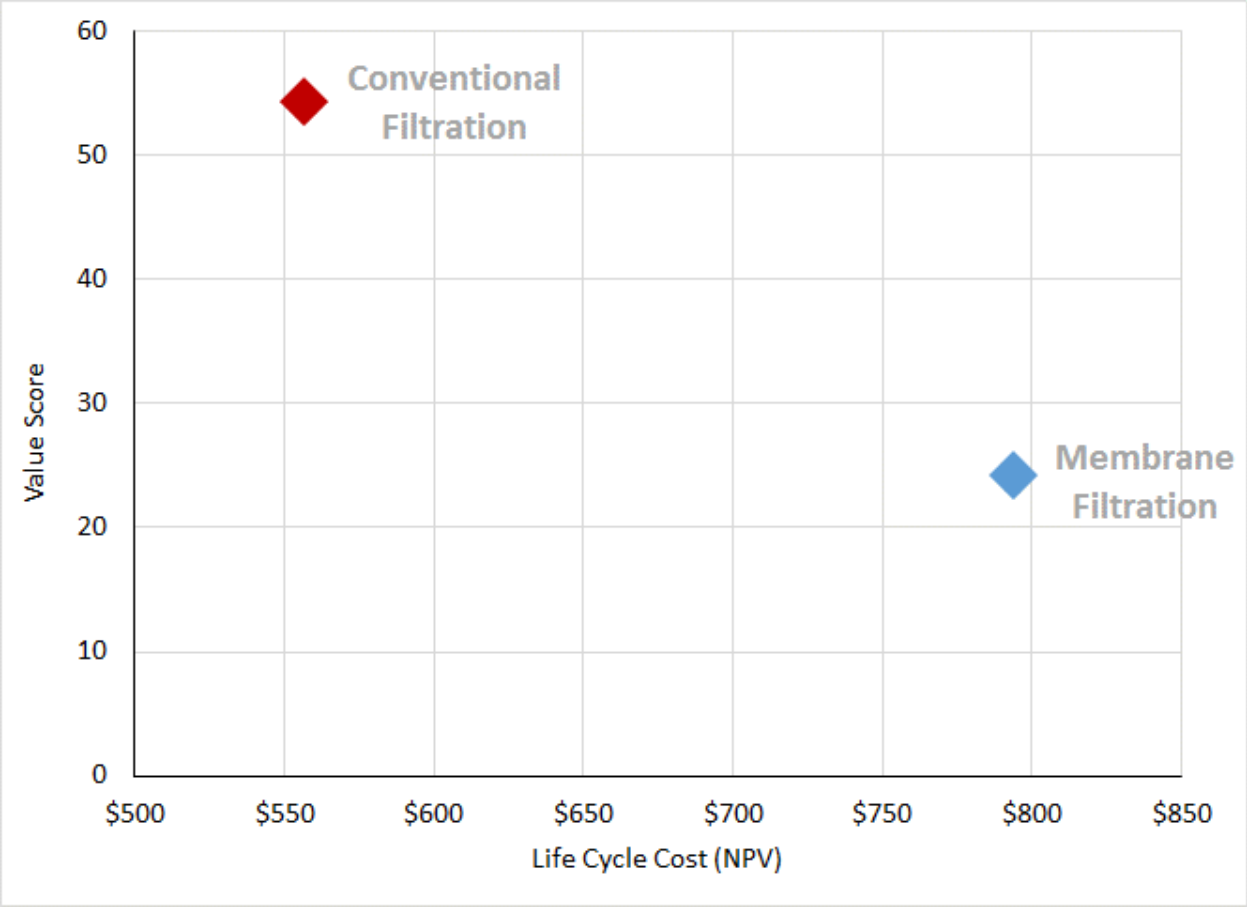
In all three weighing schemes, the Conventional Filtration alternative results in higher performance.

Another means to evaluate the performance of the alternatives is to contrast the total lifecycle cost of the alternatives against their total decision score. To avoid double counting of the cost element, the Cost Benefit value is removed from the calculation of the decision score. The lifecycle cost is the addition of the construction cost and 25 years of operating costs. The resulting total value score is then graphically plotted against the lifecycle cost (see Figures 13, 14, and 15).

This comparison also allows for a calculation of the investment required per unit of value. The table associated with the scatter plot presents the total cost ($M) to gain a unit of value. The same three weighting scenarios are evaluated.

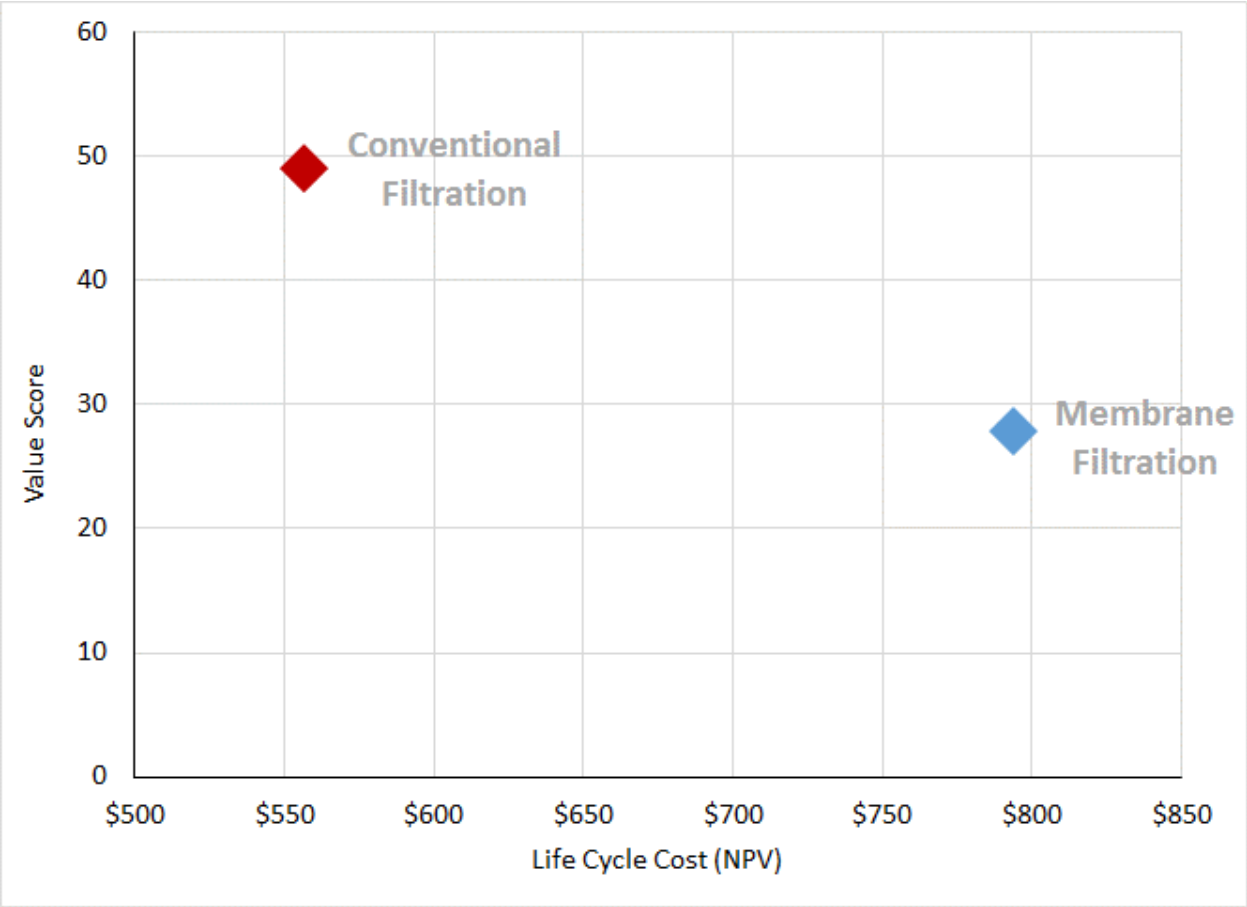
The results indicate that the Conventional Filtration alternative provides greater value at less cost. The Membrane Filtration option costs more and provides less value; therefore, the additional value per million dollars invested is a negative number when moving from the Conventional to the Membrane Filtration. Conventional Filtration is the superior alternative in both value and cost in all three weighting scenarios.

Figure 13: Team Weighting Scatter Plot and Table



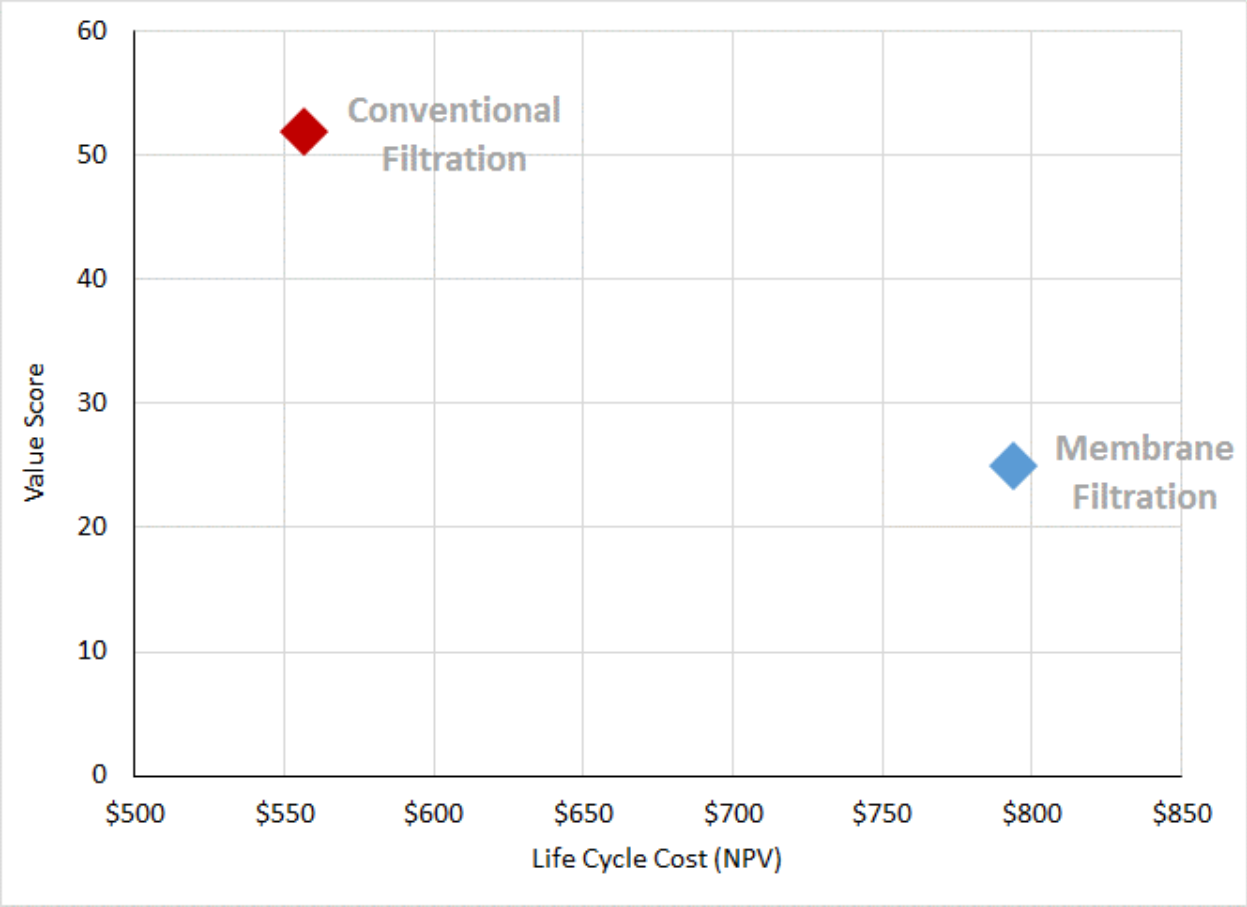
	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
Conventional	54.3	$ 557.00	$ 10.25	---	---	---
Membrane	24.2	$ 794.00	$ 32.75	-30.1	$ 237.00	-7.87

Figure 14: Equal Weighting Scatter Plot and Table



	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
Conventional	49.0	$ 557.00	$ 11.36	---	---	---
Membrane	27.9	$ 794.00	$ 28.50	-21.2	$ 237.00	-11.18

Figure 15: 60/40 Split Weighting Scatter Plot and Table



	Value Score	Lifecycle Cost $M	$M per unit of value (lower better)	Additional value	Additional Lifecycle Cost $M	Additional $M per unit of value
Conventional	51.9	$ 557.00	$ 10.74	---	---	---
Membrane	25.0	$ 794.00	$ 31.76	-26.9	$ 237.00	-8.83

This scatter plot view and associated table demonstrate the superior performance benefit of Conventional Filtration.

The Filtration Team used this performance evaluation to inform their discussion.

7 Summary and Recommendation

PWB has generated a significant amount of source water quality data and pilot testing results that are directly applicable to decisions made on filtration technology for Bull Run. The water has turbidity levels that average 0.4 NTU, with some episodes of elevated color. Algal blooms are not apparent in the source water monitoring, but future changes in how the water is withdrawn from the reservoir could exacerbate that.

Information was presented on the treatment technologies used by large water treatment plants in North America. The clear majority (146) of the facilities use granular media filtration. Thirty-eight (38) use granular media as part of their biological filtration system and very few (4) use membrane filtration. Only one large plant, Salem, Oregon, is using slow sand filtration technology.

For each of the three technologies used by large treatment systems, an evaluation of the technology's ability to provide the benefits important to the community and PWB staff was conducted. The evaluation was performed in two phases: a screening phase to identify how the treatment systems could be configured to meet the required treatment benefits, and a cost-development phase. A rigorous multivariate decision process was used to select the preferred technology.

Both the technical team and the Executive Committee concluded granular media filtration, which includes conventional and direct filtration, as the preferred technology alternative for treatment of Bull Run water.

Appendices

A. Bull Run Intake Water Quality

B. Bull Run Filtration Pilot Testing Summary

C. Summary of Existing Large Water Treatment Plant Technologies

D. References

E. CPES Model Cost Estimate

Appendix A

Technical Memo

Date:	September 18, 2018
Project:	Bull Run Filtration Project 699275.01.03
To:	Portland Water Bureau Filtration Decision Team
Copy to:	HDR, Barney &Worth
Prepared by:	Lee Odell
Approved by:	Kelly Irving
Subject:	**Bull Run Intake Water Quality**

Introduction

The purpose of this technical memorandum is to provide a summary of the intake water quality for the Bull Run Intake. Data for the past 10 years, from January 2007 through December 2017, were reviewed.

Bull Run Water Quality Summary

Raw water quality was reviewed and summarized as a first step in evaluating filtration technologies. Examining the raw water quality can help identify the appropriate filtration technology. For example, if high levels of algae were present in a drinking water source, that may indicate the need for clarification prior to filtration. Table 1 shows a summary of intake water quality parameters that were available for the Bull Run Supply over the past 10 years, except microbiological measures, for the intake. Microbiological water quality parameters are presented later in this TM. A summary of water quality analytes is provided as Attachment A at the end of this Technical Memorandum.

Table 1. Water Quality Parameter Data Summary from the Bull Run Intake, 2007-2017

	Algae #/ml	Color C.U.	TOC, mg/L	DOC, mg/L	UV_{254}, mg/L	Fe, ug/L	Mn, ug/L	Temp C	pH, s.u.	TSS, mg/L	Turb, NTU	ALK, mg/L as $CACO_3$
Maximum	3340	75	4.1	6.58	0.110	223	55.7	18.7	7.6	16	17	18
Average	291	11	1.09	2.08	0.047	46	9.9	9.5	7.1	1.0	0.4	7.8
Minimum	4.1	6	0.67	0.35	0.024	0	1.1	2.5	6.3	0.5	0.1	4.1
# of samples	1067	3826	329	28	286	209	212	3022	4439	210	6819	573

Note: Abbreviated terms defined in following text.

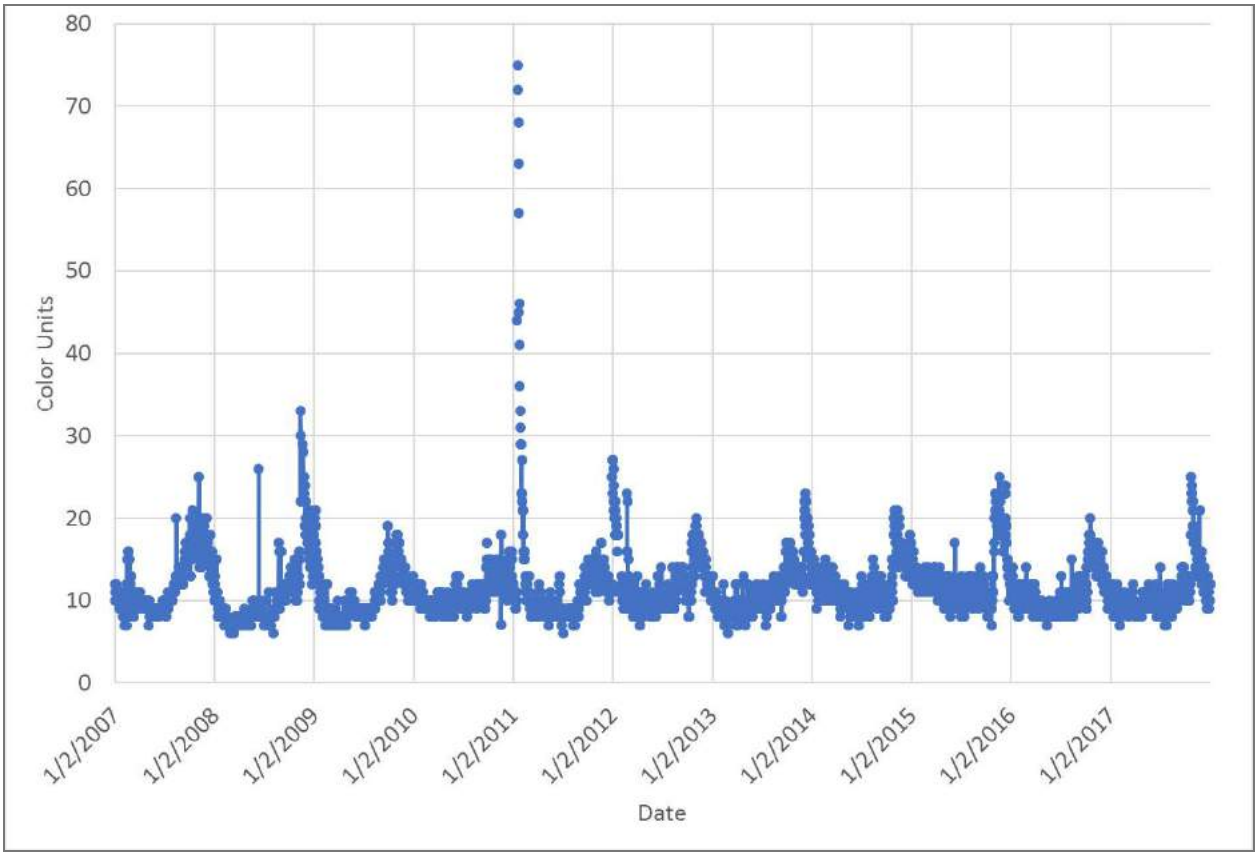
Algal analysis is done using the Whipple grid method by counting algal presence in 30 fields of view at 1,000X magnification, and reported as natural counting units (e.g., cells, colonies, filaments) per milliliter. Comparing these numbers to other methods, which use cell/mL or biovolume, would be misleading.

Algae data include 1,067 data points collected in seven different data sets. Most of the algae data were collected and analyzed by Portland Water Bureau (PWB) staff while about 3% of the samples were tested by an outside contractor.

Discussion of algae levels and their effect on selection of a water treatment process is not straightforward. Some northwest surface supplies such as Bellingham and Salem OR have recorded algal counts in excess of 1,000,000 colonies/mL during filter clogging events. Yet, other sources such as AWWA's operator training program define an algae bloom as 2,000 colonies/mL and still others have noted that as few as 3 colonies of specific cyanobacteria such as Uroglena (Schafran, 2016) can cause taste and odor events. In addition, the Water Bureau's intake supply can come from the various levels of the Bull Run Reservoir, to manage the release of colder water during critical periods to improve fish habitat. This variation can result in a range of algal counts from 4.1 to 3,340 colonies per ml (Table 1). A time series graph was not provided because the typical algae levels recorded at the intake are well below any definition of a large bloom and may not represent future conditions.

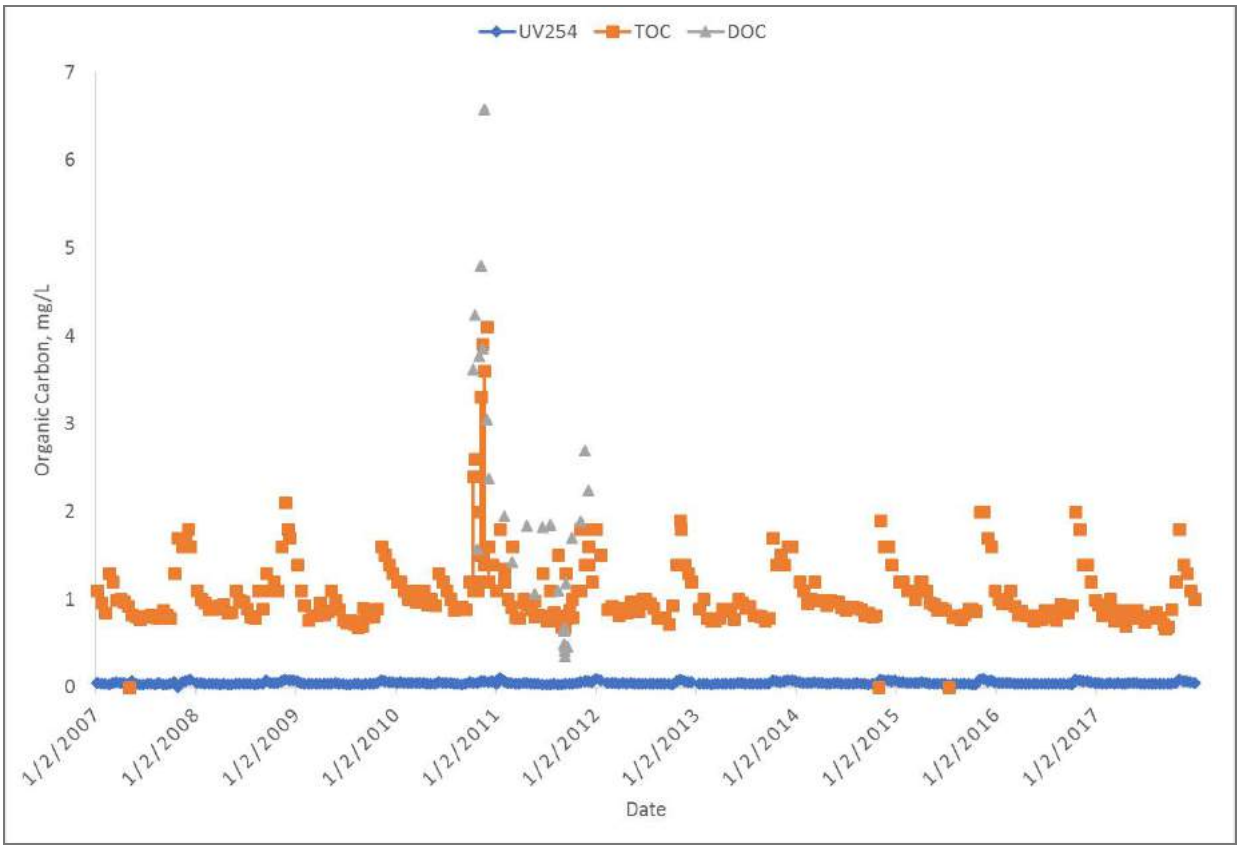
Color is routinely collected by treatment operators, which represents nearly 85% of the data. Some additional samples were analyzed by Bureau staff and a contract lab. Average color in the water is 11 color units (c.u.), which is less than the EPA's secondary maximum contaminant level (MCL) standard of 15. Color does exceed 15 c.u. each fall or winter. Figure 1 shows a time series chart of color over the 10-year period.

Figure 1. Bull Run Intake Water Color, 2007-2017



For total organic carbon (**TOC**), dissolved organic carbon (**DOC**) and **UV_{254}**, there is a limited data set. The average TOC in 329 samples collected over the 10-year period shows an average concentration of 1.1 mg/L and a maximum concentration of 4.1 mg/L. DOC was tested during a Water Research Foundation project in 2010 and 2011, and the data set is limited to 28 samples collected at the intake. There were 286 samples tested for UV_{254}. This data shows low levels of organic compounds that react to that specific wavelength of UV light. Figure 2 shows a time series plot of TOC, DOC and UV_{254}. Some DOC levels appear higher than TOC levels. The DOC samples were conducted by a consultant as part of a Water Research Foundation project and did not necessarily use the same analytical method as PWB normally uses.

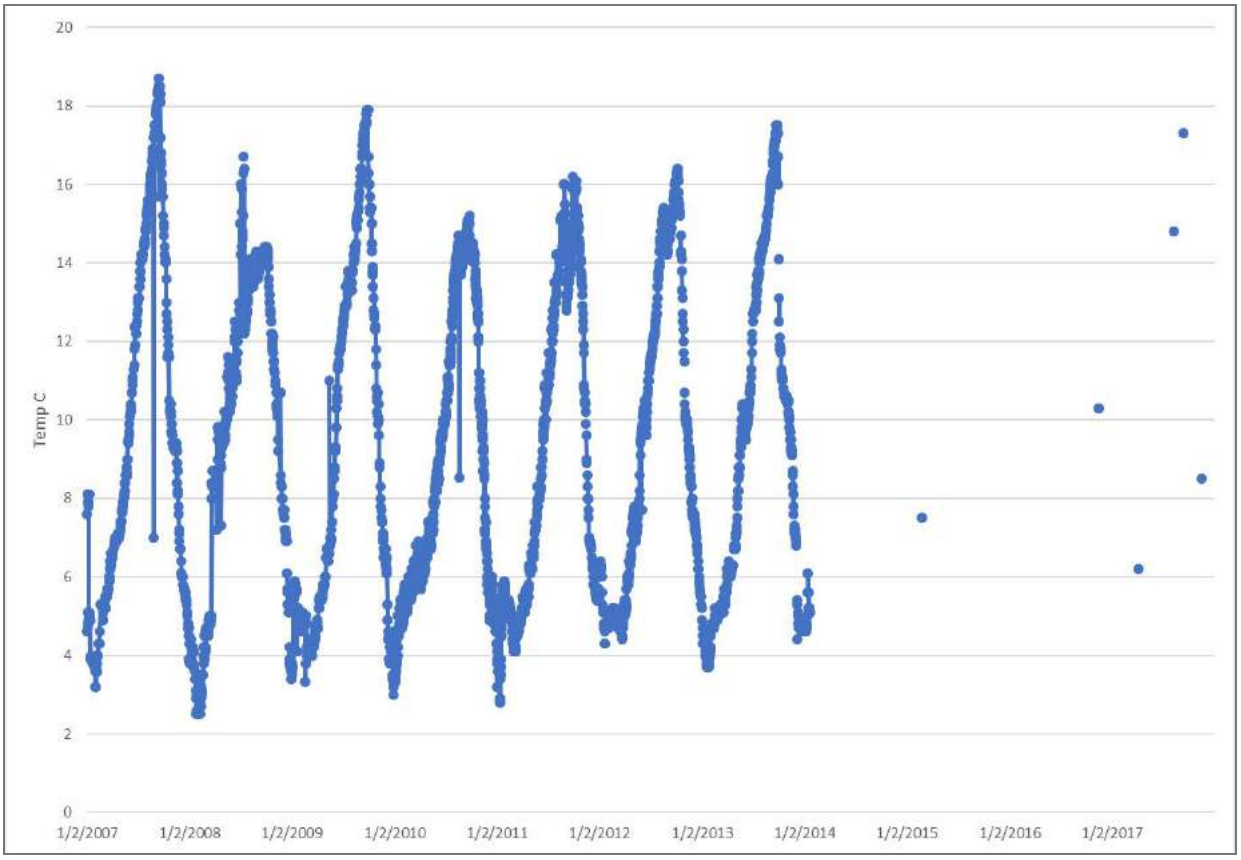
Figure 2. Bull Run Intake TOC, DOC and UV254, Time Series 2007-2017



Iron (**Fe**) concentrations in the raw water average 46 micrograms per liter (ug/L), far below the secondary MCL of 300 ug/L. Even the maximum value recorded is less than the MCL, therefore no graph was provided. Manganese (**Mn**) concentrations average only 9.9 ug/L, well below the secondary MCL of 50. Some systems have established a treatment goal of 20 ug/L for manganese to prevent scale buildup in the distribution system. For manganese, 33 samples of the 212 samples (16%) were 20 ug/L or greater.

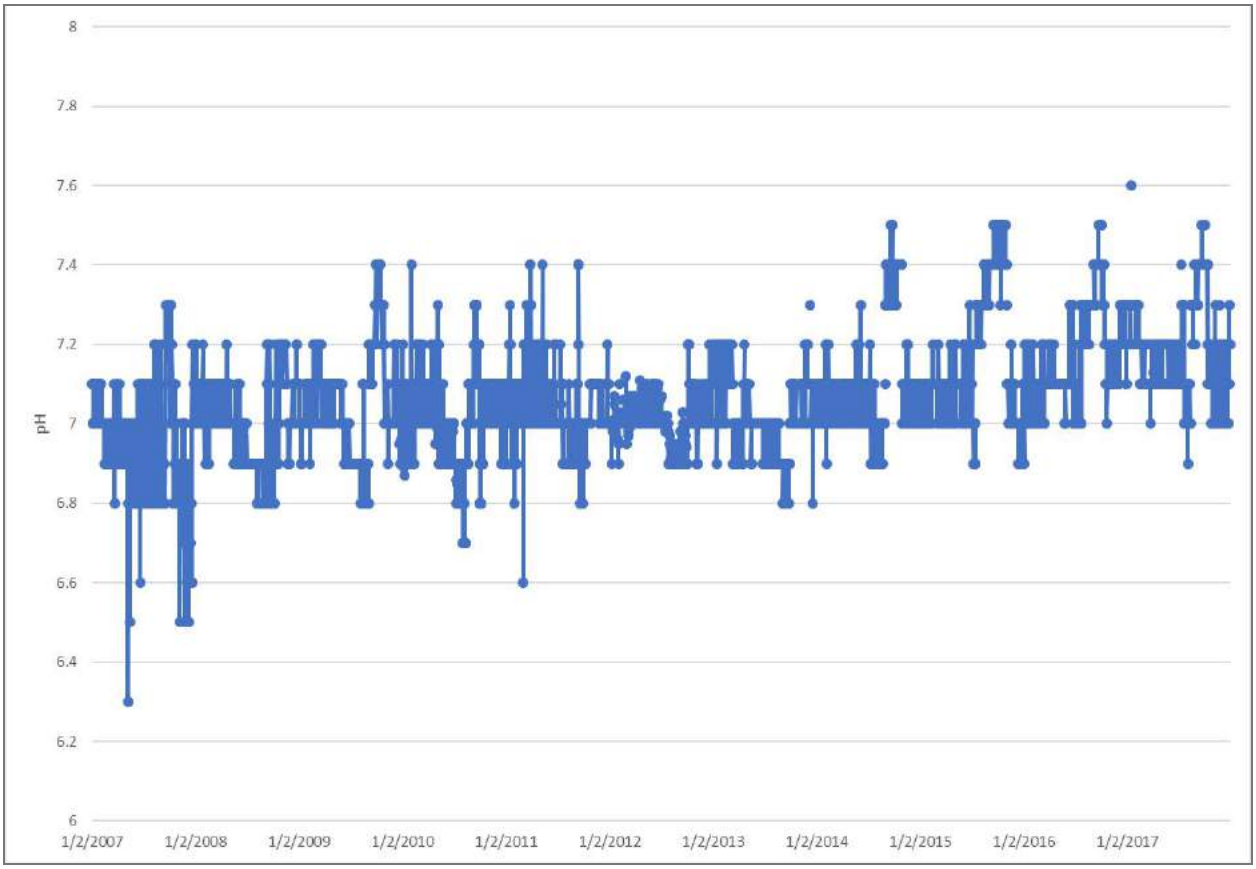
Water **temperature** is routinely collected by the treatment operators. Temperatures ranged from 2.5 to 18.7 degrees C. Figure 3 shows a time series plot of temperature.

Figure 3. Water Temperature at Bull Run Intake, Time Series 2007-2017



The intake **pH** varies from 6.3 to 7.6 standard units (s.u.). Samples are routinely collected by the treatment operators, as well as additional samples by Bureau staff. Figure 4 shows the pH over the 10-year period.

Figure 4. Bull Run Intake pH, Time Series 2007-2017



Total suspended solids (**TSS**) samples were collected 210 times over the 10-year period. The range was 0.5 to 16 mg/L and averaged 1 mg/L. Because TSS has the same trend as turbidity and turbidity is more widely used in filtration evaluations, TSS data is not shown graphically

Turbidity was collected frequently over the period by treatment operators and recorded continuously by the SCADA system. The SCADA system continues to record the influent turbidity when the system is off-line during turbidity events. The turbidimeter is located within the intake chamber and since no water is flowing through the intake chamber when the system is off-line, it does not capture the turbidity peaks during these events. The turbidity measurement was recorded once or twice per day in the data set from the SCADA system. The data set includes 6,819 readings. The average turbidity is 0.4 nephelometric turbidity units (NTU) and the maximum value was 17 NTU. Figure 5 shows a time series plot of turbidity over the period and Figure 6 shows a probability distribution for turbidity. The distribution shows that 99.9% of samples are less than 11 NTU, 99.5% of samples are less than 4 NTU, and 99% of samples are less than 3 NTU.

Figure 5. Bull Run Intake Turbidity, Time Series 2007-2017

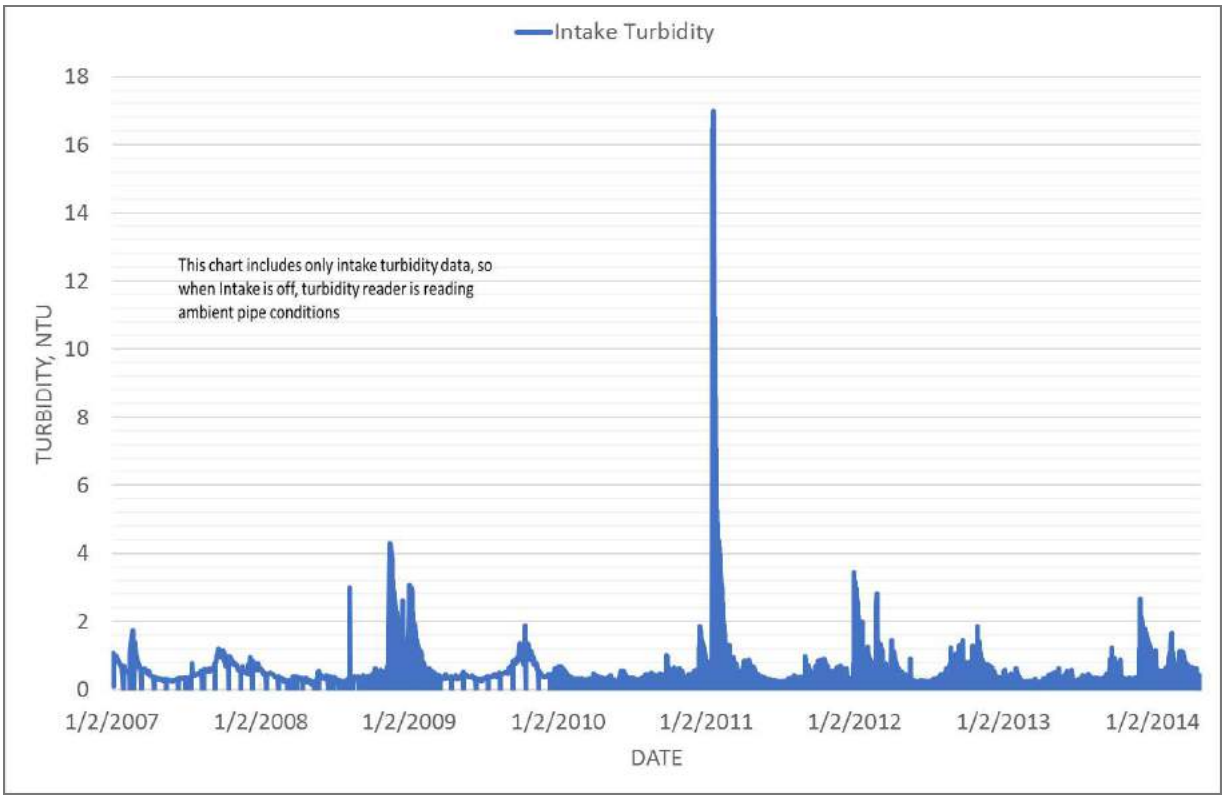
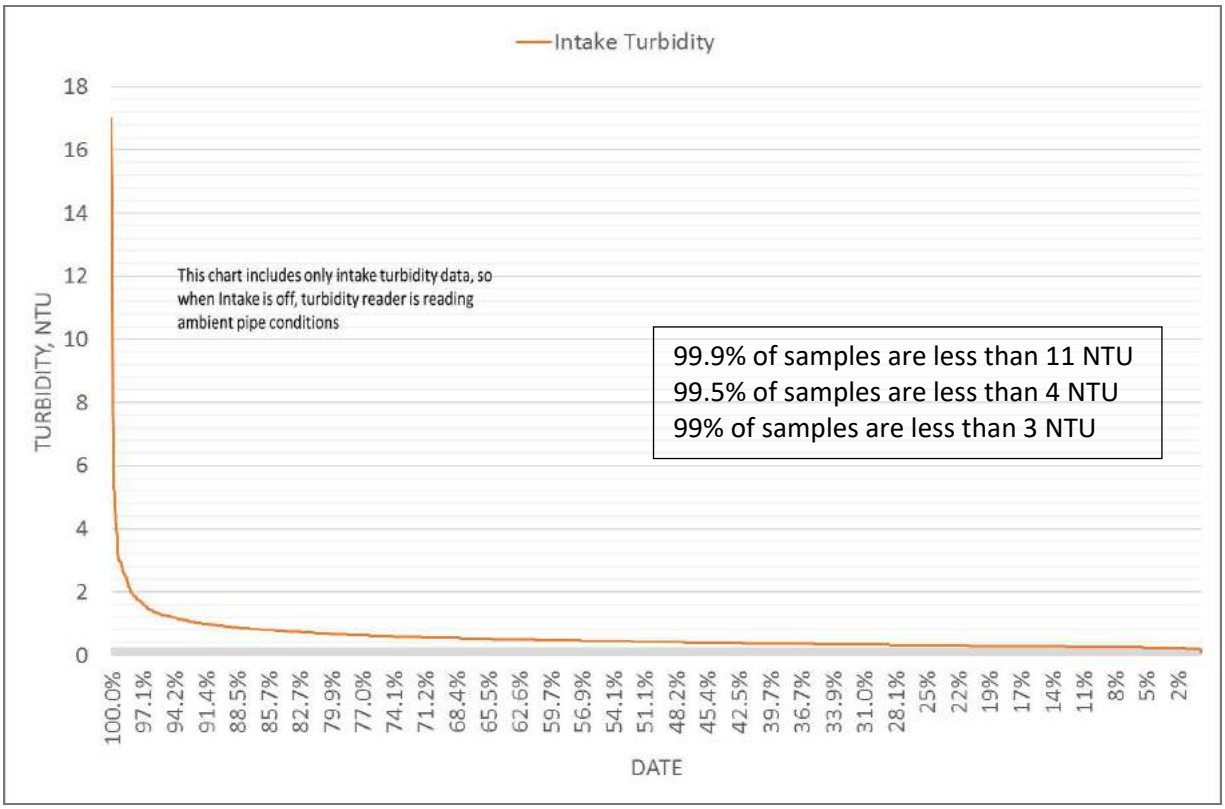
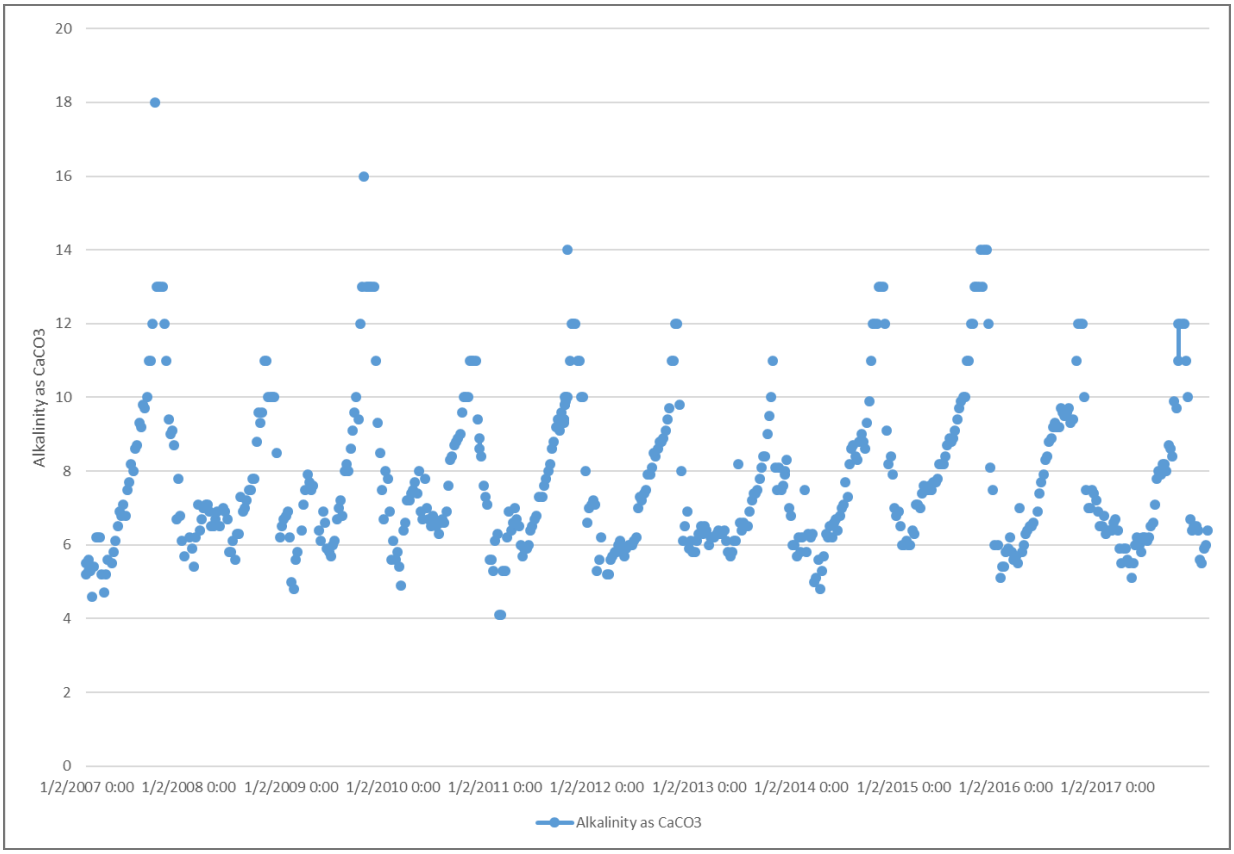


Figure 6. Bull Run Intake Turbidity Distribution, Time Series 2007-2017



Raw water **alkalinity** levels range between 4 and 18 mg/L as $CaCO_3$, with an average of 7.8 mg/L as $CaCO_3$, as shown in Figure 7.

Figure 7. Bull Run Intake Alkalinity, Time Series 2007-2017



Summary of Microbiology Data

Microbiological water quality can impact the selection of filtration technology, especially if microbiologically concentrations indicate the source water is degraded. Table 2 shows concentrations of *Cryptosporidium* oocysts, E. Coli, fecal coliforms, *Giardia* oocysts, and total coliform at the intake. These indicators demonstrate that the watershed is well protected, and that microbiological quality of the source is very good. To remain unfiltered, Portland had to conduct rigorous monitoring and demonstrate low levels of microbiological contaminants since the 1989 passing of the surface water treatment rule filtration avoidance criteria.

Table 2: Bull Run Intake Microbiological Water Quality

	CRYPTOSPORIDIUM, OOCYSTS/L	GIARDIA, OOCYST/L	E. COLI, CFU/ML	FECAL COL., CFU/ML	TOTAL COL., CFU/ML
Maximum	0.18182	0.270	55.6	47	1203
Average	0.00074368	0.0036	2.7	2.1	1160
Minimum	Not Detected	Not Detected	Not Detected	Not Detected	1
Number of Samples	2243	3314	1310	1096	4278

References

Schafran, Gary C., 2016, Controlling Alae Related Tastes and Odors, VA AWWA Water Quality and Research Committee Seminar

Attachment A

Intake Water Quality Analytes

Analysis Code	Analyte	Unit	Method Reporting Limit	Analysis Method
ALG-T	Algae, total	cells/ml	1	SM10200A-F
ALG-T	Algae, total	units/mL	0	SM10200A-F
ALG-TX	Algae, total by contract lab	#/ml	1	ML/SM 10200F
ALG-V	Algae, viable	cells/ml	1	SM10200A-F
ALG-V	Algae, viable	units/mL	0	SM10200A-F
ALG-V	Algae, viable	units/mL	1	SM10200A-F
ALG-VX	Algae, viable by contract lab	cells/ml	0	SM10200A-F
ALK-T	Alkalinity, total by lab	mg/L as CaCO3	1	SM2320B
ALK-T	Alkalinity, total by lab	mg/L as CaCO3	2	SM2320B
ALK-T	Alkalinity, total by lab	mL	1	SM2320B
ALK-TX	Alkalinity, total, by contract lab	mg/L as CaCO3	2	SM2320B
ALK-TX	Alkalinity, total, by contract lab	mg/L as CaCO3	9	SM2320B
COLOR-A	Color, Apparent, by lab	units	5	SM2120F
COLOR-ATO	Apparent Color, by Treatment Operator (TO)	units	5	HM 10048
COLORX	Color, by contract lab	units	5	SM2120B
CRYPT-C	Crypto count			
CRYPT-CNC	Crypto count, Non-Compliance			
CRYPT-CX	Crypto count, by contract lab			
CRYPT-CX	Crypto count, by contract lab			
CRYPT-DL	Crypto detection limit			
CRYPTO	Crypto per L	oocysts/L		
CRYPTOX	Crypto per 100 L, by contract lab			
DOC	Dissolved organic carbon	mg/L	0.1	SM5310C
DOCX	Dissolved organic carbon, by outside lab	mg/L	0.5	SM5310C
EC-NAM	E. Coli by NA/MUG		1	SM9221 F
EC-QTY	E. Coli Quanti-Tray, by lab	MPN/100mL		SM9223 B QTY
EC-QTY	E. Coli Quanti-Tray, by lab	MPN/100mL		SM9223 B QTY
EC-QTY18	E. Coli Quanti-Tray - 18 Hr	MPN/100mL		SM9223 B QTY
EC-QTY18	E. Coli Quanti-Tray - 18 Hr	MPN/100mL		SM9223 B QTY
EC-QTY-TO	E. Coli Quanti-Tray, by TO	MPN/100 mL		SM9223 B QTY
EC-QTYX	E. Coli by Quantitray, by contract lab			SM9223 B QTY
FC-MF	Fecal coliform, membrane filter (MF)	cfu/100 ml		SM9222 D
FC-MF	Fecal coliform, membrane filter	cfu/100 ml		SM9222 D
FC-MFX	Fecal coliform, MF, by contract lab	cfu/100 ml		SM9222 D
FE	Iron	mg/L	0.2	SM3111B
FE-DX	Iron, dissolved, by contract lab	mg/L	0.01	EPA 200.7
FE-DX	Iron, dissolved, by contract lab	mg/L	0.02	EPA 200.7
FE-ICPMS	Iron, by ICPMS	ug/L	5	EPA 200.8
FEX	Iron, by contract lab	mg/L	0.01	EPA 200.7
FEX	Iron, by contract lab	mg/L	0.02	EPA 200.7
FEX	Iron, by contract lab	mg/L	0.03	EPA 200.7
GIARD-C	Giardia count			
GIARD-CNC	Giardia count, non-compliance			
GIARD-CX	Giardia count, by contract lab			
GIARD-CX	Giardia count, by contract lab			
GIARD-DL	Giardia detection limit			
GIARDIA	Giardia per L	cysts/L		
GIARDIAX	Giardia per 100 L, by contract lab			
MN	Manganese	mg/L	0.005	SM3111B
MN	Manganese	mg/L	0.03	SM3111B
MN-DX	Manganese, dissolved, by contract lab	mg/L	0.0006	EPA 200.7
MN-ICPMS	Manganese, by ICPMS	ug/L	0.5	EPA 200.8
MN-ICPMS	Manganese, by ICPMS	ug/L	0.5	EPA 200.8
MNX	Manganese, by contract lab	mg/L	0.00005	EPA 200.7

Analysis Code	Analyte	Unit	Method Reporting Limit	Analysis Method
MNX	Manganese, by contract lab	mg/L	0.00006	EPA 200.7
MNX	Manganese, by contract lab	mg/L	0.0001	EPA 200.7
MNX	Manganese, by contract lab	mg/L	0.0003	EPA 200.7
MNX	Manganese, by contract lab	mg/L	0.0006	EPA 200.7
MNX	Manganese, by contract lab	mg/L	0.005	EPA 200.7
PH	pH by lab	units	0.1	SM4500-H B
PH-ALK	pH by lab, for alkalinity	units	0.1	SM4500B
PH-TO	pH by TO	units	0.1	SM4500B
PH-WQ	pH by WQ Insp	units		SM4500B
SOLID-SS	Solids, total suspended	mg/L	0.5	SM2540D
SOLID-SS	Solids, total suspended	mg/L	1	SM2540D
SOLID-SS	Solids, total suspended	mg/L	1	SM2540D
SOLID-SSX	Solids, total suspended, by contract lab	mg/L	5	SM2540 D
TC-ATYP	Total coliform, atypical count (MF test)	cfu/100 ml	1	SM9222B
TC-MF	Total coliform, membrane filter	cfu/100 ml	1	SM9222 B
TC-MF	Total coliform, typical count (MF Test)	cfu/100 ml	1	SM9222 B
TC-NC	Total coliform, non-coliform (MF Test)	cfu/100 ml	1	SM9222B
TC-QTY	Total coliform by Quanti-Tray, by lab	MPN/100 mL	1	SM9223 B QTY
TC-QTY18	Total coliform by Quanti-Tray - 18 Hr	MPN/100 mL	1	SM9223 B QTY
TC-QTY-TO	Total coliform by Quanti-Tray, by TOs	MPN/100 mL	1	SM9223 B QTY
TC-QTYX	Total coliform by Quantitray, by cont. lab		1	SM9223 B QTY
TEMPW	Temperature, Water, by lab	degrees C	0.1	SM2550B
TEMPW-TO	Temperature, Water, by TO	degrees C	0.1	SM2550B
TEMPW-WB	Temperature, Water, by WB Personnel	degrees C		SM2550B
TEMPW-WQ	Temperature, Water, by WQ Insp	degrees C	0.1	SM2550B
TOC	Total organic carbon	mg/L	0.1	SM5310C
TOC	Total organic carbon	mg/L	0.3	SM5310C
TOC	Total organic carbon	mg/L	0.3	SM5310C
TOCX	Total organic carbon, by contract lab	mg/L	0.5	SM5310C
TURB	Turbidity, by lab	NTU	0.05	SM2130B
TURB	Turbidity, by lab	NTU	0.1	SM2130B
TURB	Turbidity, by lab	NTU	0.3	SM2130B
TURB-TO	Turbidity, by TO	NTU	0.05	SM2130B
TURB-TO-END	End turbidity, crypto/giardia by TO	NTU	0.05	SM2130B
TURB-TO-OLTIME	Online turbidity reading time, by TO			
TURB-TO-OLTIME	Online turbidity reading time, by TO			
TURB-TO-START	Start turbidity, crypto/giardia by TO	NTU	0.05	SM2130B
TURB-WQ	Turbidity by WQ Insp	NTU	0.05	SM2130B
TURBX	Turbidity, by contract lab	NTU	0.2	EPA 180.1
UV_{254}	UV_{254}	absorbance/cm	0.001	SM5910B
UV_{254}	UV_{254}	absorbance/cm	0.005	SM5910B
UV_{254}	UV_{254}	absorbance/cm	0.005	SM5910B
UV_{254X}	UV_{254}, by contract lab	absorbance/cm	0.001	SM5910B

Appendix B

Technical Memo

Date:	August 30, 2018
Project:	Bull Run Filtration Project 699275.01.03
To:	Portland Water Bureau Filtration Decision Team
Copy to:	HDR, Barney &Worth
Prepared by:	Lee Odell
Approved by:	Kelly Irving
Subject:	**Bull Run Filtration Pilot Testing Summary**

Introduction

Between February 1990 and April 1993, the Portland Water Bureau (PWB) produced seven reports pertaining to pilot testing conducted by James M. Montgomery, Inc., in the Bull Run Watershed, as follows:

- Alternatives Analysis (JMM, 1990a),
- Pre-Design Report (JMM, 1990b),
- Equipment Specifications (JMM 1991a),
- Disinfection Report (JMM 1991b),
- Chloramination Chemistry Study (JMM 1991c),
- Pilot Plant Study (JMM 1992a),
- Preliminary Facility Plan (JMM 1992b),
- Summary Report (JMM 1993).

In addition, the Water Bureau participated in a Water Research Foundation pilot study to evaluate the microbial removal capabilities of low pressure membranes (MWH Americas, 1997) and an EPA Environmental Verification Pilot Study using the Zenon ZeeWeed® ZW-500 submerged membrane in June 2001.

This section of the TM summarizes the key findings from each of these pilot efforts.

Bull Run Media Filtration Pilot Testing Summary

The 1990-1993 pilot testing identified above successfully demonstrated media filtration with ozone at high loading rates with a wide range of media configurations.

Granular media filtration pilot testing was completed in several phases. First, water chemistry was evaluated, followed by studies examining pre-oxidation, flocculation, filter media and loading rates, heterotrophic plate count control, disinfection by product formation, elevated turbidity performance,

and finally *giardia* challenge testing. A set of pilot testing goals was developed for the testing, as shown in Table 1.

Table 1. Portland Media Pilot Filtration Pilot Testing Goals

Parameter	Pilot Testing Goal
Filtered Water Turbidity	0.1 NTU
Particle Removal 4-7 microns 5-15 microns	 99% 99%
Giardia cyst Removal	99%
Virus Removal	90%
Disinfection Byproducts Total trihalomethanes (THMs) Total haloacetic acids(HAAs) Cyanogen chloride	 15 µg/L 10 µg/L 5 µg/L
Filtered Water heterotrophic plate count (HPC)	10 cfu/mL
Minimum Unit Filter Run Volume (UFRV)	5,000 gal/sq ft
Filter Maturation Turbidity	0.2 NTU
Turbidity Breakthrough Level	Not defined*
Terminal Headloss	10 feet, including clean bed headloss
Maximum Filter Maturation	3% of UFRV

*Generally, turbidity breakthrough occurs as the void spaces within the filter media become filled and the solids holding capacity becomes exhausted, resulting in a rapid increase in filtered water turbidity. During this study, turbidity breakthrough was characterized by a gradual increase from a stable, low-operating turbidity. Because the increase was not rapid, it was difficult to determine a "turbidity breakthrough level" that was acceptable as a goal. Filter runs were generally terminated due to headloss or when the filtered water turbidity began to increase from a stable operating level.
Abbreviations: NTU is nephelometric turbidity units, ug/L is micrograms per liter, cfu/ml is colony forming units per milliliter, UFRV is unit filter run volume, gal is gallon, sq ft is square foot.

Chemical Evaluation

The chemical evaluation considered alternative coagulant, coagulant aid polymers, filter aid polymers and pH of coagulation to determine the optimal chemical addition scheme for subsequent pilot testing. Longer filter runs were observed with polymer alone, compared to a combination of coagulant salt (ferric chloride) and polymer; however, organics removal was significantly less effective with polymer alone. A filter aid significantly improved filter run length and filter efficiency, while pH adjustment with the combination of ferric chloride and polymer had little impact on filter performance.

Preoxidation Evaluation

The pre-oxidation study examined the oxidant demand and decay characteristics for ozone, chlorine and chloramine, and compared their performance as a pretreatment for filtration. Figure 1 shows that longer filter runs were achieved with each of the pre-oxidants. Figure 2 shows that pre-oxidation with ozone improved particle removal efficiency compared to chlorine and chloramines. The optimal ozone dose was approximately 1.4 mg/L.

Figure 1. Effect of Pre-oxidant Dose on Unit Filter Run Volume (UFRV) *(JMM, 1993a)*

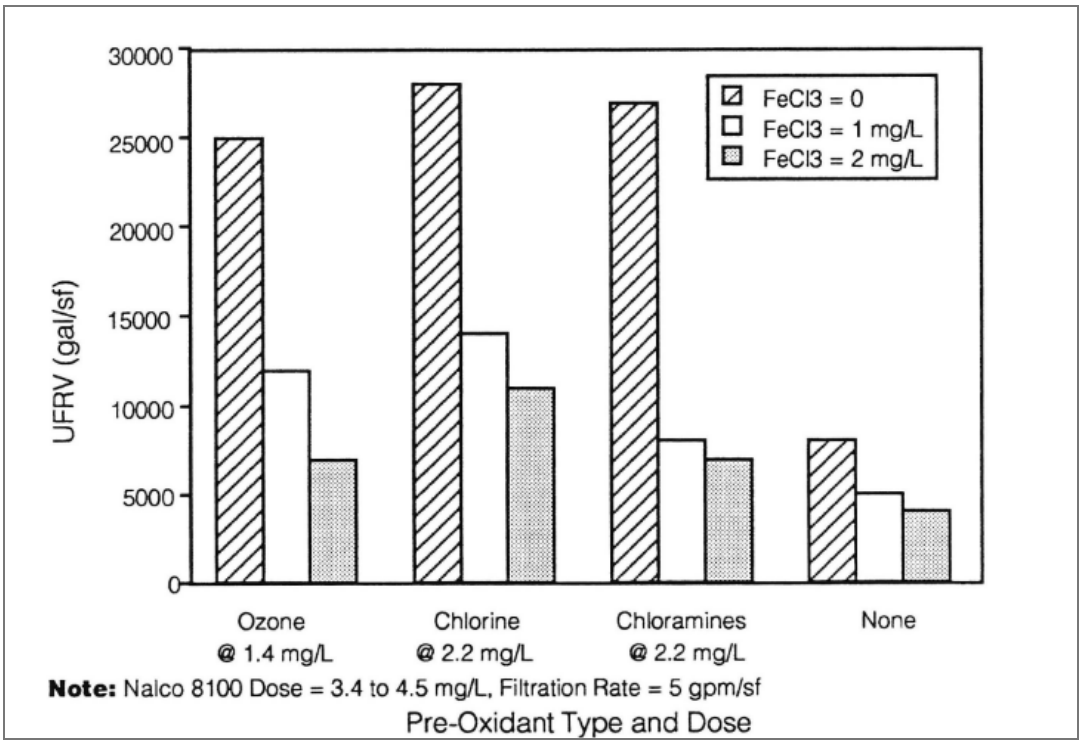
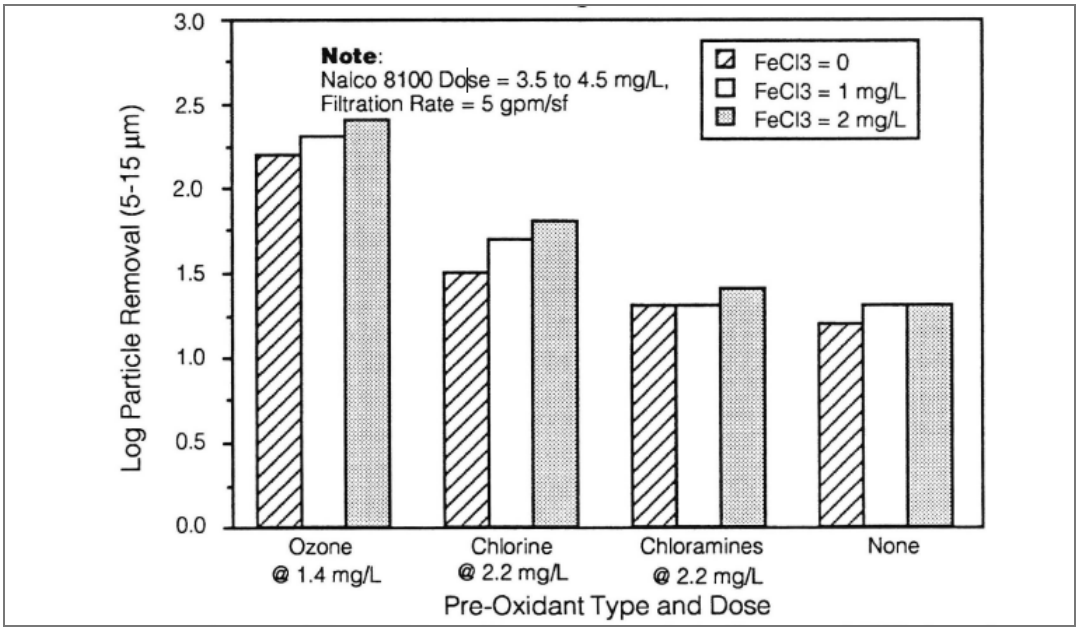


Figure 2. Effect of Pre-oxidant Dose on Particle Removal Efficiency *(JMM, 1993a)*



Flocculation Evaluation

The flocculation evaluation showed mixed results. With a combination of ferric chloride and polymer, flocculation up to 30 minutes shortened filter run lengths and produced higher filtered water turbidity compared to polymer alone. With a polymer alone, flocculation improved filter run length and reduced the amount of time it took the filter to mature after backwashing.

Evaluation of Filter Media and Filtration Rates

Multiple granular media types, sizes, bed depths and loading rates were tested during this phase of the pilot testing. The three filter media and filtration rates evaluated were mono media anthracite, mono media granular activated carbon (GAC), and dual media sand with anthracite. The tests were conducted with a preoxidation ozone dose of 1.5 mg/L and polymer only as a coagulant. A filter aid polymer was also used. Filter media sizes for the anthracite ranged from 1 to 2 mm and bed depths of 20”, 40” and 120” were tested. GAC media size was 1.4 mm and a bed depth of 94” was used. The dual media filter used a 0.5 mm sand with a 9” depth under 80” of 1.5 mm anthracite.

Initial tests were done using 20-inch, 40-inch, and 60-inch of anthracite media, with a 1 mm effective size. Loading rates of 5, 7.5 and 10 gallons per minute per square foot (gpm/sq. ft.) were tested, with results showing adequate filter run UFRVs, but the filtered water turbidity and log particle removal were decreased as the filter loading rate increased. Unit filter run volume is the number of gallons run through a square foot of filter during a filter run.

Deeper media beds and different sizes of anthracite were investigated. The filter’s performance improved with greater L:d ratios (length of filter media depth in mm to diameter of media in mm) of the media bed design. The L:d ratio is the length or depth of the filter in mm, divided by the diameter of the media in mm. An L:d ratio of 1,300 for 1.0 mm anthracite is 51” deep, for 1.5 mm anthracite the bed depth would be 77” and for 2.0 mm anthracite the bed depth would be 102”. Table 2 summarizes the results of this deeper media bed testing, which was conducted March 19 through May 17, 1991. During this period, the ozone dose and coagulant/filter aid feed doses were kept relatively constant.

Table 2. Summary of Filter Media and Filter Rate Testing (JMM,1993a)

Date	Media	Size, mm	Depth, in	L:d ratio	Loading Rate, GPM/sq ft	UFRV, gal/sq ft	Filtered Water Turbidity, NTU	Log Particle Removal	Filter Run Termination
3/19/1991	Anthracite	1.5	68	1,151	15	45,000	0.06	1.71	Headloss
3/19/1991	Anthracite	1.5	77	1,304	15	25,200	0.07	1.40	Turbidity
3/19/1991	Anthracite	1.0	100	2,540	15	29,700	0.06	1.62	Turbidity
3/22/1991	Anthracite	1.5	68	1,151	15	34,200	0.05	1.82	Headloss
3/22/1991	Anthracite	1.5	77	1,304	15	20,700	0.06	1.49	Headloss
3/22/1991	Anthracite	1.0	100	2,540	15	21,600	0.04	1.62	Headloss
3/25/1991	Anthracite	1.5	68	1,151	15	30,600	0.05	1.85	Headloss
3/25/1991	Anthracite	1.5	77	1,304	15	32,400	0.06	1.54	Headloss
3/25/1991	Anthracite	1.0	100	2,540	15	27,000	0.04	1.68	Headloss
3/28/1991	Anthracite	1.5	100	1,693	10	61,200	0.05	1.78	Turbidity
3/28/1991	Anthracite	1.5	120	2,032	10	78,000	0.05	1.84	Turbidity
3/28/1991	GAC	1.4	94	1,705	10	46,800	0.04	1.93	Turbidity
4/2/1991	Anthracite	1.5	100	1,693	15	57,600	0.05	1.59	Time
4/2/1991	Anthracite	1.5	120	2,032	15	63,000	0.04	1.73	Time
4/2/1991	GAC	1.4	94	1,705	15	40,500	0.04	1.58	Turbidity
4/5/1991	Anthracite	1.5	100	1,693	10	8,400	0.04	2.23	Turbidity
4/5/1991	Anthracite	1.5	120	2,032	10	7,200	0.04	2.05	Turbidity
4/5/1991	GAC	1.4	94	1,705	10	5,280	0.04	1.85	Turbidity
4/7/1991	Anthracite	1.5	100	1,693	17.5	27,300	0.07	1.58	Headloss
4/7/1991	Anthracite	1.5	120	2,032	17.5	29,400	0.06	1.73	Headloss
4/7/1991	GAC	1.4	94	1,705	17.5	19,320	0.05	1.82	Headloss
5/14/1991	Anthracite	1.5	100	1,693	15	72,900	0.04	1.90	Headloss
5/14/1991	Anthracite and Sand	1.5/0.5	80/10	1,863	15	66,600	0.04	1.89	Headloss
5/17/1991	Anthracite	1.5	100	1,693	15	55,800	0.04	1.94	Time
5/17/1991	Anthracite and Sand	1.5/0.5	80/10	1,863	15	54,900	0.04	1.95	Time

Note: all tests with 1.5 mg/L ozone dose, NALCO 8100 polymer coagulant and filter aid polymer.

An L:d ratio of 1500 or greater appears to have some slight benefit in lower filtered water turbidity, increased particle removal and increased UFRV as shown in Figures 3, 4 and 5, respectively.

Figure 3. PWB 1991 Pilot Testing Results for Filter Various Bed Configurations L:d vs FW Turbidity (March 19 through May 17, 1991)

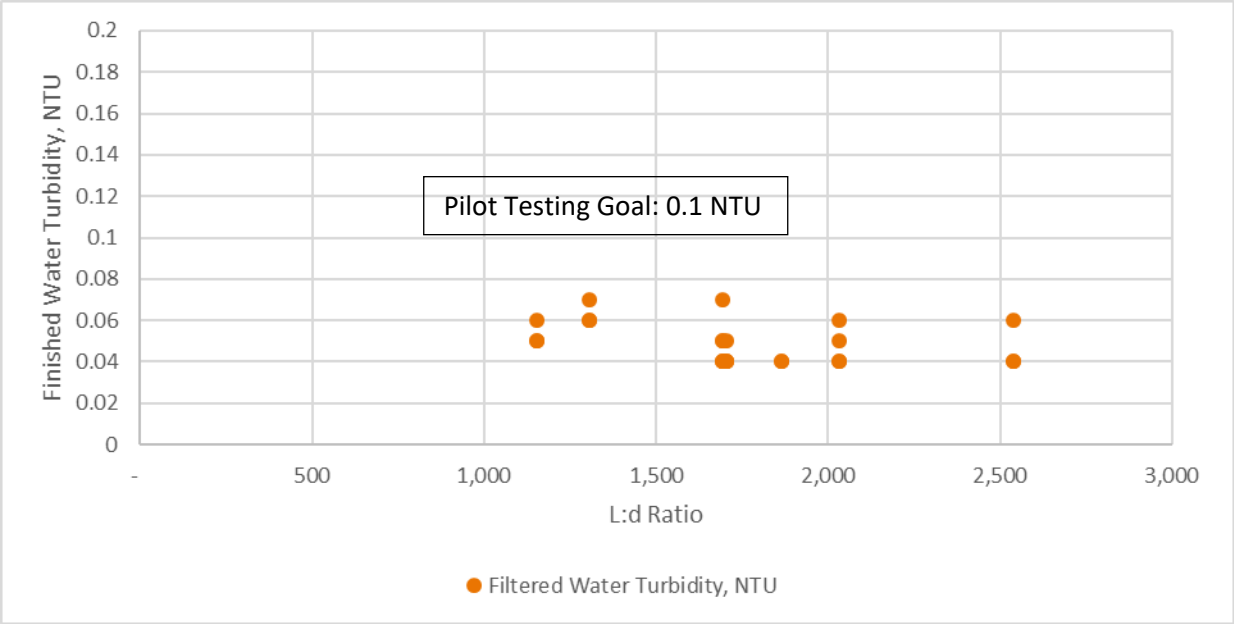


Figure 4. PWB 1991 Pilot Testing Results for Filter Various Bed Configurations L:d vs Log Particle Removal (March 19 through May 17, 1991)

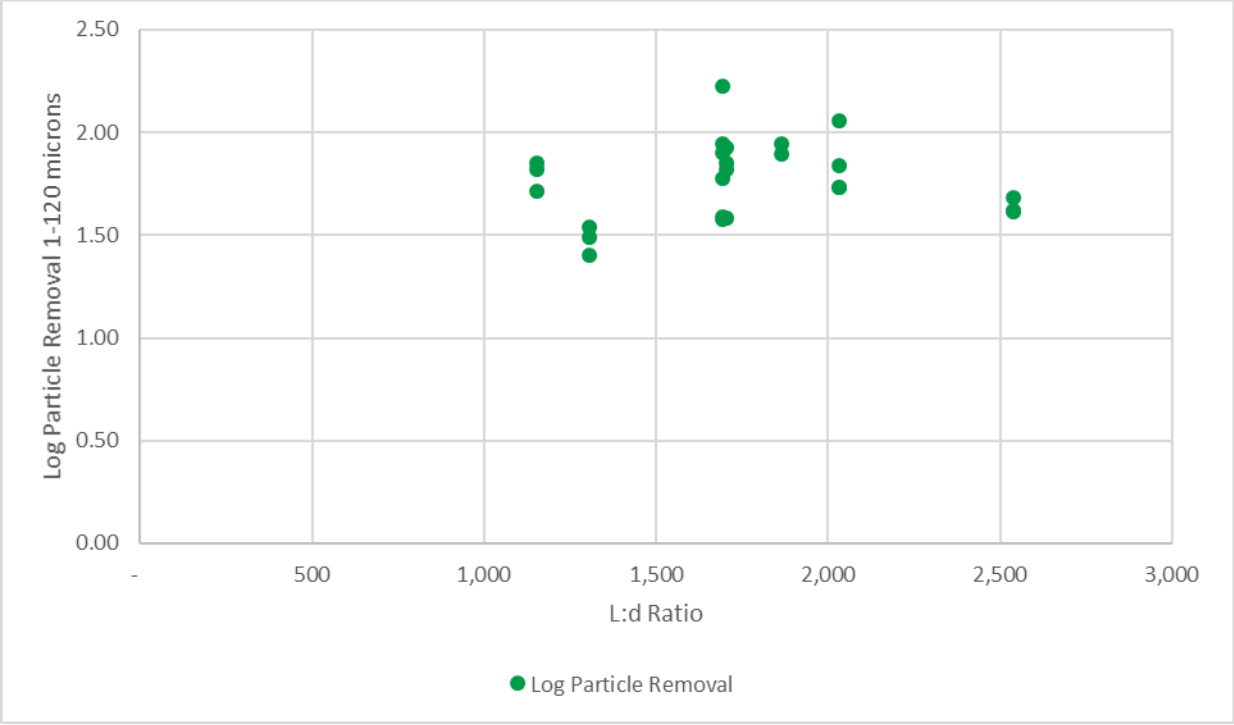
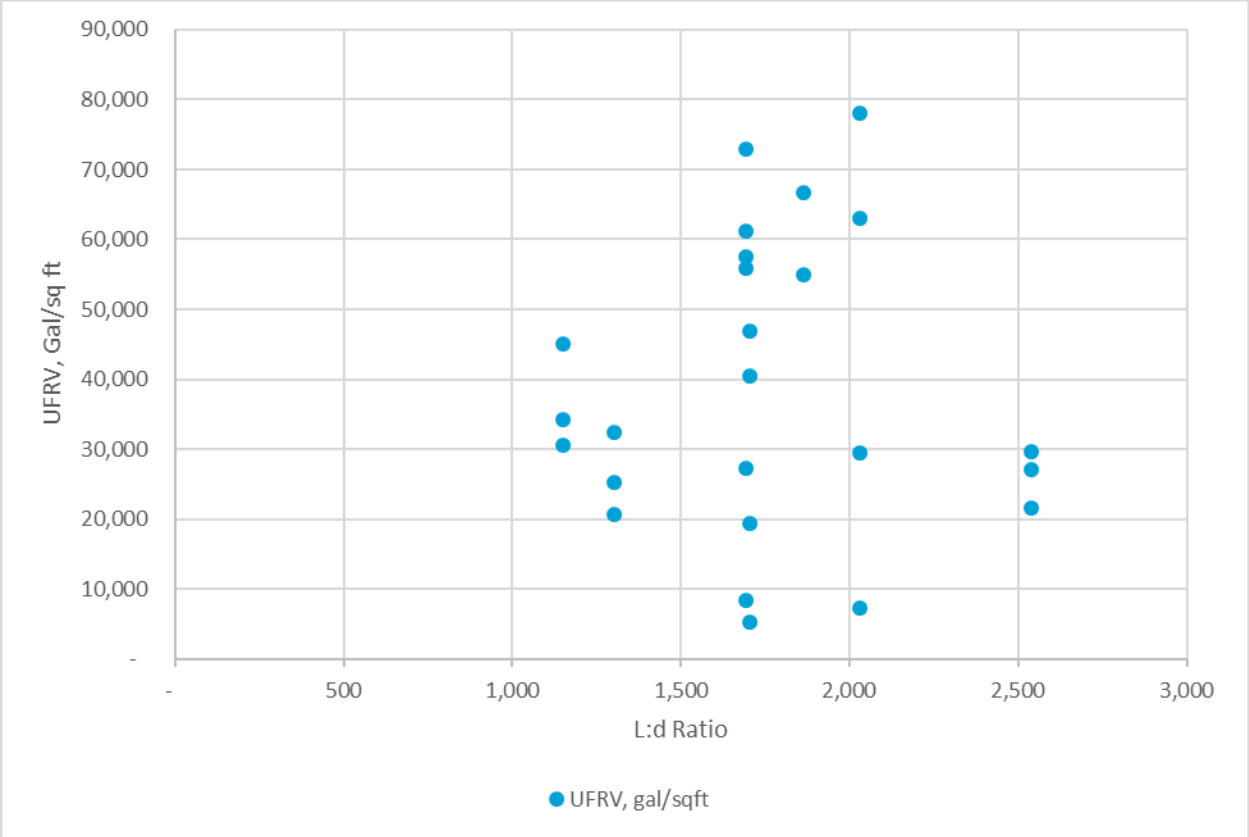


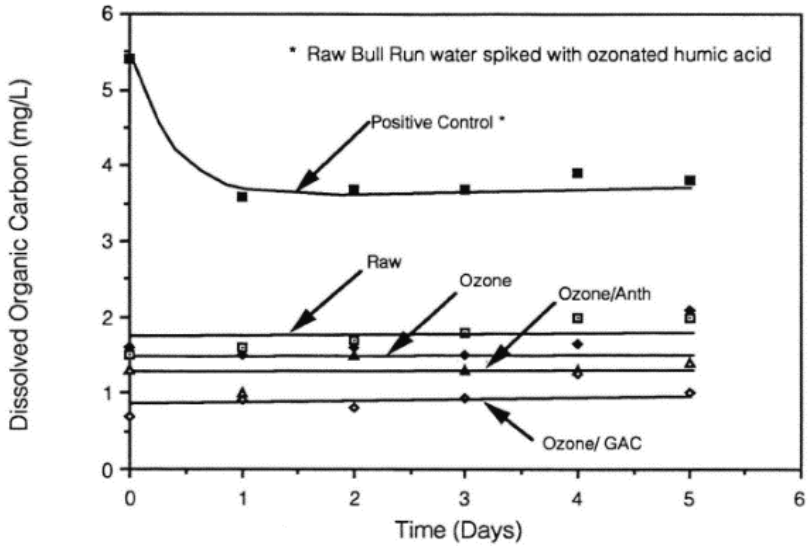
Figure 5. PWB 1991 Pilot Testing Results for Filter Various Bed Configurations L:d vs UFRV (March 19 through May 17, 1991)



Heterotrophic Plate Count Evaluation

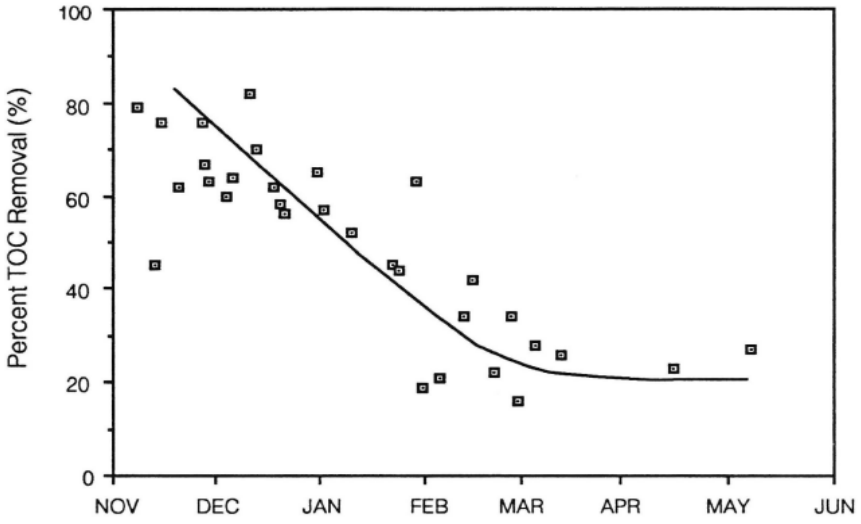
The evaluation conducted during this phase of the testing examined whether pre-oxidation with ozone was likely to exacerbate potential regrowth of bacteria in the distribution system. The evaluation included the impact of ozone and media filtration with anthracite and GAC on the levels of heterotrophic plate counts (HPC), total organic carbon (TOC), dissolved organic carbon (DOC) and biodegradable organic carbon (BDOC). The test results showed that the raw water, and the ozonated or ozonated/filtered water were very stable, as shown in Figure 6. Over a period of five days, the BDOC level in the water stayed the same in the raw and treated waters. By comparison, raw Bull Run water that was spiked with ozonated humic acid had decreased BDOC levels of 33% over the same period. The same waters spiked with HPC showed essentially no difference in biological growth potential between raw Bull Run water, ozonated water and ozonated water filtered with anthracite or GAC.

Figure 6. Biodegradable Dissolved Organic Carbon in Raw and Treated Bull Run Water (JMM, 1993a)



The ozonated GAC media filter was operated for more than 175 days of continuous operation. During this period, TOC removal decreased from initial levels of approximately 80% removal to a sustained value of approximately 20% removal as the GAC became exhausted, as shown in Figure 7.

Figure 7. TOC Removal across a Continuously Operated Ozone-GAC Filter



Disinfection By-Product Formation

Tests were conducted for disinfection by-product formation using a simulated distribution system reaction both at the University of North Carolina and in the pilot trailer at Bull Run headworks. The results demonstrated that ozone significantly reduced the amount of total Trihalomethanes (THM) and Halo Acetic Acids (HAA) formed after chlorine or chlorine and chloramine formation. Cyanogen chlorine was minimized in chloraminated waters by increasing the chlorine to ammonia ratio and minimizing the free chlorine contact time, prior to ammonia addition. The primary DBPs produced by ozonation were

aldehydes. The results from this study indicated that ozonation of raw Bull Run water resulted in formaldehyde concentrations of approximately 15 µg/L.

Pilot treatment processes were evaluated for their ability to control oxidation by-products (OBP) formation. Disinfection by-product (DBP) production appeared to be directly related to the process' ability to remove organic precursor material as measured by total oil and grease (TOG) and ultraviolet light (UV_{254}) absorbance. UV_{254} appeared to be a better surrogate for THM and HAA formation potential than total organic carbon (TOC). Granular activated carbon (GAC) filtration removed more precursor material than did anthracite filtration and resulting DBP levels were lower for GAC-filtered water compared to anthracite. Water which had been coagulated/filtered with ferric chloride and cationic polymer also produced lower DBPs than did water coagulated/filtered with cationic polymer alone.

Taste and Odor Control Evaluation

The two most common taste and odor causing compounds in surface water are algal by-products: geosmin and 2-methylisoborneol (MIB), which can exhibit a swampy, musty flavor and odor to the water. GAC media that had been in service for two months was able to remove 20 nanograms per liter (ng/l) of MIB and geosmin to undetectable levels with empty-bed contact times of 2.5 and 5 minutes. Ozone was also effective at oxidizing these compounds at doses as low as 0.5 mg/L. The ozone dose used in the pilot filters of 1.5 mg/l was enough to reduce geosmin and MIB to levels below the detection limit. Coagulation filtration with anthracite removed approximately 25% of spiked MIB.

Elevated Turbidity Evaluation

Bull Run water was spiked with clay and sediments collected from the watershed and filtered with 100” of 1.5 mm anthracite and with a dual media filter of 80” of 1.5 mm anthracite over 10” of sand. The water was pre-ozonated and treated with a coagulant polymer and filter aid polymers. The raw water turbidity was elevated in the range of 2 to 5 nephelometric turbidity units (NTU). The sediments collected within the watershed were more readily removed than the clay added to the water. The dual anthracite and sand media performed similarly to the mono media filter of anthracite.

Giardia Challenge Evaluation

Raw water was spiked with *giardia* cysts in the mono media and dual media filters. The filters tested were pretreated with ozone at 1.5 mg/l and the coagulant polymer and filter aids were used. Filter loading rates of 10 and 15 gpm/sq. ft. were tested. The evaluation did not achieve 2 log removal (99%); however, the cyst removal did generally correspond to log particles removal discussed previously and those that were measured during this evaluation.

Lessons Learned from the Filtration Pilot Study

The pilot study results clearly demonstrated that ozone is useful as a pre-oxidant to improve filter performance and reduce taste, odor, and disinfection by-product levels.

The coagulant selection of polymer-only is unusual, and additional evaluation is merited if a coagulation process is part of the future filtration facility.

The deep media filter beds also increased filter efficiency, but additional study is merited to explore the trade-offs of head loss, increased log particle removal and long filter runs. It is likely that a shorter media bed depth operated at a lower filter loading rate could achieve similar or better log removal performance at a lower overall plant head loss than a deep bed at a higher loading rate.

Operating the filters in a biological filter mode, with either anthracite or GAC media, does not appear to pose a higher risk for distribution system regrowth than unfiltered chlorinated and chloraminated Bull Run water.

Water Research Foundation Membrane Bench and Pilot Scale Testing

The PWB participated in a Water Research Foundation project conducted by MWH Americas. The report, titled Membrane Filtration for Microbial Removal, was published in 1997. The specific objectives of the study were to:

- Evaluate the efficiencies of a variety of membranes for removing several different microorganisms and characterize them in terms of microbial removal, molecular weight cutoff and/or pore size,
- Provide greater insight into the mechanisms of microbial removal by low-pressure membranes,
- Identify and investigate existing and potential methods to assess membrane integrity and treatment reliability; and
- Conduct a survey of low-pressure membrane plants to determine full-scale treatment efficiency and process costs.

The project was conducted at two levels: bench and pilot scale. The bench scale studies, which were conducted with laboratory scale membrane modules, were designed to evaluate microbial removal efficiencies under controlled conditions, as well as to provide greater insight into the mechanisms of microbial removal by membranes.

Microbial challenge studies were conducted on both synthetic and natural waters. Pilot scale studies were employed to confirm results obtained at bench scale as well as to provide information on removal and operation under continual membrane operation over extended time periods. Portland tested three membrane configurations:

1. A 0.2-micron hollow fiber (out-in flow) microfiltration (MF) membrane
2. A 500,000 dalton hollow fiber (in-out flow) ultrafiltration (UF) membrane
3. A 100,000 dalton hollow fiber (in-out flow) UF membrane

The MF and UF membranes were operated at a pressure of 30 psi.

Microbial challenge studies were conducted using microorganisms targeted or being targeted by current and anticipated water quality regulations as well as those found in natural waters. *Cryptosporidium parvum, Giardia muris*, *MS2* virus, *Pseudomonas aeruginosa*, total coliform, and heterotrophic plate count (HPC) bacteria were all employed to evaluate the microbial removal efficiencies of the various membranes.

In challenge testing with spiked *giardia* and *cryptosporidium* cysts, each of the membranes showed greater than 6 log (99.9999%) removal. Coliform bacteria were removed from raw water levels of 53 to 160 cfu/mL to less than 1 cfu/mL in the permeate. HPC removals were 2.1 to 2.5 logs. MS2 bacteriophage removal was 2 logs (99%) for the MF membrane and greater than 5 logs (99.999%) for the UF membranes. Log rejection of MS2 decreased significantly as the flux rate was increased. At a flux rate of 12 gallons per square foot per day per psi of operating pressure (gfd/psi), the log removal was reduced to 1 log (90%). During the pilot study, transmembrane pressures in the UF membranes increased to over 20 psi within the first 10 days of operation. The MF membrane transmembrane pressure increased to 15 psi in six days of operation.

TOC removal in the membranes ranged from 5 to 12%. UV_{254} removal ranged from 7 to 17%.

U.S. EPA Verification Testing

Zenon tested a pilot unit of their ZeeWeed® ZW-500 ultrafiltration membrane at Bull Run headworks in 2001. The ZW-500 UF is not commonly used in drinking water applications. It has a pore size of 157,000 dalton and is a hollow fiber immersed membrane with an outside-in flow path. A vacuum is applied to the downstream side of the membrane to pull water through the unit. The tests occurred in three separate one-month periods over the course of a year. Flux rates ranged from 46 to 50 gfd, and water temperatures ranged from 6 to 15 degrees C. Filtered water turbidity was 0.04 to 0.05 NTU. Influent turbidity was spiked up to 200 NTU. *Giardia*, *cryptosporidium* and MS-2 Phage were also spiked. *Giardia* removal was greater than 3.3 logs in all three periods. *Cryptosporidium* removal was greater than 4.3 logs, and MS 2 Phase removal was 3.3 logs or greater in each period. Transmembrane pressure was less than 11 psi in each of the three tests.

TOC removal ranged from 19 to 22%. UV_{254} removal ranged from 13 to 34%. THM reduction ranged from 13% to 34%, and HAA reduction ranged from 1% to 49%, as shown in Table 3.

Table 3. Removal of TOD, UV_{254}, and Reduction of THMs and HAAs in Simulated Distribution System (SDS) Testing with the ZW-500 UF Membrane

Testing Period	TOC	UV_{254}	TTHMs, SDS	HAA, SDS
Period 1	19%	24%	13%	1%
Period 2	22%	22%	14%	5%
Period 3	13%	45%	34%	49%

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Appendix C

Technical Memo

Date:	September 18, 2018
Project:	Bull Run Filtration Project 699275.01.03
To:	Portland Water Bureau Filtration Decision Team
Copy to:	HDR, Barney &Worth
Prepared by:	Lee Odell
Approved by:	Kelly Irving
Subject:	**Summary of Existing Large Water Treatment Plant Technologies**

Introduction

The purpose of this technical memorandum is to summarize the technologies in use at large water treatment plants (WTPs) in North America. The list is not complete but summarizes the type of filtration in use at 167 of the largest surface water treatment plants in North America. It is expected that additional water treatment plants will be added to the list by the time the filtration technology decision is made.

Large Water Treatment Plant Treatment Technologies

Table 1 provides a list of large (at least 50 million of gallons per day [MGD]) surface water treatment plants serving most of the largest cities and metropolitan areas in North America. There are some notable exceptions Like Miami and Orlando, FL, which are both served by 100% groundwater. The list is arranged from largest capacity to the lowest. Of the 167 plants currently on the list:

- 1 (Salem, OR) uses slow sand filtration,
- 4 use membrane filtration,
- 146 use media filtration,
- 38 include biological filtration,
- 6 (including Portland) are unfiltered

The table shows that most large water treatment plants use media filtration. The large plants that use membranes include:

- The Region of Peel's Lakeview Water Treatment Plant (located in Ontario), which is a 240 MGD WTP. Of that total, 120 MGD is treated with a submerged ultrafiltration (UF) membrane and 120 MGD is treated with biological media filtration.
- The Region of Peel also owns the Lorne Park Water Treatment Plant which splits its 132 MGD capacity between submerged UF membranes and biological media filtration.
- San Diego County Water Authority's Twin Oaks Water Treatment Operator (WTO), is a 120 MGD submerged UF membrane WTP that is followed by ozone and biological GAC filters.
- The Columbia Heights WTP in Minneapolis, MN, is the largest pressure UF membrane plant at 70 MGD.

Table 1. Filtration Type of North American Water Treatment Plants Over 50 MGD

Utility	Plant	Design Capacity, (MGD)	Slow Sand	Membrane	Media Filter	Media w/ Biological Filter	Unfiltered
New York Dept. of Env. Protection, NY	Cat-Del WTP	2,020	▪	▪	▪	▪	■
City of Chicago, Dept. of Water, IL	Jardine WPP	960	▪	▪	■	▪	▪
North Texas Municipal Water Dist., TX	Wylie WTPs I, II, III & IV	700	▪	▪	■	■	▪
Los Angeles Water & Power, CA	Los Angeles Aqueduct WTP	600	▪	▪	■	■	▪
Southern Nevada Water Authority, NV	Alfred Merritt Smith WTP	600	▪	▪	■	■	▪
Metro Water District of Southern CA	Robert A. Skinner WTP #1	570	▪	▪	■	■	▪
Metro Water District of Southern CA	F. E. Weymouth WTP	520	▪	▪	■	■	▪
Metro Water District of Southern CA	Robert B. Diemer WTP	520	▪	▪	■	■	▪
City of Chicago, Dept. of Water, IL	South WPP	480	▪	▪	■	▪	▪
Metro Vancouver, BC	Seymour-Capilano WTP	475	▪	▪	■	▪	▪
Massachusetts Water Resources Authority, MA	Carroll WTP	450	▪	▪	▪	▪	■
City of Houston, TX	Northeast WTP	400	▪	▪	■	▪	▪
Dallas Water Util., TX	Eastside WTP	400	▪	▪	■	■	▪
Great Lakes Water Authority, MI (Detroit)	Lake Huron WTP	400	▪	▪	■	▪	▪
Metro Water District of Southern CA	Joseph Jensen WTP	400	▪	▪	■	■	▪
Mexico City, MX	Los Berros WTP	396	▪	▪	■	▪	▪
Great Lakes Water Authority, MI (Detroit)	Springwells WTP	370	▪	▪	■	▪	▪
City of Montreal, QC	Atwater WTP	359	▪	▪	■	▪	▪
San Francisco Public Utilities Comm., CA	Tesla WTP	350	▪	▪	▪	▪	■
Dallas Water Util., TX	Elm Fork WTP	330	▪	▪	■	■	▪
Guadalajara, MX	Lake Chalap WTP	328	▪	▪	■	▪	▪
Philadelphia Water Dept., PA	Baxter WTP	320	▪	▪	■	▪	▪
Metro Vancouver, BC	Coquitlam	317	▪	▪	▪	▪	■
City of Montreal, QC	Charles Baillets WTP	300	▪	▪	▪	▪	▪
Southern Nevada Water Authority, NV	River Mountains WTP	300	▪	▪	■	■	▪
New York DEP, NY	Croton WTP	290	▪	▪	■	■	▪
Washington Suburban Sanit. Comm., DC	Potomac Filtration Plant	285	▪	▪	■	▪	▪

Utility	Plant	Design Capacity, (MGD)	Slow Sand	Membrane	Media Filter	Media w/ Biological Filter	Unfiltered
Milwaukee Water Works, WI	Linnwood WTP	275	▪	▪	■	▪	▪
City of Toronto, ON	RC Harris WPP	265	▪	▪	■	▪	▪
Denver Water Dept, CO	Foothills WTP	250	▪	▪	■	▪	▪
Washington Aqueduct, DC	Dalecarlia WTP	246	▪	▪	■	▪	▪
Region of Peel, ON	Lakeview WTP	244	▪	■	■	■	▪
Great Lakes Water Authority, MI (Detroit)	Water Works Park WTP	240	▪	▪	■	■	▪
Kansas City Water Svcs Dept., MO	WaterWorks 1 NW Briarcliff Rd	240	▪	▪	■	▪	▪
Louisville Water Company, TN	Crescent Hill WTP	240	▪	▪	■	▪	▪
City of Hamilton, ON	Woodward Ave. Plant	238	▪	▪	■	▪	▪
Cincinnati Water Works, OH	Richard Miller Treatment Plant	235	▪	▪	■	▪	▪
New Orleans Water/Sewer Board, LA	Carrollton WTP	232	▪	▪	■	▪	▪
St. Louis County Water Co, MO	Central Plant 3	217	▪	▪	■	▪	▪
City of Toronto, ON	F J Horgan WPP	212	▪	▪	■	■	▪
Portland Water Bureau, OR	Bull Run	211	▪	▪	▪	▪	■
Denver Water Dept., CO	Marston WTP	200	▪	▪	■	▪	▪
United Water New Jersey (Suez)	Haworth WTP	200	▪	▪	■	▪	▪
Denver Water Dept., CO	Moffat WTP	195	▪	▪	■	▪	▪
DuPage Water Comm., IL	DuPage WTP	185	▪	▪	■	▪	▪
City of Charlotte, NC	Franklin WTP	181	▪	▪	■	▪	▪
Great Lakes Water Authority, MI (Detroit)	Northeast WTP	180	▪	▪	■	▪	▪
Great Lakes Water Authority, MI (Detroit)	Southwest WTP	180	▪	▪	■	▪	▪
Salt Lake Cnty Water Cons. Dist., UT	Jordan Valley WTP	180	▪	▪	■	▪	▪
San Francisco Public Utilities Comm., CA	Harry W. Tracy WTP	180	▪	▪	■	▪	▪
Seattle Public Utilities, WA	Cedar WTP	180	▪	▪	▪	▪	■
East Bay Municipal Utility Dist., CA	Orinda WTP	175	▪	▪	■	▪	▪
City of Austin, TX Water/WW	Ullrich WTP	167	▪	▪	■	▪	▪
City of Tacoma, WA	Green River WTP	165	▪	▪	■	■	▪
Cleveland Div. of Water, OH	Baldwin WTP	165	▪	▪	■	▪	▪
City of Toronto, ON	R.L. Clark WTP	162	▪	▪	■	▪	▪
City of Phoenix, AZ	Union Hills WTP	160	▪	▪	■	▪	▪
City of Witchita, KS	Main WTP	160	▪	▪	■	▪	▪

Utility	Plant	Design Capacity, (MGD)	Slow Sand	Membrane	Media Filter	Media w/ Biological Filter	Unfiltered
Omaha Metro Util. Dist., NE	Florence WTP	158	▪	▪	■	▪	▪
City of Calgary, AB	Bearspaw WTP	155	▪	▪	■	▪	▪
Cleveland Div of Water, OH	Garrett A. Morgan	150	▪	▪	■	▪	▪
Fairfax County Water Auth, VA	Corbalis WTP	150	▪	▪	■	▪	▪
Gwinnett County Department of Water Resources	Lanier Filtration Plant	150	▪	▪	■	▪	▪
Metro Water District of Southern CA	Henry J. Mills WTP	150	▪	▪	■	▪	▪
Toledo, (City of) Water Div., OH	Toledo WTP	150	▪	▪	■	▪	▪
City of Calgary, AB	Glenmore WTP	145	▪	▪	■	▪	▪
Metropolitan Water Dist., SLC, UT	Little Cottonwood WTP	143	▪	▪	■	■	▪
City of Phoenix, AZ	24th Street WTP	140	▪	▪	■	▪	▪
City of San Diego), CA	Miramar WTP	140	▪	▪	■	▪	▪
Monroe County Water Authority, NY (Rochester)	Shoremont WTP	140	▪	▪	■	▪	▪
City of Atlanta, GA	Hemphill WTP	136	▪	▪	■	▪	▪
City of Grand Rapids, MI	Lake Michigan Filtration Plant	135	▪	▪	■	▪	▪
Region of Peel, ON	Lorne Park WTP	132	▪	■	■	▪	▪
Richmond Dept. of Public Util., VA	Richmond WTP	132	▪	▪	■	▪	▪
Saint Paul Regional Water Services, MN	McCarrons WTP	130	▪	▪	■	■	▪
DeKalb County Public Works, GA	Scott Chandler WFP	128	▪	▪	■	▪	▪
Columbus Water Div., OH	Hap. Cremean WTP	125	▪	▪	■	■	▪
Dallas Water Util., TX	Bachman WTP	125	▪	▪	■	■	▪
Tulsa Public Works Dept., OK	A. B. Jewell WTP	125	▪	▪	■	▪	▪
City of Austin, TX Water/WW	Albert R. Davis WTP	120	▪	▪	■	▪	▪
City of San Diego), CA	Alvarado WTP	120	▪	▪	■	▪	▪
City of Tampa, FL	David L. Tippin WTP	120	▪	▪	■	▪	▪
Everett Water Util, WA	Everett WTP	120	▪	▪	■	▪	▪
Philadelphia Water Dept., PA	Queen Lane WTP	120	▪	▪	■	▪	▪
San Juan Suburban Water Dist., PR	Sidney N. Peterson WTP	120	▪	▪	■	▪	▪

Utility	Plant	Design Capacity, (MGD)	Slow Sand	Membrane	Media Filter	Media w/ Biological Filter	Unfiltered
Washington Aqueduct, DC	McMillan WTP	120	▪	▪	■	▪	▪
Charleston Comm Public Works, SC	Hanahan WTP	118	▪	▪	■	▪	▪
Pittsburgh Water and Sewer Auth., PA	Aspinwall WTP	117	▪	▪	■	▪	▪
City of Toronto, ON	Island WTP	116	▪	▪	■	▪	▪
Fairfax County Water Auth., VA	Occoqual WTP	111	▪	▪	■	▪	▪
City of Edmonton, AB	Rossdale WTP	110	▪	▪	■	▪	▪
City of Norfolk, VA	Moores Bridge WTP	108	▪	▪	■	▪	▪
Evanston Water Dept., IL	Evanston	108	▪	▪	■	▪	▪
City of Ottawa, ON	Lemieux Island WTP	106	▪	▪	■	▪	▪
City of Winnipeg, MB	Winnipeg WTP	106	▪	▪	■	■	▪
City of Edmonton, AB	E.L. Smith Plant	106	▪	▪	■	▪	▪
Milwaukee Water Works, MN	Howard Avenue WTP	105	▪	▪	■	▪	▪
Passaic Valley Water Comm., NJ	Little Falls Treatment Facility	104	▪	▪	■	▪	▪
City of Phoenix, AZ	Deer Valley WTP	100	▪	▪	■	▪	▪
City of Sacramento, Util Dept., CA	E. A. Fairbairn WTP	100	▪	▪	■	▪	▪
Cleveland Div of Water, OH	Nottingham WTP	100	▪	▪	■	▪	▪
Houston, (City of), TX	East Purification Plant III	100	▪	▪	■	▪	▪
San Diego County, CA	Twin Oaks WTP	100	▪	■	▪	■	▪
Santa Clara Valley Water Dist., CA	Santa Teresa WTP	100	▪	▪	■	■	▪
Springfield Water Dept., IL	West Parish Filters	100	▪	▪	■	▪	▪
Tulsa Public Works Dept., OK	Mohawk WTP	100	▪	▪	■	▪	▪
PRASA - North Coast Super Aqueduct Project, PR	Dr. Antonio Santiago Vazquez WTP	100	▪	▪	■	▪	▪
Tampa Water Dept., FL	Hillsborough River WTP	99	▪	▪	■	■	▪
City of Dayton, OH	Miami River WTP	96	▪	▪	■	▪	▪
Indianapolis Water Co, IN	White River WTP	96	▪	▪	■	▪	▪
St. Louis County Water Co, MO	North Plant (E & W Basins)	96	▪	▪	■	▪	▪
City of Ottawa, ON	Britannia WTP	95	▪	▪	■	▪	▪
Cobb County Marrietta, GA	Quarles	94	▪	▪	■	▪	▪

Utility	Plant	Design Capacity, (MGD)	Slow Sand	Membrane	Media Filter	Media w/ Biological Filter	Unfiltered
Albuquerque-Bernalillo County Water Authority, NM	San Juan Chama WTP	93	▪	▪	■	■	▪
City of Windsor, ON	AH Weeks WTP	92	▪	▪	■	■	▪
City of London, Regional Water Supply, ON	Lake Huron WTP	90	▪	▪	■	▪	▪
City of Minneapolis, MN	Fridley WTP	90	▪	▪	■	■	▪
City of Oklahoma City, OK	Draper WTP	90	▪	▪	■	▪	▪
East Bay Municipal Utility Dist., CA	Upper San Leandro WTP	90	▪	▪	■	■	▪
Erie County Water Authority, NY (Greater Buffalo)	Sturgeon Point WTP	90	▪	▪	■	▪	▪
Metro Water Services, TN	K. R. Harrington WTP	90	▪	▪	■	▪	▪
Metro Water Services, TN	Omohundro WTP	90	▪	▪	■	▪	▪
Seattle Public Utilities, WA	Tolt WTP	90	▪	▪	■	■	▪
Vista Irrigation Dist., CA	Vista-Escondido Joint WTP	90	▪	▪	■	▪	▪
Wyoming Util Dept., MI	Donald K. Shine WTP	90	▪	▪	■	▪	▪
Fort Collins, CO	Fort Collins WTP	87	▪	▪	■	▪	▪
Joint Water Commission, OR	JWC WTP	85	▪	▪	■	▪	▪
Aurora Water, CO	Peter Binney WFP	83	▪	▪	■	■	▪
Aurora Water, CO	Griswold WFP	80	▪	▪	■	▪	▪
Aurora Water, CO	Wemlinger WFP	80	▪	▪	■	▪	▪
City of Phoenix, AZ	Lake Pleasant WTP	80	▪	▪	■	▪	▪
Columbus Water Div., OH	Dublin Road WTP	80	▪	▪	■	■	▪
Santa Clara Valley Water Dist., CA	Rinconada WTP	80	▪	▪	■	▪	▪
Washington Suburban San. Comm., MD	Patuxent WTP	80	▪	▪	■	▪	▪
City of Burlington, ON	Burlington WTP	79	▪	▪	■	▪	▪
Des Moines Water Works, IA	Fleur Drive WTP	75	▪	▪	■	▪	▪
Gwinnett County Department of Water Resources	Shoal Creek Filtration Plant	75	▪	▪	■	▪	▪
Philadelphia Water Dept, PA	Belmont WTP	75	▪	▪	■	▪	▪
Cobb County Marrietta, GA	Wyckoff WTP	72	▪	▪	■	■	▪
Halton Region, ON	Burlington WTP	72	▪	▪	■	■	▪
City of Minneapolis, MN	Columbia Heights WTP	70	▪	■	▪	▪	▪

Utility	Plant	Design Capacity, (MGD)	Slow Sand	Membrane	Media Filter	Media w/ Biological Filter	Unfiltered
Eugene Water & Electric Board, OR	Hayden Bridge WTP	70	▪	▪	■	▪	▪
North Texas MWD, TX	Leonard WTP	70	▪	▪	■	■	▪
City of El Paso, TX	Jonathan Rogers WTP	60	▪	▪	■	■	▪
City of Syracuse, NY	Woodland Reservoir WTP	60	▪	▪	▪	▪	■
East Bay Municipal Utility Dist., CA	Sobrante WTP	60	▪	▪	■	■	▪
Mobile Area Water and Sewer Service, Mobile, AL	Stickney WTP	60	▪	▪	■	▪	▪
Montgomery Water Works and Sanitary Sewer Board, Montgomery, AL	C. T. Perry WTP	60	▪	▪	■	▪	▪
Truckee Meadows Water Authority, NV	Chalk Bluff WTP	60	▪	▪	■	▪	▪
City of Huntsville Utilities, AL	South Parkway WTP	56	▪	▪	■	■	▪
Cities of Regina & Moose Jaw, SK	Buffalo Pound WTP	55	▪	▪	■	▪	▪
Saskatoon, SK	Avenue H WTP	53	▪	▪	■	▪	▪
City of Ann Arbor, MI	Ann Arbor WTP	50	▪	▪	■	■	▪
City of Austin, TX Water/WW	Water Treatment Plant 4	50	▪	▪	■	▪	▪
City of Salem, OR	Geren Island WTP	50	■	▪	▪		▪
Erie County Water Authority, NY (Greater Buffalo)	WandeWater WTP	50	▪	▪	■	▪	▪
Monroe County Water Authority, NY (Rochester)	Webster WTP	50	▪	▪	■	▪	▪
Suez Delaware	Stanton WTP	50	▪	▪	■	▪	▪

Key:
WTP is Water Treatment Plant
WPP is Water Purification Plant
WFP is Water Filtration Plant

Appendix D

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Appendix E

CPES Model Cost Estimates

Granular Media Filtration Cost Estimate

CH2M Parametric Engineering System (CPES)

FACILITIES DESIGN & CONSTRUCTION COST MODULE

File Version: 1/26/2018

Project Capacity: >>>	160.00	Project Unit: >>>	MGD	(For example: MGD, HP, GPM...)

Project Name:	PWB Filtration Decision	
Project Number:	699275	
Project Manager:	Kelly Irving	
Estimator:	Enoch Nicholson/Lee Odell	
Project Description:	PWB Granular Media Filtration	Roundup to the nearest:
Project Location (City):	Portland OR	$10,000
Project Location (State):	OREGON	
Project Location (Country):	USA	
Cost Basis (Month/Year):	April/2018	

Item	Include? (Yes or No)	SCOPE OF PROJECT	Cost
	Yes	Flocculation: RapMix	$1,570,000
	Yes	Flocculation: Floc	$7,560,000
	Yes	DAF: DAF	$53,510,000
	No	Ozone Serpentine: Ozone	$0
	Yes	Filters: Filt	$35,130,000
	Yes	Concrete Clearwell: Clearwell	$22,620,000
	Yes	Liquid Chemical: Alum	$1,370,000
	Yes	Liquid Chemical: FAP	$320,000
	Yes	Liquid Chemical: CAP	$730,000
	No	Liquid Chemical: Hypo	$0
	Yes	On-Site Sodium Hypo: OSHG	$5,480,000
	Yes	Liquid Chemical: Caustic	$1,090,000
	Yes	Surge Basin-Decanter: BWSurge	$4,170,000
	Yes	Gravity Thickener: BWClar	$8,630,000
	Yes	Gravity Thickener: GravThick	$1,430,000
	Yes	WTP Centrifuge: Centrifuge	$6,340,000
	No	WPSPS: RecPS	$0
	Yes	Filter BW PS: BWPS	$2,720,000

SUBTOTAL - PROJECT COST			$152,670,000
ADDITIONAL PROJECT COSTS:			
Demolition:	0.00%		$0
Overall Sitework:	5.00%		$7,640,000
Plant Computer System:	5.00%		$7,640,000
Yard Electrical:	4.00%		$6,110,000
Yard Piping:	7.50%		$11,460,000
UD #1 Default Description	0.00%	$0	$0

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	A	B	C	D	E
47	UD #2 Default Description		0.00%		$0
48	UD #3 Default Description		0.00%		$0
49	SUBTOTAL with Additional Project Costs				$185,520,000
50					
51	RED FLAGS:				
52	1	Rock Excavation			
53	2	Pile Foundations			
54	3	Seismic Foundations			
55	4	Dewatering Conditions			
56	5	Wetlands Mitigation			
57	6	Weather Impacts			
58	7	Depth of Structures			
59	8	Local Building Code Restrictions			
60	9	Coatings or Finishes			
61	10	Building or Architectural Considerations			
62	11	Client Material Preferences			
63	12	Client Equipment Preferences			
64	13	Piping Galleries, Piping Trenches, Piping Racks			
65	14	Yard Piping Complexity			
66	15	Existing Site Utilities (New, Retrofit, and Complexity)			
67	16	I & C Automation (New or Retrofit)			
68	17	Electrical Feed (New or Retrofit)			
69	18	Electrical Distribution			
70	19	Shoring			
71	20	Contamination			
72	21	User Defined Red Flag 1			
73	22	User Defined Red Flag 2			
74	23	User Defined Red Flag 3			
75	24	User Defined Red Flag 4			
76	25	User Defined Red Flag 5			
77	26	User Defined Red Flag 6			
78	27	User Defined Red Flag 7			
79	TOTAL - RED FLAGS				$0
80					
81	SUBTOTAL - PROJECT COST with Additional Project Costs and Red Flag Costs				$185,520,000
82					
83	TAX:		0.00%	$0	$0
84	SUBTOTAL with Tax				$185,520,000
85					
86	CONTRACTOR MARKUPS:				
87	Overhead (includes General Conditions and General Administrative Costs)		14.00%	$185,520,000	$25,980,000
88	Subtotal				$185,520,000
89	Profit		5.00%	$185,520,000	$9,280,000
90	Subtotal				$185,520,000
91	Mob/Bonds/Insurance		3.50%	$185,520,000	$6,500,000
92	Subtotal				$227,280,000
93	Contingency		40.00%	$227,280,000	$90,920,000
94	SUBTOTAL with Markups				$318,200,000

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	A	B	C	D	E
95					
96	***LOCATION ADJUSTMENT FACTOR***		**100**	**$318,200,000**	**$318,200,000**
97	***SUBTOTAL - with Local Adjustment Factor***				**$318,200,000**
98					
99	***MARKET ADJUSTMENT FACTOR***			**$318,200,000**	**$0**
100	***SUBTOTAL - CONSTRUCTION COST with Market Adjustment Factor***				**$318,200,000**
101	***Your CPES Estimate MUST be reviewed by a Process person AND an Estimator:***				
102	***Name of Process Reviewer***			**Odell, Lee**	
103	***Name of Estimator Reviewer***				
104	***MAXIMUM CONSTRUCTION COST***				**$318,200,000**
105					
106	***NON-CONSTRUCTION COSTS:***				
107	***Permitting:***		**0.00%**	**$318,200,000**	**$0**
108	***Engineering:***		**0.00%**	**$318,200,000**	**$0**
109	***Services During Construction:***		**0.00%**	**$318,200,000**	**$0**
110	***Commissioning & Startup:***		**0.00%**	**$318,200,000**	**$0**
111	***Land / ROW:***		**$0.00**		**$0**
112	***Legal / Admin:***		**$0.00**		**$0**
113	***program management***		**$0.00**		**$0**
114	***SUBTOTAL - Non-Construction Costs***				**$0**
115					
116	***TOTAL - CAPITAL COST***				**$318,200,000**
117					
118	***Currency Conversion of TOTAL CAPITAL COST:***				
119		***Currency***	***Unit of Measure***	***Conversion Rate***	***Converted Amount***
120		**None**	**U.S. Dollar**	**1**	**318,200,000**

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	B	C	D	E	F	G	H	I
1	***Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)***							
2								
3	**Is This Facility Included in My Project? Yes**							
4	Assumptions:							
5								
6	Based on Denver Water Reuse Project							
7	2 Basins @ 15 MGD each							
8	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
9	***NOTE TO USER: The Lamella Plate Clarifier should be sized before working on the Flocculation model.***							
10								
11	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
12	Is this a Seawater Desalination Application?	**No**	Y/N					
13	Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N					
14	Input Total Flocculation Flow Rate	**160.00**	mgd	**605.67**	ML/d			
15	Conversion of Total Flocculation Flow Rate	111,111.11	gpm	7,010.02	L/s			
16	Conversion of Total Flocculation Flow Rate	247.56	cfs	7.01	m3/s			
17	Input Number of Active Flocculation Trains	**4**	#					
18	Input Number of Standby Flocculation Trains	**0**	#					Typically 0.
19	Calculate Total Number of Flocculation Trains	4	#			NT		
20	Input Flocculation Detention Time	**0.50**	min					
21	Input Number of Flocculation Basin Stages per Train	**1**	#			NFS		Valid Range: 1 - 6.
22	Calculate Flocculation Basin Water Volume per Train	1,856.67	cf	52.58	m3			
23	Calculate Flocculation Stage Water Volume	1,856.67	cf	52.58	m3			
24	Select Flocculation Baffle Type	**O/U**	Type					
25	Input Flocculation Basin Influent Weir Head, If Serpentine Baffling Selected	**1.00**	ft	**304.80**	mm			
26	Calculate Flocculation Basin Influent Weir Length	0.00	ft	0.00	mm	WL		
27	Input Internal Flocculation Basin / Stage Width per Train = Lamella Plate Clarifier Train Width (W)	**15.00**	ft	**4,572.00**	mm	IBW		The Flocculation Basin / Stage Width should equal the Clarifier Stage Width. For information, the DAF Clarifier Stage Width can be found in the DAF model cell C25. Lamella Clarifier Width can be found in cell C46 of the Lamella Clarifier model.
28	Calculate Stage Length	11.13	ft	3,391.07	mm	SL		
29	Calculate Side Water Depth	11.13	ft	3,391.07	mm	SWD		Equal to Stage Length.
30	Input Flocculator Equipment Type	**VT**	Type					For VP and VT, the flocculation stage length must be less than 20-feet.
31	Calculate Horizontal Paddle Wheel Flocc Pedestal Height	0.00	ft	0.00	mm	FPH		
32	Number of Baffle Walls per Train	0	#					
33	Include Influent Channel?	**Yes**	Y/N					
34	Input Influent Channel Width	**5.00**	ft	**1,524.00**	mm	ICW		Valid Range: ≥ 3 ft.
35	Calculate Internal Flocculation Basin Length per Train	11.13	ft	3,391.07	mm	IBL		
36	Input Basin Freeboard	**3.00**	ft	**609.60**	mm	FB		Valid Range: 1-3 ft.
37	Calculate Basin Depth	14.13	ft	4,305.47	mm			Flocculation Basin BD should be less than or equal to lamella clarifier BD. If not, add more trains and / or more stages
38	Input Perimeter Operator Deck Walkway Width	**6.00**	ft	**1,524.00**	mm	WWW		Typically 4 to 8 ft.
39	Input Central Operator Deck Walkway Width	**10.00**	ft	**1,828.80**	mm	WWWC		Typically 8 to 12 ft.
40	Include Building over Basin?	**No**	Y/N					
41	Input Structure Depth of Burial	**6.00**	ft	**0.00**	mm			
42	Input Cutback Slope	**1.50**	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
43	Input Over Excavation Depth	**1.00**	ft	**0.00**	mm			
44	For Horizontal Paddle Wheel, Input Number of Reels per Stage	**6**	#			NRS		
45	Calculate Number of Flocculation Basin Pedestal Supports	0						
46	Distance between Reel and Pedestal	0.00	in	0.00	mm			
47	Conversion from Inches to Feet	0.00	ft	0.00	mm	RPW		
48	Width of Pedestal	0.00	in	0.00	mm			
49	Conversion from Inches to Feet	0.00	ft	0.00	mm	PW		
50	Calculate Reel Length	0.00	ft	0.00	mm	RL		Valid Range: 6 to 20 ft.
51	Calculate Reel Diameter	0.00	ft	0.00	mm	RD		
52	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Stage	1	#					
53	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Train	1	#					
54	For Vertical Paddle Wheel or Vertical Turbine, Calculate Total Number of Mixers per All Trains	4	#					
55	For Vertical Paddle Wheel or Vertical Turbine, Calculate Mixer Diameter, Each	9.00	ft	2,743.20	mm	MD		
56	For Vertical Paddle Wheel or Vertical Turbine, Calculate Distance Between Mixers	3.00	ft	914.40	mm	DBM		
57	Input Stage 1 Velocity Gradient	**700.00**	sec-1					
58	Input Stage 2 Velocity Gradient	**40.00**	sec-1					
59	Input Stage 3 Velocity Gradient	**20.00**	sec-1					
60	Input Stage 4 Velocity Gradient	**0.00**	sec-1					
61	Input Stage 5 Velocity Gradient	**0.00**	sec-1					
62	Input Stage 6 Velocity Gradient	**0.00**	sec-1					
63	Input Wire to Water Flocculation Energy Input Efficiency	**75.00%**						
64	Input min water temperature	33.80	degrees F	**1.00**	degrees C			Valid Range: 0 - 40 deg C.

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	B	C	D	E	F	G	H	I
65	Dynamic (Absolute) Viscosity of Water	0.000037	lb•s/sf	0.001792	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
66	Calculate Stage 1 Power per Mixer	83.00	hp	61.89	kW			
67	Calculate Stage 2 Power per Mixer	0.00	hp	0.00	kW			
68	Calculate Stage 3 Power per Mixer	0.00	hp	0.00	kW			
69	Calculate Stage 4 Power per Mixer	0.00	hp	0.00	kW			
70	Calculate Stage 5 Power per Mixer	0.00	hp	0.00	kW			
71	Calculate Stage 6 Power per Mixer	0.00	hp	0.00	kW			
72								
73	Electrical User Inputs and Sizing Requirements:							
74	Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N					
75	Is there SWGR?	No						
76								MCC
77	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
78	Flocculation Mixers Stage 1 (total facility)	4.00	83.00	Yes	0.00	0.00	12.00	
79	Flocculation Mixers Stage 2 (total facility)	0.00	0.00	Yes	0.00	0.00	0.00	
80	Flocculation Mixers Stage 3 (total facility)	0.00	0.00	Yes	0.00	0.00	0.00	
81	Flocculation Mixers Stage 4 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
82	Flocculation Mixers Stage 5 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
83	Flocculation Mixers Stage 6 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
84	User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
85	User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
86	User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
87	**TOTAL**		**332.00**		**0.00**	**0.00**	**12.00**	**12.00**
88								
89	Electrical Equipment Widths:							
90	**Equipment**	**Depth (ft)**						
91	MCC	1.67						
92	Small AFD's	2.08						
93	Large AFD's	0.00						
94	Switchgear	0.00						
95	**Maximum Depth**	**2.08**						
96								
97	Clear Distances:							
98	**Clear Distance**	**Width**	**Length**	**Comment**				
99	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
100	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
101	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
102	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
103	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
104	CD6	**4.00**		Clear Distance behind Switchgear (If				
105	CD7	**3.00**		Clear Distance in front of Equipment	Typically 3 feet			
106	Contingency Length		**0.00**	Contingency length	Typically Zero			
107								
108	Electric Room Length (ft):							
109	CD1	3.00						
110	MCC	11.67						
111	CD2	1.00						
112	Small AFD's	13.32						
113	CD3	0.00						
114	Large AFD's	0.00						
115	CD4	0.00						
116	Swithgear	0.00						
117	CD5	0.00						
118	Contingency	0.00						
119	**Total Length**	**28.99**						
120								
121	Electric Room Width (ft):							
122	CD6	0.00	If there is no switchgear, this distance will be Zero.					
123	Maximum Equipment Depth	2.08						
124	CD7	3.00						
125	**Total Width**	**5.08**						
126								
127	**Estimating Dimensions (per trian):**	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
128								
129	Influent Channel:							
130	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
131	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
132	Concrete Thickness	2.00	ft	609.60	mm	TICS0G		
133	SOG Length	8.50	ft	2,590.80	mm			
134	SOG Width	71.50	ft	21,793.20	mm			
135	Channel Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
136	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
137	Concrete Thickness	1.50	ft	457.20	mm	TWIC		
138	Wall Length	135.00	ft	41,148.00	mm			
139	Wall Height	14.13	ft	4,305.47	mm			
140	Elevated Slab:							
141	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
142	Concrete Thickness	1.00	ft	304.80	mm			

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	B	C	D	E	F	G	H	I
143	Elevated Slab Length	8.00	ft	2,438.40	mm			
144	Elevated Slab Width	67.50	ft	20,574.00	mm			
145								
146	Flocculation Basin:							
147	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
148	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
149	Concrete Thickness	2.00	ft	609.60	mm	TFBSOG		
150	SOG Length	12.63	ft	3,848.27	mm			
151	SOG Width	71.50	ft	21,793.20	mm			
152	Basin Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
153	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
154	Concrete Thickness	1.50	ft	457.20	mm	TWFB		
155	Wall Length	80.63	ft	24,575.37	mm			If flocc basin shares a common wall with downstream facility, then common wall is counted with downstream facility.
156	Wall Height	14.13	ft	4,305.47	mm			
157	Baffle Walls:							
158	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
159	Concrete Thickness	1.00	ft	304.80	mm	BWTF		
160	Wall Width per Train	15.00	ft	4,572.00	mm	BWL		
161	Quantity of Over Baffle Walls per Train	0	#					
162	Quantity of Under Baffle Walls per Train	0	#					
163	Quantity of Under Baffle Walls per Train	0	#					
164	Over Baffle Wall Length per Facility	0.00	ft	0.00	mm			
165	Under Baffle Wall Length per Facility	0.00	ft	0.00	mm			
166	Serpentine Baffle Wall Length per Facility	0.00	ft	0.00	mm			
167	Over Baffle Wall Height	9.13	ft	2,781.47	mm			Assumes top of wall 2 ft below WSE.
168	Under Baffle Wall Height	13.13	ft	4,000.67	mm			Assumes bottom of wall 1 ft above basin floor.
169	Serpentine Baffle Wall Height	0.00	ft	0.00	mm			
170	Elevated Slab:							
171	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
172	Concrete Thickness	1.00	ft	304.80	mm	TESLC		
173	Center Walkway:							
174	Elevated Slab Width	10.00	ft	3,048.00	mm			
175	Elevated Slab Length per 2 Trains	5.13	ft	1,562.27	mm			
176	Elevated Slab Length per Facility	15.38	ft	4,686.82	mm			
177	Perimeter and Baffle Wall Walkway:							
178	Elevated Slab Width at Perimeter	7.50	ft	2,286.00	mm			Includes basin wall thickness.
179	Elevated Slab Length at Perimeter per Facility	77.75	ft	23,698.55	mm			
180	Elevated Slab Width at Baffle Wall	6.00	ft	1,828.80	mm			For VP and VT flocc basin mixing only.
181	Elevated Slab Length at Baffle Wall per Facility	0.00	ft	0.00	mm			For VP and VT flocc basin mixing only.
182								
183	Electrical Room Slab on Grade:							
184	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
185	Concrete Thickness	1.00	ft	304.80	mm			
186								
187	Overall Dimensions:							
188	Total Basin/Building Length	19.13	ft	5,829.47	mm	TBL		
189	Total Basin/Building Width	67.50	ft	20,574.00	mm	TBW		
190	SOG Length	21.13	ft	6,439.07	mm			
191	SOG Width	71.50	ft	21,793.20	mm			
192	Electrical Room Length	28.99	ft	8,835.14	mm			
193	Electrical Room Width	5.08	ft	1,549.40	mm			
194	Excavation Length	25.13	ft	7,658.27	mm			
195	Excavation Width	75.50	ft	23,012.40	mm			
196	Excavation Depth	9.00	ft	2,743.20	mm			
197								
198								
199	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
200								
201	SITEWORK:							
202	Excavation	1,215	CY	929.21	m3	***$6.72***	$8,171	
203	Imported Structural Backfill	141	CY	107.43	m3	***$50.94***	$7,158	
204	Native Backfill	453	CY	346.20	m3	***$8.27***	$3,743	
205	Haul Excess	763	CY	583.01	m3	***$8.27***	$6,303	
206	Allowance for Misc Items	5%				$25,374.40	$1,269	
207	Subtotal						$26,643	
208								
209	CONCRETE:							
210	Influent Channel:							
211	Foundation	45	CY	34.42	m3	***$541.11***	$24,360	
212	Walls	106	CY	81.00	m3	***$880.79***	$93,313	
213	Elevated Slab	20	CY	15.29	m3	***$1,333.77***	$26,675	
214	Flocc Basin							
215	Foundation	67	CY	51.12	m3	***$541.11***	$36,183	
216	Basin Walls	63	CY	48.38	m3	***$880.79***	$55,730	
217	Over Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
218	Under Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
219	Serpentine Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
220	Elevated Slab	23	CY	17.96	m3	***$1,333.77***	$31,338	
221	Flocc Bearing Supports	0	EA			$0.00	$0	
222	Electrical Room							

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	B	C	D	E	F	G	H	I
223	Slab on Grade	5	CY	4.17	m3	***$490.62***	$2,677	
224	Allowance for Misc Items	5%				$270,276.92	$13,514	
225	Subtotal						$283,791	
226								
227	MASONRY:	**High**						
228	CMU Building	0	SF	0.00	m2	***$198.37***	$0	
229	Electrical Room	147	SF	13.69	m2	***$198.37***	$29,229	
230	Subtotal	147					$29,229	
231								
232	METALS:							
233	Aluminum Handrail	259	LF	79.02	m	***$90.92***	$23,571	
234	Stairs (1 set per basin)	55	RISERS			***$495.92***	$27,153	
235	Allowance for Misc Items	10%				$50,724.21	$5,072	
236	Subtotal						$55,797	
237								
238	WOODS & PLASTICS:							
239	FRP Weir	60	LF	18.29	m	$41.64	$2,498	
240	FRP Ladder	8	EA			$1,529.16	$12,233	
241	Allowance for Misc Items	5%				$14,731.45	$737	
242	Subtotal						$15,468	
243								
244	THERMAL & MOISTURE PROTECTION:							
245	Concrete Liner	0	SF	0.00	m2	**$16.00**	$0	
246	Allowance for Misc Items	10%				$0.00	$0	
247	Subtotal						$0	
248								
249	DOORS & WINDOWS:							
250	Stainless Steel Door (2' x 2') for O/U Baffling	0	EA			$1,332.36	$0	
251	Stainless Steel Door (7' x 2.5') for O/U Baffling	0	EA			$5,829.09	$0	
252	Stainless Steel Door (2' x 2') for Serpentine Baffling	0	EA			$1,332.36	$0	
253	Allowance for Misc Items	5%				$0.00	$0	
254	Subtotal						$0	
255								
256	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
257	Horizontal Paddle Wheel Flocculation Mechanism (Paddles & Drives)	0	LF	0.00	m	***$0.00***	$0	
258	Vertical Paddle Wheel Flocculation Mechanism (Paddles & Drives)	4	EA			***$0.00***	$0	
259	Vertical Turbine Flocculation Mechanism (Turbines & Drives)	332	hp	247.57	kW	***$1,546.21***	$513,342	
260	Vertical Turbine Flocculator VFD's	332	hp	247.57	kW	***$563.81***	$187,186	
261	Fabricated Slide Gate	4	EA			***$9,614.74***	$38,459	
262	Allowance for Misc Items	10%				$738,987.57	$73,899	
263	Subtotal						$812,886	
264								
265	ELECTRICAL:							
266	*MCC's*							
267	Sections	7	EA			***$10,730.27***	$75,112	
268	*AFD's*							
269	Flocculation Mixers Stage 1 (total facility) (83 hp each)	4	EA			***$19,749.53***	$78,998	
270	Flocculation Mixers Stage 2 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
271	Flocculation Mixers Stage 3 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
272	Flocculation Mixers Stage 4 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
273	Flocculation Mixers Stage 5 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
274	Flocculation Mixers Stage 6 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
275	*Switchgear*							
276	Units	0	EA			***$49,359.23***	$0	
277	Electrical Conduit & Wire	572	LF	174.35	m	***$12.06***	$6,898	
278	Allowance for Misc Items	10%				$161,007.72	$16,101	
279	Subtotal						$177,108	
280								
281	INSTRUMENTS & CONTROLS:							
282	Instruments							
283	Level Switch	4	EA			***$695.44***	$2,782	
284	Number of Analog I/O Counts	10	EA			***$264.27***	$2,537	
285	Number of Digital I/O Counts	24	EA			***$62.59***	$1,502	
286	Number of PLC's	1	EA			***$13,074.33***	$13,074	
287	I&C Conduit & Wire	1,080	LF	329.18	m	***$12.06***	$13,024	
288	Allowance for Misc Items	10%				$32,918.93	$3,292	
289	Subtotal						$36,211	
290								
291	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
292	Item 1 Description	0.00		0.00		0.00	$0	
293	Item 2 Description	0.00		0.00		0.00	$0	
294	Item 3 Description	0.00		0.00		0.00	$0	
295	Item 4 Description	0.00		0.00		0.00	$0	
296	Item 5 Description	0.00		0.00		0.00	$0	
297	Item 6 Description	0.00		0.00		0.00	$0	
298	Item 7 Description	0.00		0.00		0.00	$0	
299	Item 8 Description	0.00		0.00		0.00	$0	
300	Item 9 Description	0.00		0.00		0.00	$0	
301	Item 10 Description	0.00		0.00		0.00	$0	
302	Item 11 Description	0.00		0.00		0.00	$0	
303	Item 12 Description	0.00		0.00		0.00	$0	
304	Item 13 Description	0.00		0.00		0.00	$0	
305	Item 14 Description	0.00		0.00		0.00	$0	
306	Item 15 Description	0.00		0.00		0.00	$0	
307	Subtotal						$0	
308								
309	Subtotal						$1,437,133	
310								
311	ALLOWANCES:		**User Override**					
312	Finishes Allowance	2.00%		$1,562,101	$31,242			
313	I&C Allowance	2.00%		$1,562,101	$31,242			
314	Mechanical Allowance	2.00%		$1,562,101	$31,242			
315	Electrical Allowance	2.00%		$1,562,101	$31,242			
316						Facility Cost Name		
317	Facility Cost	**160,000,000**	**GPD**	**$0.01**	**$1,562,101**	FCPFC01		
318	Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.01**	**$1,898,219**	FCPFC02		

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	B	C	D	E	F	G	H	I
319	Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$0.02**	**$3,255,785**	FCPFC03		
320	Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$0.02**	**$2,679,284**	FCPFC05		
321	Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$0.02**	**$3,255,785**	FCPFC06		

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	B	C	D	E	F	G	H	I
1	***Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)***							
2								
3	**Is This Facility Included in My Project? Yes**							
4	Assumptions:							
5								
6	Based on Denver Water Reuse Project							
7	2 Basins @ 15 MGD each							
8	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
9	***NOTE TO USER: The Lamella Plate Clarifier should be sized before working on the Flocculation model.***							
10								
11	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
12	Is this a Seawater Desalination Application?	**No**	Y/N					
13	Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N					
14	Input Total Flocculation Flow Rate	**160.00**	mgd	**605.67**	ML/d			
15	Conversion of Total Flocculation Flow Rate	111,111.11	gpm	7,010.02	L/s			
16	Conversion of Total Flocculation Flow Rate	247.56	cfs	7.01	m3/s			
17	Input Number of Active Flocculation Trains	**8**	#					
18	Input Number of Standby Flocculation Trains	**0**	#					Typically 0.
19	Calculate Total Number of Flocculation Trains	8	#			NT		
20	Input Flocculation Detention Time	**10.00**	min					
21	Input Number of Flocculation Basin Stages per Train	**3**	#			NFS		Valid Range: 1 - 6.
22	Calculate Flocculation Basin Water Volume per Train	18,566.75	cf	525.75	m3			
23	Calculate Flocculation Stage Water Volume	6,188.92	cf	175.25	m3			
24	Select Flocculation Baffle Type	**O/U**	Type					
25	Input Flocculation Basin Influent Weir Head, If Serpentine Baffling Selected	**1.00**	ft	**304.80**	mm			
26	Calculate Flocculation Basin Influent Weir Length	0.00	ft	0.00	mm	WL		
27	Input Internal Flocculation Basin / Stage Width per Train = Lamella Plate Clarifier Train Width (W)	**25.00**	ft	**7,620.00**	mm	IBW		The Flocculation Basin / Stage Width should equal the Clarifier Stage Width. For information, the DAF Clarifier Stage Width can be found in the DAF model cell C25. Lamella Clarifier Width can be found in cell C46 of the Lamella Clarifier model.
28	Calculate Stage Length	15.73	ft	4,795.70	mm	SL		
29	Calculate Side Water Depth	15.73	ft	4,795.70	mm	SWD		Equal to Stage Length.
30	Input Flocculator Equipment Type	**HP**	Type					For VP and VT, the flocculation stage length must be less than 20-feet.
31	Calculate Horizontal Paddle Wheel Flocc Pedestal Height	7.87	ft	2,397.85	mm	FPH		
32	Number of Baffle Walls per Train	2	#					
33	Include Influent Channel?	**Yes**	Y/N					
34	Input Influent Channel Width	**5.00**	ft	**1,524.00**	mm	ICW		Valid Range: ≥ 3 ft.
35	Calculate Internal Flocculation Basin Length per Train	49.20	ft	14,996.71	mm	IBL		
36	Input Basin Freeboard	**3.00**	ft	**609.60**	mm	FB		Valid Range: 1-3 ft.
37	Calculate Basin Depth	18.73	ft	5,710.10	mm			Flocculation Basin BD should be less than or equal to lamella clarifier BD. If not, add more trains and / or more stages
38	Input Perimeter Operator Deck Walkway Width	**6.00**	ft	**1,524.00**	mm	WWW		Typically 4 to 8 ft.
39	Input Central Operator Deck Walkway Width	**10.00**	ft	**1,828.80**	mm	WWWC		Typically 8 to 12 ft.
40	Include Building over Basin?	**Yes**	Y/N					
41	Input Structure Depth of Burial	**6.00**	ft	**0.00**	mm			
42	Input Cutback Slope	**1.50**	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
43	Input Over Excavation Depth	**1.00**	ft	**0.00**	mm			
44	For Horizontal Paddle Wheel, Input Number of Reels per Stage	**6**	#			NRS		
45	Calculate Number of Flocculation Basin Pedestal Supports	7						
46	Distance between Reel and Pedestal	3.00	in	76.20	mm			
47	Conversion from Inches to Feet	0.25	ft	76.20	mm	RPW		
48	Width of Pedestal	12.00	in	304.80	mm			
49	Conversion from Inches to Feet	1.00	ft	304.80	mm	PW		
50	Calculate Reel Length	2.50	ft	762.00	mm	RL	**Warning! Reel length outside valid range.**	Valid Range: 6 to 20 ft.
51	Calculate Reel Diameter	13.73	ft	4,186.10	mm	RD		
52	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Stage	0	#					
53	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Train	0	#					
54	For Vertical Paddle Wheel or Vertical Turbine, Calculate Total Number of Mixers per All Trains	0	#					
55	For Vertical Paddle Wheel or Vertical Turbine, Calculate Mixer Diameter, Each	0.00	ft	0.00	mm	MD		
56	For Vertical Paddle Wheel or Vertical Turbine, Calculate Distance Between Mixers	0.00	ft	0.00	mm	DBM		
57	Input Stage 1 Velocity Gradient	**60.00**	sec-1					
58	Input Stage 2 Velocity Gradient	**40.00**	sec-1					
59	Input Stage 3 Velocity Gradient	**20.00**	sec-1					
60	Input Stage 4 Velocity Gradient	**0.00**	sec-1					
61	Input Stage 5 Velocity Gradient	**0.00**	sec-1					
62	Input Stage 6 Velocity Gradient	**0.00**	sec-1					
63	Input Wire to Water Flocculation Energy Input Efficiency	**75.00%**						

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	B	C	D	E	F	G	H	I
64	Input min water temperature	32.00	degrees F	**0.00**	degrees C			Valid Range: 0 - 40 deg C.
65	Dynamic (Absolute) Viscosity of Water	0.000037	lb•s/sf	0.001792	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
66	Calculate Stage 1 Power per Mixer	3.00	hp	2.24	kW			
67	Calculate Stage 2 Power per Mixer	1.00	hp	0.75	kW			
68	Calculate Stage 3 Power per Mixer	1.00	hp	0.75	kW			
69	Calculate Stage 4 Power per Mixer	0.00	hp	0.00	kW			
70	Calculate Stage 5 Power per Mixer	0.00	hp	0.00	kW			
71	Calculate Stage 6 Power per Mixer	0.00	hp	0.00	kW			
72								
73	Electrical User Inputs and Sizing Requirements:							
74	Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N					
75	Is there SWGR?	No						
76								**MCC**
77	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
78	Flocculation Mixers Stage 1 (total facility)	8.00	3.00	Yes	0.00	24.00	16.00	
79	Flocculation Mixers Stage 2 (total facility)	8.00	1.00	Yes	0.00	24.00	16.00	
80	Flocculation Mixers Stage 3 (total facility)	8.00	1.00	Yes	0.00	24.00	16.00	
81	Flocculation Mixers Stage 4 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
82	Flocculation Mixers Stage 5 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
83	Flocculation Mixers Stage 6 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
84	User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
85	User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
86	User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
87	**TOTAL**		**40.00**		**0.00**	**72.00**	**48.00**	**120.00**
88								
89	Electrical Equipment Widths:							
90	**Equipment**	**Depth (ft)**						
91	MCC	1.67						
92	Small AFD's	0.00						
93	Large AFD's	0.00						
94	Switchgear	0.00						
95	**Maximum Depth**	**1.67**						
96								
97	Clear Distances:							
98	**Clear Distance**	**Width**	**Length**	**Comment**				
99	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
100	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
101	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
102	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
103	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
104	CD6	**4.00**		Clear Distance behind Switchgear (If				
105	CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet			
106	Contingency Length		**0.00**	Contingency length	Typically Zero			
107								
108	Electric Room Length (ft):							
109	CD1	3.00						
110	MCC	26.67						
111	CD2	1.00						
112	Small AFD's	0.00						
113	CD3	0.00						
114	Large AFD's	0.00						
115	CD4	0.00						
116	Swithgear	0.00						
117	CD5	0.00						
118	Contingency	0.00						
119	**Total Length**	**30.67**						
120								
121	Electric Room Width (ft):							
122	CD6	0.00	If there is no switchgear, this distance will be Zero.					
123	Maximum Equipment Depth	1.67						
124	CD7	3.00						
125	**Total Width**	**4.67**						
126								
127	**Estimating Dimensions (per trian):**	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
128								
129	Influent Channel:							
130	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
131	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
132	Concrete Thickness	2.00	ft	609.60	mm	TICS0G		
133	SOG Length	8.50	ft	2,590.80	mm			
134	SOG Width	217.50	ft	66,294.00	mm			
135	Channel Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
136	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
137	Concrete Thickness	1.50	ft	457.20	mm	TWIC		
138	Wall Length	427.00	ft	130,149.60	mm			
139	Wall Height	18.73	ft	5,710.10	mm			
140	Elevated Slab:							
141	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"

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	B	C	D	E	F	G	H	I
142	Concrete Thickness	1.00	ft	304.80	mm			
143	Elevated Slab Length	8.00	ft	2,438.40	mm			
144	Elevated Slab Width	213.50	ft	65,074.80	mm			
145								
146	Flocculation Basin:							
147	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
148	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
149	Concrete Thickness	2.00	ft	609.60	mm	TFBSOG		
150	SOG Length	50.70	ft	15,453.91	mm			
151	SOG Width	217.50	ft	66,294.00	mm			
152	Basin Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
153	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
154	Concrete Thickness	1.50	ft	457.20	mm	TWFB		
155	Wall Length	487.82	ft	148,686.36	mm			If flocc basin shares a common wall with downstream facility, then common wall is counted with downstream facility.
156	Wall Height	18.73	ft	5,710.10	mm			
157	Baffle Walls:							
158	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
159	Concrete Thickness	1.00	ft	304.80	mm	BWTF		
160	Wall Width per Train	25.00	ft	7,620.00	mm	BWL		
161	Quantity of Over Baffle Walls per Train	1	#					
162	Quantity of Under Baffle Walls per Train	1	#					
163	Quantity of Under Baffle Walls per Train	0	#					
164	Over Baffle Wall Length per Facility	200.00	ft	60,960.00	mm			
165	Under Baffle Wall Length per Facility	200.00	ft	60,960.00	mm			
166	Serpentine Baffle Wall Length per Facility	0.00	ft	0.00	mm			
167	Over Baffle Wall Height	13.73	ft	4,186.10	mm			Assumes top of wall 2 ft below WSE.
168	Under Baffle Wall Height	17.73	ft	5,405.30	mm			Assumes bottom of wall 1 ft above basin floor.
169	Serpentine Baffle Wall Height	0.00	ft	0.00	mm			
170	Elevated Slab:							
171	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
172	Concrete Thickness	1.00	ft	304.80	mm	TESLC		
173	Center Walkway:							
174	Elevated Slab Width	10.00	ft	3,048.00	mm			
175	Elevated Slab Length per 2 Trains	43.20	ft	13,167.91	mm			
176	Elevated Slab Length per Facility	302.41	ft	92,175.35	mm			
177	Perimeter and Baffle Wall Walkway:							
178	Elevated Slab Width at Perimeter	7.50	ft	2,286.00	mm			Includes basin wall thickness.
179	Elevated Slab Length at Perimeter per Facility	299.90	ft	91,410.61	mm			
180	Elevated Slab Width at Baffle Wall	0.00	ft	0.00	mm			For VP and VT flocc basin mixing only.
181	Elevated Slab Length at Baffle Wall per Facility	0.00	ft	0.00	mm			For VP and VT flocc basin mixing only.
182								
183	Electrical Room Slab on Grade:							
184	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
185	Concrete Thickness	1.00	ft	304.80	mm			
186								
187	Overall Dimensions:							
188	Total Basin/Building Length	57.20	ft	17,435.11	mm	TBL		
189	Total Basin/Building Width	213.50	ft	65,074.80	mm	TBW		
190	SOG Length	59.20	ft	18,044.71	mm			
191	SOG Width	217.50	ft	66,294.00	mm			
192	Electrical Room Length	30.67	ft	9,347.20	mm			
193	Electrical Room Width	4.67	ft	1,422.40	mm			
194	Excavation Length	63.20	ft	19,263.91	mm			
195	Excavation Width	221.50	ft	67,513.20	mm			
196	Excavation Depth	9.00	ft	2,743.20	mm			
197								
198								
199	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
200								
201	SITEWORK:							
202	Excavation	6,661	CY	5,092.90	m3	***$6.72***	$44,784	
203	Imported Structural Backfill	1,037	CY	792.83	m3	***$50.94***	$52,825	
204	Native Backfill	1,281	CY	979.52	m3	***$8.27***	$10,589	
205	Haul Excess	5,380	CY	4,113.39	m3	***$8.27***	$44,468	
206	Allowance for Misc Items	5%				$152,666.73	$7,633	
207	Subtotal						$160,300	
208								
209	CONCRETE:							
210	Influent Channel:							
211	Foundation	137	CY	104.70	m3	***$541.11***	$74,101	
212	Walls	444	CY	339.78	m3	***$880.79***	$391,434	
213	Elevated Slab	63	CY	48.37	m3	***$1,333.77***	$84,373	
214	Flocc Basin							
215	Foundation	817	CY	624.54	m3	***$541.11***	$442,009	
216	Basin Walls	508	CY	388.17	m3	***$880.79***	$447,184	
217	Over Baffle Wall	102	CY	77.78	m3	***$880.79***	$89,606	
218	Under Baffle Wall	131	CY	100.43	m3	***$880.79***	$115,703	
219	Serpentine Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
220	Elevated Slab	99	CY	75.93	m3	***$1,333.77***	$132,453	
221	Flocc Bearing Supports	168	EA			$970.52	$163,048	

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	B	C	D	E	F	G	H	I
222	Electrical Room							
223	Slab on Grade	5	CY	4.05	m3	***$490.62***	$2,600	
224	Allowance for Misc Items	5%				$1,942,511.32	$97,126	
225	Subtotal						$2,039,637	
226								
227	MASONRY:	**High**						
228	CMU Building	12,213	SF	1,134.59	m2	***$198.37***	$2,422,572	
229	Electrical Room	143	SF	13.30	m2	***$198.37***	$28,389	
230	Subtotal	12,356					$2,450,961	
231								
232	METALS:							
233	Aluminum Handrail	948	LF	289.02	m	***$90.92***	$86,211	
234	Stairs (1 set per basin)	165	RISERS			***$495.92***	$81,731	
235	Allowance for Misc Items	10%				$167,941.92	$16,794	
236	Subtotal						$184,736	
237								
238	WOODS & PLASTICS:							
239	FRP Weir	200	LF	60.96	m	$41.64	$8,327	
240	FRP Ladder	16	EA			$2,028.03	$32,449	
241	Allowance for Misc Items	5%				$40,775.82	$2,039	
242	Subtotal						$42,815	
243								
244	THERMAL & MOISTURE PROTECTION:							
245	Concrete Liner	0	SF	0.00	m2	**$16.00**	$0	
246	Allowance for Misc Items	10%				$0.00	$0	
247	Subtotal						$0	
248								
249	DOORS & WINDOWS:							
250	Stainless Steel Door (2' x 2') for O/U Baffling	16	EA			$1,332.36	$21,318	
251	Stainless Steel Door (7' x 2.5') for O/U Baffling	16	EA			$5,829.09	$93,265	
252	Stainless Steel Door (2' x 2') for Serpentine Baffling	0	EA			$1,332.36	$0	
253	Allowance for Misc Items	5%				$114,583.32	$5,729	
254	Subtotal						$120,312	
255								
256	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
257	Horizontal Paddle Wheel Flocculation Mechanism (Paddles & Drives)	600	LF	182.88	m	***$1,627.75***	$976,648	
258	Vertical Paddle Wheel Flocculation Mechanism (Paddles & Drives)	0	EA			***$0.00***	$0	
259	Vertical Turbine Flocculation Mechanism (Turbines & Drives)	0	hp	0.00	kW	***$0.00***	$0	
260	Vertical Turbine Flocculator VFD's	0	hp	0.00	kW	***$0.00***	$0	
261	Fabricated Slide Gate	8	EA			***$9,614.74***	$76,918	
262	Allowance for Misc Items	10%				$1,053,565.57	$105,357	
263	Subtotal						$1,158,922	
264								
265	ELECTRICAL:							
266	*MCC's*							
267	Sections	16	EA			***$10,730.27***	$171,684	
268	*AFD's*							
269	Flocculation Mixers Stage 1 (total facility) (3 hp each)	8	EA			***$9,258.95***	$74,072	
270	Flocculation Mixers Stage 2 (total facility) (1 hp each)	8	EA			***$8,996.69***	$71,974	
271	Flocculation Mixers Stage 3 (total facility) (1 hp each)	8	EA			***$8,996.69***	$71,974	
272	Flocculation Mixers Stage 4 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
273	Flocculation Mixers Stage 5 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
274	Flocculation Mixers Stage 6 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
275	*Switchgear*							
276	Units	0	EA			***$49,359.23***	$0	
277	Electrical Conduit & Wire	10,440	LF	3,182.11	m	***$12.06***	$125,896	
278	Allowance for Misc Items	10%				$515,598.67	$51,560	
279	Subtotal						$567,159	
280								
281	INSTRUMENTS & CONTROLS:							
282	Instruments							
283	Level Switch	8	EA			***$695.44***	$5,564	
284	Number of Analog I/O Counts	58	EA			***$264.27***	$15,222	
285	Number of Digital I/O Counts	144	EA			***$62.59***	$9,013	
286	Number of PLC's	1	EA			***$13,074.33***	$13,074	
287	I&C Conduit & Wire	13,664	LF	4,164.79	m	***$12.06***	$164,774	
288	Allowance for Misc Items	10%				$207,646.55	$20,765	
289	Subtotal						$228,411	
290								
291	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
292	Item 1 Description	0.00		0.00		0.00	$0	
293	Item 2 Description	0.00		0.00		0.00	$0	
294	Item 3 Description	0.00		0.00		0.00	$0	
295	Item 4 Description	0.00		0.00		0.00	$0	
296	Item 5 Description	0.00		0.00		0.00	$0	
297	Item 6 Description	0.00		0.00		0.00	$0	
298	Item 7 Description	0.00		0.00		0.00	$0	
299	Item 8 Description	0.00		0.00		0.00	$0	
300	Item 9 Description	0.00		0.00		0.00	$0	
301	Item 10 Description	0.00		0.00		0.00	$0	
302	Item 11 Description	0.00		0.00		0.00	$0	
303	Item 12 Description	0.00		0.00		0.00	$0	
304	Item 13 Description	0.00		0.00		0.00	$0	
305	Item 14 Description	0.00		0.00		0.00	$0	
306	Item 15 Description	0.00		0.00		0.00	$0	
307	Subtotal						$0	
308								
309	Subtotal						$6,953,253	
310								
311	ALLOWANCES:		**User Override**					
312	Finishes Allowance	2.00%		$7,557,883	$151,158			
313	I&C Allowance	2.00%		$7,557,883	$151,158			
314	Mechanical Allowance	2.00%		$7,557,883	$151,158			
315	Electrical Allowance	2.00%		$7,557,883	$151,158			
316						Facility Cost Name		
317	Facility Cost	**160,000,000**	**GPD**	**$0.05**	**$7,557,883**	FCPFC01		
318	Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.06**	**$9,184,113**	FCPFC02		

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	B	C	D	E	F	G	H	I
319	Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$0.10**	**$15,752,397**	FCPFC03		
320	Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$0.08**	**$12,963,122**	FCPFC05		
321	Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$0.10**	**$15,752,397**	FCPFC06		

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	B	C	D	E	F	G	H	I
1	***Dissolved Air Flotation***							
2								
3	**Is This Facility Included in My Project? Yes**							
4	***Assumptions:***							
5								
6	***1.) High-rate DAF based on Infilco Degremont AquaDAF.***							
7	***2.) Conventional DAF based on Parkson DAF.***							
8	***3.) Precede DAF with Flocculation with equal basin width to DAF.***							
9	***4.) Default System includes Mechanical Float Skimming.***							
10	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
11	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
12	DAF SYSTEM SIZING							
13	1.) Is this a Seawater Desalination Application?	**No**	Y/N					
14	2.) Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N					Fixed
15	3.) Input Total Plant Flow	**160.00**	mgd	**605.67**	ML/d	Q		
16	Conversion of Total Plant Flow from MGD to GPM	111,111.11	gpm	25,236.08	m3/hr	QM		
17	4.) Input DAF Type	**High Rate**	Type			DTYP		Conventional OR High Rate
18	5.) Input Flotation Zone Surface Loading Rate	**10.00**	gpm/sf	**24.45**	m/h	FSLR		Typically, 4 to 6 gpm/sf for Conventional & 10 to 12 gpm/sf for High Rate
19	6.) Input Flotation Zone Side Water Depth	**15.00**	ft	**4,572.00**	mm	SWD		Typically 10 to 15 feet
20	Calculate Total Surface Area of Flotation Zone per Train = QM/FSLR	11,111.11	sf	1,032.26	m2	FZA		
21	7.) For Conventional DAF, Select Single Train Flotation Area from Standard Sizes	**1,395.00**	sf	129.60	m2	SCTS		
22	8.) For High Rate DAF, Select Single Train Flotation Area from Standard Sizes	**717.00**	sf	66.61	m2	SHTS		
23	Calculate Number of Trains	16	#			NT		
24	Calculate Length of Flotation Zone	17.90	ft	5,455.92	mm	FZL		
25	Calculate Width of Flotation Zone	40.00	ft	12,192.00	mm	FZW		
26	Calculate Capacity of Each Train	6,944.44	gpm	1,577.25	m3/hr	QTM		
27	9.) Input Influent Channel, Contact Zone, and Effluent Channel Velocity	**0.50**	fps	**0.15**	m/s	VEL		Typically < 0.5 fps
28	Calculate Influent Channel, Contact Zone, and Effluent Channel Length = QTM/7.48/60/VEL/FZW OR 3	3.00	ft	914.40	mm	ICL, CZLB, SBL, ECL		
29	Calculate Contact Zone Under Baffle Entry Opening Height = QTM/7.48/60/VEL/FZW OR 3	3.00	ft	914.40	mm	CZEH		
30	Calculate Contact Zone Top Length = sin(15)/cos(15)*(CZBH - CZEH) + CZLB	6.35	ft	1,935.29	mm	CZLT		
31	Effluent Collection System Plenum Height for High Rate DAF	3.00	ft	914.40	mm	PH		
32	10.) Input Effluent Collection Lateral Velocity for Conventional DAF	**2.50**	fps	**0.76**	m/s	ECVEL		Typically 2.5 fps or less
33	Number of Effluent Collection Laterals for Conventional DAF	0.00	#			NCL		
34	Calculate Effluent Collection Lateral Pipe Diameter for Conventional DAF Train	0.00	in	0.00	mm	CLD		2.5 feet lower than effluent weir
35	Calculate Effluent Collection Lateral Spacing for Conventional DAF Train	0.00	ft	0.00	mm	CLSP		2.5 feet lower than effluent weir
36	Calculate Contact Zone 75-Degree Exit Baffle Height =	15.50	ft	4,724.40	mm	CZBH		2.5 feet lower than effluent weir
37	Calculate Float Weir Height = SWD+PH+0.5	18.50	ft	5,638.80	mm	FWH		0.5 feet higher than effluent weir
38	Sludge Float Trough Width	1.50	ft	457.20	mm	FTW		
39	Calculate Sludge Float Trough Depth	4.00	ft	1,219.20	mm	FTD		Based on hydraulic float removal at 3 fps
40	Calculate Recycle Pumping & Compressor Gallery Length	17.58	ft	5,359.40	mm	GL		
41	11.) Input Freeboard	**3.00**	ft	**1,219.20**	mm	FB		Typically 2 to 4 feet
42	Calculate Basin Depth BD = SWD+PH+FB	21.00	ft	6,400.80	mm	BD		
43	12.) Input Structure Depth of Burial	**0.00**	ft	**1,828.80**	mm	DB		
44	13.) Is the Basin Covered?	**No**	Y/N					
45	SATURATED AIR RECYCLE SYSTEM SIZING							
46	14.) Input Grams of Air per Cubic Meter Water Treated	**10.00**	g/m3			ALR		Typically 8 to 10 g/m3
47	15.) Input Air Saturation Recycle Stream Pressure	**85.00**	psig	**586.05**	kPa	RSP		Typically 60 to 90 psig
48	Conversion of Air Saturation Recycle Stream Pressure from PSIG to kPA	586.06	kPa			RSPM		
49	16.) Input Maximum Water Temperature	68.00	degrees F	**20.00**	degrees C	WT		Valid Range: 0 - 40 deg C. Warmer water requires greater recycle ratio for a given air loading rate and recycle stream pressure.
50	Dynamic (Absolute) Viscosity of Water	0.000021	lb•s/sf	0.001002	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
51	Calculate Air Dissolution at Recycle Stream Pressure & Water Temperature	117.21	mg/L			AD		See Data from air dissolution graphs worksheet
52	Calculate Air Saturation Recycle Stream Ratio = ALR/AD	0.09				ARR		
53	Calculate Number of Packed Saturators	16.00	#			#S		Equals Number of Trains
54	17.) Input Saturator Surface Loading Rate	**34.00**	gpm/sf	**83.12**	m/h			Typically 34 gpm/sf
55	18.) Input Saturator Packing Depth	**4.00**	ft	**1,219.20**	mm			Typically 4 feet or 0 feet, if No Packing
56	19.) Input Saturator Bottom Pool Depth	**3.00**	ft	**914.40**	mm			Typically 3 feet
57	20.) Input Saturator Freeboard Above Packing	**3.00**	ft	**914.40**	mm			Typically 3 feet
58	21.) Input Saturator Clear Height Above Deck	**3.00**	ft	**914.40**	mm			Typically 3 feet
59	22.) Input Saturator Inlet Velocity	**5.00**	fps	**1.52**	m/s			Typically 5 fps
60	23.) Input Saturator Outlet Velocity	**2.50**	fps	**0.76**	m/s			Typically 2.5 fps
61	Calculate Saturator Diameter	4.71	ft	1,435.70	mm	SD		
62	Calculate Saturator Height	13.00	ft	3,962.40	mm	SH		
63	Calculate Saturator Inlet Header Diameter	6.96	in	176.72	mm	SIHD		
64	Calculate Saturator Inlet Lateral Diameter	4.92	in	124.96	mm	SILD		
65	Calculate Saturator Outlet Header Diameter	9.84	in	249.91	mm	SOHD		
66	Calculate Saturator Outlet Half-Lateral Diameter	6.96	in	176.72	mm	SOHLD		
67	Calculate Number of Saturator Sub-Laterals	5.00	#			NSL		
68	Calculate Saturator Sub Lateral Diameter	4.40	in	111.77	mm	SOSLD		
69	Calculate Saturator Outlet Nozzle Header Diameter	3.48	in	88.36	mm	SODH		
70	Calculate Number of Recycle Pumps	16.00	#			#RP		Equals Number of Trains

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	B	C	D	E	F	G	H	I
71	Calculate Recycle Pump Capacity, each = QTM*ARR	592.47	gpm	134.56	m3/hr	RPC		
72	Calculate Recycle Pump Power, each = RPC*RSP/1714/0.75	40.00	hp	29.83	kW	RPP		
73	24.) Select Standard Recycle Pump Horsepower	**55.00**	hp	41.01	kW			Based on ITT Goulds Model 3196 Horizontal End Suction Centifugal Pump
74	Calculate Recycle Pump Suction Diameter	8.00	in	203.20	mm	RPS		
75	Calculate Recycle Pump Discharge Diameter	6.00	in	152.40	mm	RPD		
76	Calculate Recycle Pump Length	5.58	ft	1,701.80	mm	RPL		
77	Calculate Recycle Pump Width	2.00	ft	609.60	mm	RPW		
78	Calculate Recycle Pump Height	3.25	ft	990.60	mm	RPH		
79	Calculate Number of Compressors	2.00	#			#C		1 Duty and 1 Standby
80	25.) Input Compressor Inlet Air Density	**0.08**	lb/cf	**1.28**	kg/m3	IAD		0.075 for Dry Air @ Sea Level and 70 deg F
81	Calculate Compressor Capacity, each = AD*Q*ARR*8.3454/1440/IAD	115.91	icfm	3.28	m3/min	CC		
82	26.) Select Standard Rotary Screw Compressor Capacity	**116.00**	scfm	3.28	m3/min			Based on Gardner Denver Rotary Screw Compressor
83	Calculate Compressor Power	30.00	hp	22.37	kW	CHP		
84	Calculate Compressor Length	3.96	ft	1,206.50	mm	CL		
85	Calculate Compressor Width	2.46	ft	749.30	mm	CW		
86	Calculate Compressor Height	5.42	ft	1,651.00	mm	CH		
87	27.) Input Minimum Number of DAF Trains On-Line to Size Compressor Receiver Storage Volume	**1.00**	#			MDT		
88	28.) Input Maximum Number of Compressor Motor Starts per Hour	**3.00**	#			MMS		Typically 3 to 4
89	Calculate Minimum Compressed Air Use	7.24	icfm	0.21	m3/min	MCA		
90	29.) Input Compressed Air Density	**0.63**	lb/cf	**10.09**	kg/m3	CAD		0.626 for Dry Air @ 120 psig and 120 deg F
91	Calculate Minimum Receiver Storage Volume for 125 psig/120 deg F Air	2,064.42	gal	7.81	m3	TRSV		Calculated
92	Calculate Number of Receivers	2.00	#			#R		1 Duty and 1 Standby
93	30.) Select Standard Receiver Volume	**2,180.00**	gal	**8.25**	m3	SRSV		
94	Calculate Receiver Storage Diameter, each	5.00	ft	1,524.00	mm	RSD		
95	Calculate Receiver Storage Height w/1-Foot Stand, each	6.00	ft	1,828.80	mm	RSH		
96	Calculate Receiver Storage Length, each	16.00	ft	4,876.80	mm	RSL		
97	**(1) PARKSON CONVENTIONAL DAF SINGLE TRAIN STANDARD FLOTATION AREA (SF)**	**(2) Flotation Basin Width (ft)**	**(3) Flotation Basin Length (ft)**	**(4) Budget Quote**	**(5) Number of Saturator Outlet Quarter Laterals**	**(6) Number of 14-inch Perforated Effluent Collection Laterals on 4-foot Centers**	**(1) IDI High Rate AQUADAF Single Train Standard Flotation Area (SF)**	**(2) Flotation Basin Width (ft)**
98	720	24	30	$ 376,505.00	3.0	8.0	65	8.0
99	920	27	34	$ 455,513.00	4.0	8.0	110	12.0
100	1040	29	36	$ 502,918.00	4.0	8.0	162	16.0
101	1150	30	38.5	$ 546,372.00	4.0	8.0	222	20.0
102	1395	30	46.5	$ 643,157.00	4.0	8.0	292	24.0
103							369	28.0
104							463	32.0
105							581	36.0
106							717	40.0
107	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
108	Estimating Dimensions (per Train):							
109	DAF Basin							
110	Slab on Grade:							
111	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on18"
112	Concrete Thickness	2.00	ft	609.60	mm	TLCS0G		
113	SOG Width (2 + PWLC + FZW + PWLC + 2)	48.00	ft	14,630.40	mm	WLCSOG		Assumes no common wall
114	SOG Length (IWLC + CL + IWLC + CL + CZBH/2*SIN15 + FZL + IWLC + STW + IWLC + CL + IWLC + CL + PWLC + 2)	46.69	ft	14,231.03	mm	LLCSOG		
115	Perimeter Walls:							
116	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 16"
117	Concrete Thickness	2.00	ft	609.60	mm	PWLC		
118	Wall Length = (L + L + W)	133.38	ft	40,654.06	mm			
119	Wall Height = BD	21.00	ft	6,400.80	mm			
120	Internal Walls:							
121	Concrete Thickness	**15.00**	in	**381.00**	mm			Model based on 12"
122	Concrete Thickness	1.25	ft	381.00	mm	IWLC		
123	Wall Length = (5 * FZW)	200.00	ft	60,960.00	mm			
124	Wall Height = BD - FB	18.00	ft	5,486.40	mm			
125	Elevated Slab:							
126	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 12"
127	Concrete Thickness	1.50	ft	457.20	mm	TESLC		
128	Elevated Slab Length = (L + L + W + W)	177.38	ft	54,065.26	mm			Assumes Perimeter Walkway on all 4 sides
129	Elevated Slab Width	6.00	ft	1,828.80	mm	TESIC		Fixed
130								
131	Gallery							
132	Slab on Grade:							
133	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 18"
134	Concrete Thickness	2.00	ft	609.60	mm	TECS0G		
135	SOG Width (Match DAF Basin)	48.00	ft	14,630.40	mm	WECSOG		
136	SOG Length (2 + TWEC + GL + TWEC + 2)	25.58	ft	7,797.80	mm	LECSOG		
137	Walls:							
138	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 16"
139	Concrete Thickness	2.00	ft	609.60	mm	TWEC		
140	Wall Length = (GL + W + GL)	75.17	ft	22,910.80	mm			
141	Wall Height = BD	21.00	ft	6,400.80	mm			
142	Elevated Slab:							
143	Concrete Thickness	**15.00**	in	**381.00**	mm			Model based on 12"
144	Concrete Thickness	1.25	ft	381.00	mm	TESEC		
145	Elevated Slab Width (Match DAF Basin)	44.00	ft	13,411.20	mm			

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	B	C	D	E	F	G	H	I
146	Elevated Slab Length (TWEC + GL + TWEC)	21.58	ft	6,578.60	mm	TESIC		
147								
148	Overall Dimensions:							
149	SOG Width	48.00	ft	14,630.40	mm	SOGW		
150	SOG Length	72.27	ft	22,028.83	mm	SOGL		
151	Building Width (SOGW - 4)	44.00	ft	13,411.20	mm			
152	Building Length (SOGL - 4)	68.27	ft	20,809.63	mm			
153	Excavation Width	52.00	ft	15,849.60	mm			
154	Excavation Length	76.27	ft	23,248.03	mm			
155	Excavation Depth (DB + TLCSOG + 1)	3.00	ft	914.40	mm			
156								
157								
158	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
159	SITEWORK:							
160	Excavation	8,663.36	CY	6,623.62	m3	***$6.72***	$58,244	
161	Imported Structural Backfill	2,350.34	CY	1,796.96	m3	***$50.94***	$119,730	
162	Native Backfill	684.12	CY	523.05	m3	***$8.27***	$5,654	
163	Haul Excess	7,979.24	CY	6,100.57	m3	***$8.27***	$65,951	
164	Allowance for Misc Items	5%				$249,579.71	$12,479	
165	Subtotal						$262,059	
166								
167	CONCRETE:							
168	*DAF Basin:*							
169	Foundation	2,656.13	CY	2,030.75	m3	***$541.11***	$1,437,246	
170	Perimeter Walls	3,319.67	CY	2,538.07	m3	***$880.79***	$2,923,940	
171	Internal Walls	2,666.67	CY	2,038.81	m3	***$1,333.77***	$3,556,710	
172	Elevated Slab	946.02	CY	723.29	m3	***$490.62***	$464,135	
173	*Gallery:*							
174	Foundation	1,455.41	CY	1,112.74	m3	***$541.11***	$787,529	
175	Walls	1,870.81	CY	1,430.34	m3	***$880.79***	$1,647,801	
176	Elevated Slab	703.46	CY	537.83	m3	***$1,333.77***	$938,247	
177	Allowance for Misc Items	5%				$11,755,607.51	$587,780	
178	Subtotal						$12,343,388	
179								
180	MASONRY:	**High**						
181	CMU Building	0.00	SF	0.00	m2	***$198.37***	$0	
182	Subtotal						$0	
183								
184	METALS:							
185	Aluminum Handrail	1,924.37	LF	586.55	m	***$90.92***	$174,960	
186	Additional Handrail with NO Building	1,544.55	LF	470.78	m	***$90.92***	$140,427	
187	Aluminum Grating	960.00	SF	89.19	m2	***$90.92***	$87,281	
188	Stairs (1 per basin)	504.00	RISERS			***$495.92***	$249,942	
189	Allowance for Misc Items	10%				$652,611.06	$65,261	
190	Subtotal						$717,872	
191								
192	WOODS & PLASTICS:							
193	FRP Ladder	32.00	EA			***$2,050.07***	$65,602	
194	Allowance for Misc Items	5%				$65,602.22	$3,280	
195	Subtotal						$68,882	
196								
197	THERMAL & MOISTURE PROTECTION:							
198	Concrete Liner	0.00	SF	0.00	m2	**$16.00**	$0	
199	Allowance for Misc Items	10%				$0.00	$0	
200	Subtotal						$0	
201								
202	EQUIPMENT:							
203								**Budgetary Quote: (CPES will automatically add Installation Factor)**
204	Conventional DAF Equipment Scope of Supply per DAF Unit	16.00	EA			***$0.00***	$0	
205	Single Train Flotation Area (sf):	1,395.00						
206	Surface Skimmer, 304 SS reciprocating type mechanisms and							
207	Sludge Beach, 304SS with mounting hardware.							
208	Air Dispersion System, SCH 10 304SS vertical riser with isolation valves and lateral header with nozzles, for 10% recycle @ design flow.							
209	Recycle Pumps, base mounted Goulds Model 3196, suction and discharge wafer style isolation valves, check valves and magnetic flow meter with transmitter, One installed spare.							
210	Underflow Collection Pipes, SCH 80 PVC with 304 SS support brackets.							
211	Effluent Level Control Weir, FRP or SS with mounting hardware							
212	Sludge hopper spray system with spray nozzles and auto valve.							
213	Packed Tower Saturator with level control valve, outlet with isolation valve, air pressure controls and air filters with isolation valving.							
214	Duplex Screw Compressor and air receiver, each @ 100% of air required.							
215	Control Panel with PLC for process control and HOA operations.							
216	Lot of Isolation Valves, Anchors and Fasteners for supplied equipment.							
217	Submittals, Startup Services and IOM Manual							
218								
219	High Rate DAF Equipment Scope of Supply per DAF Unit	16.00	EA			***$1,774,928.51***	$28,398,856	
220	Single Train Flotation Area (sf):	717.00						
221	Mechanical sludge scraper system.							
222	Sludge Beach, 304SS with mounting hardware.							
223	Air Dispersion System, SCH 10 304SS vertical riser with isolation valves and lateral header with nozzles, for 10% recycle @ design flow.							
224	Recycle Pump, vertical turbine pumps per unit with VFD, butterfly isolation and check valves.							
225	Aluminum false flooring and support columns.							

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	B	C	D	E	F	G	H	I
226	Effluent Level Control Weir, FRP or SS with mounting hardware							
227	Sludge hopper spray system with spray nozzles and auto valve.							
228	Unpacked Saturator with level control valve, outlet with isolation valve, air pressure controls and air filters with isolation valving.							
229	Rotary Screw Compressor and air receiver system.							
230	Control Panel with PLC for process control and HOA operations.							
231	Lot of Isolation Valves, Anchors and Fasteners for supplied equipment.							
232	Submittals, Startup Services and IOM Manual							
233	Allowance for Misc Items	10%				$28,398,856.23	$2,839,886	
234	Subtotal						$31,238,742	
235								
236	INSTRUMENTS & CONTROLS:							
237	Turbidimeters	16.00	EA			***$11,714.68***	$187,435	
238	Allowance for Misc Items	5%				$187,434.90	$9,372	
239	Subtotal						$196,807	
240								
241	MECHANICAL:							
242	Mud Valves	48.00	EA			***$2,252.82***	$108,136	
243	Allowance for Misc Items	10%				$108,135.52	$10,814	
244	Subtotal						$118,949	
245								
246	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
247	Item 1 Description	0.00		0.00		0.00	$0	
248	Item 2 Description	0.00		0.00		0.00	$0	
249	Item 3 Description	0.00		0.00		0.00	$0	
250	Item 4 Description	0.00		0.00		0.00	$0	
251	Item 5 Description	0.00		0.00		0.00	$0	
252	Item 6 Description	0.00		0.00		0.00	$0	
253	Item 7 Description	0.00		0.00		0.00	$0	
254	Item 8 Description	0.00		0.00		0.00	$0	
255	Item 9 Description	0.00		0.00		0.00	$0	
256	Item 10 Description	0.00		0.00		0.00	$0	
257	Item 11 Description	0.00		0.00		0.00	$0	
258	Item 12 Description	0.00		0.00		0.00	$0	
259	Item 13 Description	0.00		0.00		0.00	$0	
260	Item 14 Description	0.00		0.00		0.00	$0	
261	Item 15 Description	0.00		0.00		0.00	$0	
262	Subtotal						$0	
263								
264	Subtotal						$44,946,699	
265								
266	ALLOWANCES:		**User Override**					
267	Finishes Allowance	2.00%		$53,507,975	$1,070,159			
268	I&C Allowance	4.00%		$53,507,975	$2,140,319			
269	Mechanical Allowance	6.00%		$53,507,975	$3,210,478	Includes Drain, USL, SA (Sample) piping		
270	Electrical Allowance	4.00%		$53,507,975	$2,140,319			
271						Facility Cost Name		
272	**Facility Cost**	**160,000,000**	**GPD**	**$0.33**	**$53,507,975**	CDFFC01		
273	**Facility Cost with Standard Additional Project Costs Added**	**160,000,000**	**GPD**	**$0.41**	**$65,021,284**	CDFFC02		
274	**Facility Cost with Standard Additional Project Costs and Contractor Markups Added**	**160,000,000**	**GPD**	**$0.70**	**$111,523,138**	CDFFC03		
275	**Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)**	**160,000,000**	**GPD**	**$0.57**	**$91,775,752**	CDFFC05		
276	**Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added**	**160,000,000**	**GPD**	**$0.70**	**$111,523,138**	CDFFC06		

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	B	C	D	E	F	G	H	I
1	***Ozone - Serpentine***							
2	**PROCESS DESIGN CRITERIA**							
3	**Is This Facility Included in My Project? No**							
4	**Type of Feed Gas: Delivered LOX**							
5	**Type of Dissolution: Diffused Bubble**							
6	**Type of Contactor: Serpentine**							
7	**Number of parallel trains or contactors: Minimum of 2**							
8								
9	**Process User Inputs:**	**Value (English)**	**Value (English)**	**Value (Metric)**	**Value (Metric)**	**Name**	**Red Flags**	**Comment**
10	1.) Input Summer Maximum Plant Flow Rate	**160.00**	mgd	**605.67**	ML/d			
11	2.) Input Winter Maximum Plant Flow Rate	**70.00**	mgd	**264.98**	ML/d			
12	3.) Input Maximum Oxidation Flow Rate	**160.00**	mgd	**605.67**	ML/d			
13	4.) Input Number of Contactors	**4**	each	4.00	each			Typically 2 minimum.
14								
15	**Process User Inputs:**	**Value (English)**	**Value (English)**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Value (Metric)**	**Value (Metric)**
16	Ozone Chemistry and Contactor Sizing:	**Summer**	**Winter**	**Oxidation**		**Summer**	**Winter**	**Oxidation**
17	4.) Input Water Temperature	77.00	42.80	42.80	degrees F	**25.00**	**6.00**	**6.00**
18	Calculate Maximum Plant Flow Rate	160.00	70.00	160.00	mgd	605.67	264.98	605.67
19	5.) Input Ozone Immediate Demand	**0.40**	**0.40**	**1.00**	mg/L	0.40	0.40	1.00
20	6.) Input Ozone Residual Development to Ozone Transferred Ratio	**0.40**	**0.40**	**0.40**	Slope development line	0.40	0.40	0.40
21	Calculate Ozone Residual Intercept	-0.16	-0.16	-0.40	mg/L	-0.16	-0.16	-0.40
22	7.) Input Ozone Residual Decay Rate	**0.30**	**0.15**	**0.15**	1/min	0.30	0.15	0.15
23	8.) Input Ozone Transfer Efficiency	**95.00%**	**95.00%**	**95.00%**		95.00%	95.00%	95.00%
24	9.) Input Hydraulic Retention Time for Disinfection Cell at Max Flow	**5.00**	11.43	5.00	minutes	5.00	11.43	5.00
25	10.) Input Short Circuiting Factor for Disinfection Cell	**0.60**				0.60	0.00	0.00
26	Calculate T10 Time for Disinfection Cell	3.00	6.86	3.00	minutes	3.00	6.86	3.00
27	Calculate Disinfection Cell Water Volume, Each Train	18,566.75	18,566.75	18,566.75	cf	525.75	525.75	525.75
28	Calculate Required Disinfection Contactor Water Volume, Each Train	18,566.75			cf	525.75		
29	11.) Input Hydraulic Retention Time for AOP Contactor at Max Flow	**5.00**	11.43	5.00	minutes	5.00	11.43	5.00
30	12.) Input Short Circuiting Factor for AOP Contactor	**0.60**	0.60	0.60		0.60	0.60	0.60
31	Calculate T10 Time for AOP Contactor	3.00	6.86	3.00	minutes	3.00	6.86	3.00
32	Calculate AOP Contactor Water Volume, Each Train	18,566.75	18,566.75	18,566.75	cf	525.75	525.75	525.75
33	Calculate Required AOP Contactor Water Volume, Each Train	18,566.75			cf	525.75		
34	13.) Input Desired Cryptosporidium Log Inactivation	**0.0**	**0.0**	**0.0**	-log	0.00	0.00	0.00
35	Calculate Required Cryptosporidium Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
36	14.) Input Desired Giardia Log Inactivation	**0.0**	**0.0**	**0.0**	-log	0.00	0.00	0.00
37	Calculate Required Giardia Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
38	15.) Input Desired Virus Log Inactivation	**0.0**	**0.0**	**0.0**	-log	0.00	0.00	0.00
39	Calculate Required Virus Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
40	Calculate Controlling Required Pathogen Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
41	16.) Input Design Applied Ozone Dose	**1.50**	**1.50**	**3.00**	mg/L	1.50	1.50	3.00
42	Calculate Transferred Ozone Dose	1.43	1.43	2.85	mg/L	1.43	1.43	2.85
43	Calculate Ozone Generation Capacity	2,002.90	876.27	4,005.79	lb/d	908.50	397.47	1,817.00
44	17.) Input if Hydrogen Peroxide required	**No**	**No**	**No**	Y/N	No	No	No
45	Calculate Initial Residual in Disinfection Contactor	0.41	0.41	0.74	mg-min/L	0.41	0.41	0.74
46	Calculate End Residual in Disinfection Contactor	0.09	0.07	0.35	mg-min/L	0.09	0.07	0.35
47	Calculate CT Achieved in Disinfection Contactor	0.27	0.51	1.05	mg-min/L	0.27	0.51	1.05
48	Calculate Initial Residual in AOP Contactor	0.09	0.07	0.35	mg-min/L	0.09	0.07	0.35
49	Calculate End Residual in AOP Contactor	0.02	0.01	0.17	mg-min/L	0.02	0.01	0.17
50	Calculate CT Achieved in AOP Contactor	0.06	0.09	0.50	mg-min/L	0.06	0.09	0.50
51	Calculate Total CT Achieved in Full Contactor	0.34	0.60	1.54	mg-min/L	0.34	0.60	1.54
52	**Process User Inputs:**	**Value (English)**	**Value (English)**	**Value (Metric)**	**Value (Metric)**	**Name**	**Red Flags**	**Comment**
53	18.) Input Contactor Side Water Depth	**20.00**	ft	**6,096.00**	mm	SWD		Typically 20 ft for Good Transfer Efficiency
54	Distance from Top of SWD to Roof of Building	3.00	ft		mm	FB		Fixed
55	19.) Input Desired AOP Contactor Length to Width Ratio	**20.00**						Typically 20 to 40:1 to Promote Plug Flow
56	20.) Input Odd Number of Passes, Minimum 3 Passes	**3**	#			NP		
57	Calculate Pass Water Width	6.81	ft	2,076.60	mm	SPW		
58	Calculate Pass Water Length	45.42	ft	13,844.00	mm	SPL		
59	Calculate Contactor Water Width	22.78	ft	6,943.03	mm	CW		

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	B	C	D	E	F	G	H	I
60	Calculate Injection Cell Length	8.46	ft	2,577.43	mm	ICL		
61	Calculate Disinfection Cell Water Length	40.75	ft	12,421.86	mm	DCL		
62	Calculate Upflow Cell Water Length Required	6.79	ft	2,070.31	mm	UCL		
63	Calculate Overflow Channel Length	10.00	ft	3,048.00	mm	OFL		
64	Calculate Effluent Weir Distance from Contactor Outlet	6.81	ft	2,076.60	mm	EWCL		
65	Calculate Effluent Weir Head	1.95	ft	595.07	mm	WH		
66	Ozone Generation and Off-Gas Destruction Sizing:							
67	Calculate Ozone Design Dose	3.00	mg/L	3.00	mg/L			Maximum of Design Applied Ozone Dose
68	Calculate Design Daily Ozone Generation Capacity	4,005.79	lb/d	1,817.00	kg/d			Maximum of Ozone Generation Capacity
69	21.) Input Design Ozone Weight Percent	**10%**						Either 10% or 12%
70	Calculate Design Daily Oxygen Usage	40,057.92	lb/d	18,169.97	kg/d			
71	Calculate Ozone Generation Capacity at 10% Weight	4,005.79	lb/d	1,817.00	kg/d			
72	Standby Ozone Generation Capacity Provided at 10% Weight	0%						Fixed
73	Calculate Ozone Generation Capacity at 8% Weight	6,409.27	lb/d	2,907.19	kg/d			
74	Standby Ozone Capacity Provided at 8% Weight	60%						Fixed
75	Convert Design Daily Oxygen Usage from lb/d to scfm	335.00	scfm	9.49	m3/min			Assumes gaseous oxygen density of 0.08304 lb/ft3 at standard conditions of 1 atm and 20 deg C.
76	Calculate Number of Porous Plate Dome Diffusers for Dissolution	335.00	#					Based on 1 scfm per 7-inch diameter Sanitaire Ozone dome diffuser at 20-inch water headloss.
77	Calculate Minimum Area Required to Accommodate Diffusers	770.49	sf	71.58	m2			Based on 1 diffuser per 2.3 square foot (i.e., spacing at 18 inches)
78	22.) Input Number of Active Ozone Generators	**2**	#					
79	23.) Input Number of Standby Ozone Generators	**1**	#					Typically 1 or Rely on Higher Production Capacity at Lower Ozone Concentration
80	Calculate Design Ozone Generator Capacity, Each	2,002.90	lb/d	908.50	kg/d			
81	Calculate Total Number of Generators	3	#					
82	24.) Select Ozone Cooling Water System	**Closed Loop**					**Open loop is not acceptable**	
83	25.) Input Ozone Generator and Power Supply Unit Energy Consumption	**4.70**	kWh/lb	**10.36**	kWh/kg			Typically 4.5 to 7 kWh/lb
84	26.) Input Ozone Generator and Power Supply Unit Energy Consumption Conversion to Waste Heat	**85%**						Typically 85% to 95%
85	Calculate Maximum Waste Heat Generation Rate	60,705.24	BTU/min	25,618.97	kWh/d			
86	27.) Input Design Temperature Rise for Heat Rejection Water	**7.50**	degrees F	-13.61	degrees C			Typically 5 to 10 deg F
87	28.) Input Heat Exchanger Efficiency	**90%**						Typically 70% to 90%
88	Calculate Preliminary Heat Rejection Water Flow Rate	1,077.64	gpm	67.99	L/s			Confirm cooling water requirement with ozone generator supplier or specify refrigerant chiller system.
89	Calculate Preliminary Cooling Pump Horsepower, Each	9.72	hp	7.25	kW			Assume 25 ft TDH and 70% pump efficiency
90	29.) Input Design Days of Liquid Oxygen Storage at Design Ozone Weight Percent	**30.00**	days					
91	Calculate Total Liquid Oxygen Storage	1,201,737.60	lb	545,099.01	kg			
92	Convert Total Liquid Oxygen Storage from lb to gallons	126,232.94	gal	477,843.67	L			
93	Calculate Minimum Days of Liquid Oxygen Storage at 10% Ozone	30.00	days					
94	Calculate Minimum Days of Liquid Oxygen Storage at 8% Ozone	15.00	days					
95	30.) Input Number of Liquid Oxygen Storage Tanks	**3**	#					Typically 2 or More
96	Calculate Volume of Liquid Oxygen Storage Tank, Each	42,077.65	gal	159,281.22	L			
97	31.) Input Liquid Oxygen Storage Tank, Diameter	**12.00**	ft	**3,657.60**	mm	DLOX		Typically 14' or Less
98	32.) Indicate Orientation of LOX Tank	**Horizontal**						Use Horizontal Only if There is an Aesthetic Concern
99	Calculate Liquid Oxygen Storage Tank Length/Height	49.74	ft	15,159.41	mm	LLOX		
100	Calculate Number of Liquid Oxygen Vaporizers	3	#			#VP		Fixed to Equal Number of Tanks, Minimum of 2
101	Liquid Oxygen Vaporizer Footprint, each	24.00	sf	2.23	m2	VPFP		Fixed
102	Number of Active Thermal Catalytic Ozone Destructors	4	#					Fixed to Equal Number of Contactors
103	33.) Input Number of Standby Thermal Catalytic Ozone Destructors	**1**	#					
104	34.) Input Design Ozone Weight % in Ozone Off-Gas to Thermal Catalytic Ozone Destructors	**2.40%**						Typically assume worst case ozone transfer efficiency to contactor and highest ozone production concentration in the feed gas. If 80% transfer worst case at 12% ozone concentration, then (1-0.8)*0.12*100 = 2.4%.
105	35.) Do Destruct Units Need Enclosure for Noise Concerns?	**Yes**						Locate Indoors if Noise is a Concern

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	B	C	D	E	F	G	H	I
106	Calculate Capacity of Thermal Catalytic Ozone Destructor, Each	115.15	scfm	3.26	m3/min			Assumes 110% of the gas flow at 8% ozone by weight. Assumes gaseous oxygen density of 0.08304 lb/ft3 at standard conditions of 1 atm and 20 deg C.
107	36.) Input Cooling Water Flow per Generator - value to come from Vendor	700.00	gpm	44.16	L/s			
108	37.) Input Cooling Water Flow per PSU - value to come from Vendor	20.00	gpm	1.26	L/s			
109	Calculate Cooling Pump Horsepower, Each	6.49	hp	4.84	kW			Assume 25 ft TDH and 70% pump efficiency
110	38.) Input Distance from LOX Pad to Generation Room	20.00	ft	6,096.00	mm			
111	39.) Input Distance from Generation Room to Upstream End of Contactor	150.00	ft	45,720.00	mm			
112	40.) Input Distance from Middle of Contactor to Destruct Room	50.00	ft	15,240.00	mm			
113	41.) Input Ozone Generation Bldg Depth of Burial	0.00	ft	914.40	mm			
114	42.) Input Ozone Generation Bldg Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
115	43.) Input Ozone Generation Bldg Over Excavation Depth	1.00	ft	609.60	mm			
116	44.) Input LOX Pad Depth of Burial	0.00	ft	609.60	mm			
117	45.) Input LOX Pad Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
118	46.) Input LOX Pad Over Excavation Depth	1.00	ft	609.60	mm			
119	47.) Input Ozone Contactor Depth of Burial	10.00	ft	3,048.00	mm			
120	48.) Input Ozone Contactor Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
121	49.) Input Ozone Contactor Over Excavation Depth	1.00	ft	609.60	mm			
122								
123	**Mechanical Sizing Requirements:**							
124	**Pipe Name**	**Input Velocity (fps, fpm)**				**Standard Pipe Size (inches)**	**Nominal Pipe Size (mm)**	**Name**
125	Influent Pipe	5.00	fps	1.52	m/s	48.00	1200.00	53.26152154
126	Effluent Pipe	5.00	fps	1.52	m/s	48.00	1200.00	
127	Overflow Pipe	5.00	fps	1.52	m/s	96.00	2050.00	
128	Total LOX Pipe	2.00	fps	0.61	m/s	1.50	40.00	
129	Total GOX Pipe Upstream of PRV	1,800.00	fpm	9.14	m/s	3.00	80.00	
130	Total GOX Pipe Downstream of PRV	1,800.00	fpm	9.14	m/s	6.00	150.00	
131	Individual GOX Pipe Downstream of PRV	1,800.00	fpm	9.14	m/s	4.00	100.00	
132	Nitrogen	1,800.00	fpm	9.14	m/s	1.00	25.00	
133	Header Ozone Gas PIpe	1,800.00	fpm	9.14	m/s	6.00	150.00	
134	Individual Ozone Generator Gas Pipe	1,900.00	fpm	9.65	m/s	4.00	100.00	
135	Individual Ozone Contactor Gas Pipe	1,800.00	fpm	9.14	m/s	3.00	80.00	
136	Ozone Off-Gas Pipe per Train	1,800.00	fpm	9.14	m/s	4.00	100.00	
137	Ozone Off-Gas Pipe Combined	1,800.00	fpm	9.14	m/s	8.00	200.00	
138	Ozone Off-Gas Pipe per Destruct Unit	1,800.00	fpm	9.14	m/s	4.00	100.00	
139	Total Cooling Water Pipe (open loop)	7.00	fps	2.13	m/s	8.00	200.00	
140	Individual Skid Cooling Water Pipe (open loop)	7.00	fps	2.13	m/s	6.00	150.00	
141	Total Cooling Water Pipe (closed loop)	7.00	fps	2.13	m/s	12.00	300.00	
142	Individual Generator Cooling Water Pipe (closed loop)	7.00	fps	2.13	m/s	8.00	200.00	
143	Individual PSU Cooling Water Pipe (closed loop)	7.00	fps	2.13	m/s	1.50	40.00	
144								
145	**Mechanical Material Requirements: Note to User: Only piping, valves, and fittings outside of Ozone Supplier Skids are summarized below.**							

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	B	C	D	E	F	G	H	I
146	**Pipe Name**	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Comments**	**Red Flags**
147	Influent Pipe	OZI	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
148	Effluent Pipe	OZW	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
149	Overflow Pipe	OF	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
150	LOX Pipe	LOX	Exposed	Copper	NA	NA		
151	Total GOX Pipe Upstream of PRV	GOX	Exposed	**304 SST**	NA	NA		
152	Total GOX Pipe Downstream of PRV	GOX	Exposed	**316 SST**	NA	NA		
153	Individual GOX Pipe Downstream of PRV	GOX	Exposed	**316 SST**	NA	NA		
154	Header Ozone Gas PIpe	O3	Exposed	316 SST	NA	NA		
155	Individual Ozone Generator Gas Pipe	O3	Exposed	316 SST	NA	NA		
156	Individual Ozone Contactor Gas Pipe	O3	Exposed	316 SST	NA	NA		
157	Nitrogen	N2	Exposed	Copper	NA	NA		
158	Ozone Off-Gas Pipe per Train	OZG	Exposed	316 SST	NA	NA		
159	Ozone Off-Gas Pipe Combined	OZG	Exposed	316 SST	NA	NA		
160	Ozone Off-Gas Pipe per Destruct Unit	OZG	Exposed	316 SST	NA	NA		
161	Total Cooling Water Pipe (open loop)	CWS/CWR	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
162	Individual Skid Cooling Water Pipe (open loop)	CWS/CWR	Exposed	**Steel**	**Cement Mortar**	**Cement Mortar**		
163	Total Cooling Water Pipe (closed loop)	GCWS/GCWR	Exposed	304 SST	NA	NA		
164	Individual Generator Cooling Water Pipe (closed loop)	GCWS/GCWR	Exposed	304 SST	NA	NA		
165	Individual PSU Cooling Water Pipe (closed loop)	GCWS/GCWR	Exposed	304 SST	NA	NA		
166								
167	Electrical User Inputs and Sizing Requirements:							
168	50.) Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N					
169	51.) Is there SWGR?	No						
170								
171	Electrical Equipment Lengths:							**MCC**
172	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
173	Ozone Generators/Destruct (Active)	2.00	525.99	**No**	24.00	0.00	0.00	
174	Ozone Generators/Destruct (Standby)	1.00	525.99	**No**	12.00	0.00	0.00	
175	Cooling Water Pumps (Active)	2.00	6.49	**No**	4.00	0.00	0.00	
176	Cooling Water Pumps (Standby)	1.00	6.49	**No**	2.00	0.00	0.00	
177	TOTAL		**1597.46**		**42.00**	**0.00**	**0.00**	**42.00**
178								
179	Electrical Equipment Widths:							
180	**Equipment**	**Depth (ft)**						
181	MCC	1.67						
182	Small AFD's	0.00						
183	Large AFD's	0.00						
184	Switchgear	0.00						
185	Maximum Depth	**1.67**						
186								
187	Clear Distances:							
188	**Clear Distance**	**Width**	**Length**	**Comment**				
189	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
190	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
191	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
192	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
193	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
194	CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
195	CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet			
196	Contingency Length		**0.00**	Contingency length	Typically Zero			
197								
198	Electric Room Length (ft):							
199	CD1	3.00						
200	MCC	16.67						
201	CD2	1.00						
202	Small AFD's	0.00						
203	CD3	0.00						
204	Large AFD's	0.00						
205	CD4	0.00						
206	Swithgear	0.00						
207	CD5	0.00						
208	Contingency	0.00						
209	Total Length	**20.67**						
210								
211	Electric Room Width (ft):							
212	CD6	0.00	If there is no switchgear, this distance will be Zero.					
213	Maximum Equipment Depth	1.67						
214	CD7	3.00						
215	Total Width	**4.67**						
216								
217	**Estimating Dimensions:**	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
218	**Ozone Contactor Facility:**							
219	Basin Width	98.11	ft	29902.68	mm	Total BW		
220	Basin Length	119.09	ft	36299.41	mm	BL		

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	B	C	D	E	F	G	H	I
221	Basin Divider Wall Length	106.09	ft	32337.01	mm			
222	Walls							
223	Perimeter and Divider Wall Height (Walls 11, 12, 13, 14) (SWD + FB)	23.00	ft	7010.40	mm	PDWH		
224	Wall 1 Height (SWD)	20.00	ft	6096.00	mm	CIWH-1		
225	Wall 2 Height (SWD - 3)	17.00	ft	5181.60	mm	CIWH-2		
226	Wall 3 Height (SWD + FB - 4)	19.00	ft	5791.20	mm	CIWH-3		
227	Wall 4 Height (SWD - 3)	17.00	ft	5181.60	mm	CIWH-4		
228	Wall 5 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-5		
229	Wall 6 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-6		
230	Wall 7 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-7		
231	Wall 8 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-8		
232	Wall 9 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-9		
233	Wall 10 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-10		
234	Wall 15 Height (SWD - WH)	18.05	ft	5500.93	mm	CIWH-15		
235	Perimeter Wall Thickness (Walls 11, 12, 13)	**1.50**	ft	**457.20**	mm	WPT	Model based on 1.5'	
236	Wall 1 Thickness	**1.00**	ft	**304.80**	mm	W1T		
237	Wall 2 Thickness	**1.33**	ft	**405.38**	mm	W2T	Model based on 1.33'	
238	Wall 3 Thickness	**1.17**	ft	**356.62**	mm	W3T	Model based on 1.17'	
239	Wall 4 Thickness	**1.33**	ft	**405.38**	mm	W4T	Model based on 1.33'	
240	Wall 5 Thickness	**1.17**	ft	**356.62**	mm	W5T	Model based on 1.17'	
241	Wall 6 Thickness	**1.33**	ft	**405.38**	mm	W6T	Model based on 1.33'	
242	Wall 7 Thickness	**1.17**	ft	**356.62**	mm	W7T	Model based on 1.17'	
243	Wall 8 Thickness	**1.33**	ft	**405.38**	mm	W8T	Model based on 1.33'	
244	Wall 9 Thickness	**1.00**	ft	**304.80**	mm	W9T		
245	Wall 10 Thickness	**1.00**	ft	**304.80**	mm	W10T		
246	Wall 15 Thickness	**1.17**	ft	**356.62**	mm	W15T	Model based on 1.17'	
247	Contactor Divider Walls 14 Thickness	**1.33**	ft	**405.38**	mm	W14T	Model based on 1.33'	
248	Wall 1 Length	22.78	ft	6943.03	mm	W1L		
249	Wall 2 Length	22.78	ft	6943.03	mm	W2L		
250	Wall 3 Length	22.78	ft	6943.03	mm	W3L		
251	Wall 4 Length	22.78	ft	6943.03	mm	W4L		
252	Wall 5 Length (ft)	54.57	ft	16633.83	mm	W5L		
253	Wall 6 Length (ft)	38.61	ft	11767.40	mm	W6L		
254	Wall 7 Length	38.61	ft	11767.40	mm	W7L		
255	Wall 8 Length	38.61	ft	11767.40	mm	W8L		
256	Wall 9 Length	38.61	ft	11767.40	mm	W9L		
257	Wall 10 Length	38.61	ft	11767.40	mm	W10L		
258	Wall 15 Length	6.81	ft	2076.60	mm	W15L		
259	Slab on Grade							
260	Slab on Grade Width	102.11	ft	31121.88	mm			
261	Slab on Grade Length	123.09	ft	37518.61	mm			
262	Slab on Grade Thickness	**18.00**	in	**457.20**	mm		Model based on 18"	
263	Slab on Grade Thickness	1.50	ft	457.20	mm	SOGT		
264	Elevated Slab							
265	Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
266	Elevated Slab Thickness	1.00	ft	304.80	mm	ESLBT		
267	Excavation							
268	Excavation Width	106.11	ft	32341.08	mm			
269	Excavation Length	127.09	ft	38737.81	mm			
270	Excavation Depth	12.50	ft	3810.00	mm			
271								
272	Ozone Generator Building:							
273	Ozone Generator Width	**8.00**	ft	**2,438.40**	mm	WOG	Model is based on 8'	
274	Ozone Generator Length	**16.00**	ft	**4,876.80**	mm	LOG	Model is based on 16'	
275	Clear Distance Around Ozone Generators	**10.00**	ft	**3,048.00**	mm	CDG	Model is based on 10'	
276	Number of Ozone Generators	3.00		3.00			Input	
277	Closed Loop Cooling Skid Length	**10.00**	ft	**3,048.00**	mm	LOC	Model is based on 10'	
278	Closed Loop Cooling Skid Width	**8.00**	ft	**2,438.40**	mm	WOC	Model is based on 8'	
279	Wall Height	12.50	ft	3810.00	mm			
280	Building Width	64.00	ft	19507.20	mm	GBW		
281	Building Length	56.00	ft	17068.80	mm	GBL		
282	Building Area	3584.00	sf	332.96	m2			
283	Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
284	Slab on Grade Thickness	1.00	ft	304.80	mm	TGB		
285	Excavation							
286	Excavation Width	68.00	ft	20726.40	mm			
287	Excavation Length	60.00	ft	18288.00	mm			
288	Excavation Depth	2.00	ft	609.60	mm			
289								
290	**Ozone Destruct Room (attached to Ozone Generation Building):**							
291	Width	20.00	ft	6096.00	mm	DBW	Fixed	
292	Length	60.00	ft	18288.00	mm	DBL		
293	Height	12.50	ft	3810.00	mm		Fixed	
294	Slab on Grade Thickness	12.00	in	304.80	mm		Model based on 12"	
295	Slab on Grade Thickness	1.00	ft	304.80	mm			
296	Indoor Ozone Destruct Building Area	1200.00	sf	111.48	m2			
297	Excavation							
298	Excavation Width	24.00	ft	7315.20	mm			
299	Excavation Length	64.00	ft	19507.20	mm			
300	Excavation Depth	2.00	ft	609.60	mm			
301								
302	**Electrical Room (in Ozone Generation Building:**							
303	Width	4.67	ft	1422.40	mm	ERW	Fixed	
304	Length	20.67	ft	6299.20	mm	ERL		

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	B	C	D	E	F	G	H	I
305	Height	12.50	ft	3810.00	mm		Fixed	
306	Slab on Grade Thickness	12.00	in	304.80	mm		Model based on 12"	
307	Slab on Grade Thickness	1.00	ft	304.80	mm			
308	Indoor Electrical Room Area	96.44	sf	8.96	m2			
309	Excavation							
310	Excavation Width	8.67	ft	2641.60	mm			
311	Excavation Length	24.67	ft	7518.40	mm			
312	Excavation Depth	2.00	ft	609.60	mm			
313								
314	**Outdoor Ozone Destruct Pad:**							
315	Width	0.00	ft	0.00	mm	DBW	Fixed	
316	Length	0.00	ft	0.00	mm	DBL		
317	Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
318	Slab on Grade Thickness	0.00	ft	0.00	mm	SOG2		
319								
320	LOX Tank Pad: Horizontal Tanks							
321	Clear Distance Around Tanks	**6.00**	ft	**1,828.80**	mm	CDT	Model is based on 6'	
322	LOX Vaporizer Length & Clear Distance	**14.00**	ft	**4,267.20**	mm		Model is based on 14'	
323	Width	60.00	ft	18288.00	mm	LPW		
324	Length	75.74	ft	23084.21	mm	LPL		
325	Area of Tank Pad	4544.14	sf	422.16	m2			
326	Allowance for Other Equipment (additional 10% area)	454.41	sf	42.22	m2			
327	Total Pad Area	4998.55	sf	464.38	m2			
328	Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
329	Slab on Grade Thickness	1.00	ft	304.80	mm	TLOX		
330	Excavation							
331	Excavation Width	64.00	ft	19507.20	mm			
332	Excavation Length	79.74	ft	24303.41	mm			
333	Excavation Depth	2.00	ft	609.60	mm			
334								
335	**COST ESTIMATE**							
336	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
337								
338	SITEWORK:							
339	Ozone Generator Building							
340	Excavation	359.73	CY	275.03	m3	***$6.72***	$2,418	
341	Imported Structural Backfill	302.22	CY	231.07	m3	***$50.94***	$15,396	
342	Native Backfill	18.96	CY	14.50	m3	***$8.27***	$157	
343	Haul Excess	340.76	CY	260.53	m3	***$8.27***	$2,817	
344	Ozone Destruct Room							
345	Excavation	142.03	CY	108.59	m3	***$6.72***	$955	
346	Imported Structural Backfill	113.78	CY	86.99	m3	***$50.94***	$5,796	
347	Native Backfill	13.04	CY	9.97	m3	***$8.27***	$108	
348	Haul Excess	129.00	CY	98.62	m3	***$8.27***	$1,066	
349	LOX Tank Pad							
350	Excavation	447.22	CY	341.92	m3	***$6.72***	$3,007	
351	Imported Structural Backfill	378.01	CY	289.01	m3	***$50.94***	$19,256	
352	Native Backfill	21.29	CY	16.28	m3	***$8.27***	$176	
353	Haul Excess	425.92	CY	325.64	m3	***$8.27***	$3,520	
354	Ozone Contactor							
355	Excavation	9259.57	CY	7079.45	m3	***$6.72***	$62,253	
356	Imported Structural Backfill	998.91	CY	763.72	m3	***$50.94***	$50,886	
357	Native Backfill	2024.29	CY	1547.68	m3	***$8.27***	$16,731	
358	Haul Excess	7235.28	CY	5531.77	m3	***$8.27***	$59,802	
359	Electrical Room							
360	Excavation	23.27	CY	17.79	m3	***$6.72***	$156	
361	Imported Structural Backfill	15.84	CY	12.11	m3	***$50.94***	$807	
362	Native Backfill	4.94	CY	3.78	m3	***$8.27***	$41	
363	Haul Excess	18.33	CY	14.01	m3	***$8.27***	$151	
364	Allowance for Misc Items	5%				$245,498.74	$12,275	
365	Subtotal						$257,774	
366								
367	CONCRETE:							
368	Contactor Basin:							
369	Foundation	698.25	CY	533.85	m3	***$541.11***	$377,826	
370	Perimeter Walls	555.06	CY	424.38	m3	***$880.79***	$488,895	
371	Divider Wall	360.60	CY	275.70	m3	***$880.79***	$317,611	
372	Wall 1	67.49	CY	51.60	m3	***$880.79***	$59,448	
373	Wall 2	76.30	CY	58.34	m3	***$880.79***	$67,206	
374	Wall 3	75.02	CY	57.36	m3	***$880.79***	$66,076	
375	Wall 4	76.30	CY	58.34	m3	***$880.79***	$67,206	
376	Wall 5	217.56	CY	166.34	m3	***$880.79***	$191,629	
377	Wall 6	174.96	CY	133.77	m3	***$880.79***	$154,104	
378	Wall 7	0.00	CY	0.00	m3	***$880.79***	$0	
379	Wall 8	0.00	CY	0.00	m3	***$880.79***	$0	
380	Wall 9	0.00	CY	0.00	m3	***$880.79***	$0	
381	Wall 10	0.00	CY	0.00	m3	***$880.79***	$0	
382	Wall 15	21.31	CY	16.29	m3	***$880.79***	$18,772	
383	Elevated Roof Slab	432.73	CY	330.85	m3	***$1,333.77***	$577,159	
384								
385	Ozone Destruct Pad:							
386	Slab on Grade	44.44	CY	33.98	m3	***$490.62***	$21,805	
387	Ozone Generator Building:							
388	Slab on Grade	132.74	CY	101.49	m3	***$490.62***	$65,125	
389	Electrical Room:							
390	Slab on Grade	3.57	CY	2.73	m3	***$490.62***	$1,752	
391	LOX Tank and Vaporizer Pad:							
392	Slab on Grade	185.13	CY	141.54	m3	***$490.62***	$90,828	
393								
394	Allowance for Misc Items	5%				$2,565,443.84	$128,272	
395	Subtotal						$2,693,716	
396								

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	B	C	D	E	F	G	H	I
397	MASONRY:	**High**						
398	Ozone Generator/ Building (incl Elec Room)	3680.44	SF	341.92	m2	***$198.37***	$730,078	
399	Ozone Destruct Building	1200.00	SF	111.48	m2	***$198.37***	$238,040	
400	Subtotal	4880.44					$968,119	
401								
402	METALS:							
403	Handrail	490.40	LF	149.47	m	***$90.92***	$44,586	
404	Perforated Plate in Inlet Cell	618.89	SF	57.50	m2	***$108.25***	$66,998	
405	Perforated Plates in Serpentine Cells	1090.08	SF	101.27	m2	***$108.25***	$118,006	
406	3' x 3' SS Air Tight Checker Plate Covers Over Inlet Cells	8.00	EA			***$1,798.69***	$14,390	
407	3' x 3' SS Air Tight Checker Plate Covers Over Contactor Cells	12.00	EA			***$1,798.69***	$21,584	
408	Ladder	20.00	EA			***$1,915.27***	$38,305	
409	Stairway	78	Risers			***$495.92***	$38,682	
410	Allowance for Misc Items	10%				$342,550.71	$34,255	
411	Subtotal						$376,806	
412								
413	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
414	Ozone System (Including Ozone Generators, Diffusion System, Instrumentation & Valves, Ozone Destruct Units, and Cooling System for Closed Loop System)	6008.69	lb/d	2725.50	kg/d	***$1,810.82***	$10,880,670	
415	LOX Tanks and Vaporizers	126233	gal	477843.67	L	***$44.62***	$5,632,532	
416	Cooling Pumps for Open Loop Cooling System (Note: Cooling Pumps are included in OSS scope for Closed Loop system) (9.72 hp each)	4	EA			***$15,753.71***	$63,015	
417	Gates at Inlet	4	EA			***$9,614.74***	$38,459	
418	Gates at Outlet	4	EA			***$9,614.74***	$38,459	
419	Allowance for Misc Items	10%				$16,653,135.35	$1,665,314	
420	Subtotal						$18,318,449	
421								
422	INSTRUMENTS & CONTROLS:							
423	Instruments							
424	Inlet and Outlet Isolation Gate Actuator	8	EA			***$6,409.82***	$51,279	
425	Level Transmitters	4	EA			***$11,264.12***	$45,056	
426	Open Loop Cooling Water Flowmeters	1	EA			***$6,954.43***	$6,954	
427	Ozone Residual Analyzers	8	EA			***$6,954.43***	$55,635	
428	Pressure Transmitters (LOX)	3	EA					
429	Level Transmitters (LOX)	3	EA					
430	Isolation Valve Actuators (LOX)	3	EA					
431	Isolation Valve Actuators (GOX)	4	EA					
432	Control Valve Actuators (GOX)	3	EA					
433	Temperature Transmitters (GOX)	4	EA					
434	Pressure Transmitters (GOX)	1	EA					
435	Dewpoint Analyzers (GOX)	1	EA					
436	Flowmeter (GOX)	3	EA					
437	Dewpoint Analyzers (Nitrogen)	1	EA					
438	Nitrogen Compressor	2	EA					
439	Control Valve Actuators (Nitrogen)	1	EA					
440	Pressure Transmitters (Nitrogen)	1	EA					
441	Temperature Transmitters (Ozone)	3	EA					
442	Isolation Valve Actuators (Ozone)	3	EA					
443	Ozone Concentration Analyzers (Ozone)	3	EA					
444	Flowmeter (Ozone)	4	EA					
445	Control Valve Actuators (Ozone)	4	EA					
446	Ozone Concentration Analyzers (Off-gas)	6	EA					
447	Control Valve Actuators (Off-gas)	5	EA					
448	Isolation Valve Actuators (Off-gas)	5	EA					
449	Temperature Transmitters (Off-gas)	10	EA					
450	Pressure Differential Transmitters (Off-gas)	5	EA					
451	Destruct Blower	5	EA					
452	Closed Loop Cooling Water Pumps	3	EA					
453	Isolation Valve Actuators (Closed Loop Cooling)	6	EA					
454	Temperature Transmitters (Closed Loop Cooling)	6	EA					
455	Flowmeters (Closed Loop Cooling)	6	EA					
456	Ambient Ozone Analyzers	2	EA					
457	Ambient Oxygen Analyzers	1	EA					
458	Number of Analog I/O Counts	178	EA			***$264.27***	$46,934	
459	Number of Digital I/O Counts	198	EA			***$62.59***	$12,393	
460	Number of Local Panels	1	EA			***$13,074.33***	$13,074	

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	B	C	D	E	F	G	H	I
461	Number of PLC's	1	EA					
462	I&C Conduit & Wire	8,745	LF	2665.57	m	$12.06	$105,460	
463	Allowance for Misc Items	5%				$336,785.64	$16,839	
464	Subtotal						$353,625	
465								
466	MECHANICAL:							
467	Pipe:							
468	Influent Pipe-OZI (48-inch, Buried, Steel)	0.00	LF	0.00	m	$1,004.58	$0	
469	Effluent Pipe-OZW (48-inch, Buried, Steel)	0.00	LF	0.00	m	$1,004.58	$0	
470	Overflow Pipe-OF (96-inch, Buried, Steel)	0.00	LF	0.00	m	$2,009.15	$0	
471	LOX Pipe-LOX (1.5-inch, Exposed, Copper)	114.00	LF	34.75	m	$105.58	$12,036	
472	Total GOX Pipe Upstream of PRV-GOX (3-inch, Exposed, 304 SST)	62.00	LF	18.90	m	$109.49	$6,789	
473	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	123.00	LF	37.49	m	$215.04	$26,450	
474	Individual GOX Pipe Downstream of PRV-GOX (4-inch, Exposed, 316 SST)	99.00	LF	30.18	m	$143.36	$14,193	
475	Header Ozone Gas PIpe-O3 (1-inch, Exposed, 316 SST)	51.00	LF	15.54	m	$35.84	$1,828	
476	Individual Ozone Generator Gas Pipe-O3 (6-inch, Exposed, 316 SST)	153.00	LF	46.63	m	$215.04	$32,901	
477	Individual Ozone Contactor Gas Pipe-O3 (4-inch, Exposed, 316 SST)	620.00	LF	188.98	m	$143.36	$88,884	
478	Nitrogen-N2 (3-inch, Exposed, Copper)	36.00	LF	10.97	m	$211.16	$7,602	
479	Ozone Off-Gas Pipe per Train-OZG (4-inch, Exposed, 316 SST)	200.00	LF	60.96	m	$143.36	$28,672	
480	Ozone Off-Gas Pipe Combined-OZG (8-inch, Exposed, 316 SST)	10.00	LF	3.05	m	$286.72	$2,867	
481	Ozone Off-Gas Pipe per Destruct Unit-OZG (4-inch, Exposed, 316 SST)	75.00	LF	22.86	m	$143.36	$10,752	
482	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	276.11	LF	84.16	m	$167.43	$46,228	
483	Individual Skid Cooling Water Pipe (open loop)-CWS/CWR (6-inch, Exposed, Steel)	70.00	LF	21.34	m	$125.57	$8,790	
484	Total Cooling Water Pipe (closed loop)-GCWS/GCWR (12-inch, Exposed, 304 SST)	88.00	LF	26.82	m	$437.98	$38,542	
485	Individual Generator Cooling Water Pipe (closed loop)-GCWS/GCWR (8-inch, Exposed, 304 SST)	123.00	LF	37.49	m	$291.99	$35,914	
486	Individual PSU Cooling Water Pipe (closed loop)-GCWS/GCWR (1.5-inch, Exposed, 304 SST)	108.00	LF	32.92	m	$54.75	$5,913	
487	Elbows							
488	LOX Pipe-LOX (1.5-inch, Exposed, Copper)	30.00	EA			$284.26	$8,528	
489	Total GOX Pipe Upstream of PRV-GOX (3-inch, Exposed, 304 SST)	3.00	EA			$568.52	$1,706	
490	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	10.00	EA			$1,268.32	$12,683	
491	Individual GOX Pipe Downstream of PRV-GOX (4-inch, Exposed, 316 SST)	3.00	EA			$845.55	$2,537	
492	Header Ozone Gas PIpe-O3 (1-inch, Exposed, 316 SST)	1.00	EA			$211.39	$211	
493	Individual Ozone Generator Gas Pipe-O3 (6-inch, Exposed, 316 SST)	3.00	EA			$1,268.32	$3,805	
494	Individual Ozone Contactor Gas Pipe-O3 (4-inch, Exposed, 316 SST)	20.00	EA			$845.55	$16,911	
495	Nitrogen-N2 (3-inch, Exposed, Copper)	2.00	EA			$568.52	$1,137	
496	Ozone Off-Gas Pipe per Train-OZG (4-inch, Exposed, 316 SST)	12.00	EA			$845.55	$10,147	
497	Ozone Off-Gas Pipe per Destruct Unit-OZG (4-inch, Exposed, 316 SST)	15.00	EA			$845.55	$12,683	
498	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	2.00	EA			$1,113.60	$2,227	
499	Individual Skid Cooling Water Pipe (open loop)-CWS/CWR (6-inch, Exposed, Steel)	3.00	EA			$835.20	$2,506	
500	Individual Generator Cooling Water Pipe (closed loop)-GCWS/GCWR (8-inch, Exposed, 304 SST)	12.00	EA			$1,516.07	$18,193	
501	Individual PSU Cooling Water Pipe (closed loop)-GCWS/GCWR (1.5-inch, Exposed, 304 SST)	12.00	EA			$284.26	$3,411	
502	Tees							
503	LOX Pipe-LOX (1.5-inch, Exposed, Copper)	3.00	EA			$398.57	$1,196	
504	Total GOX Pipe Upstream of PRV-GOX (3-inch, Exposed, 304 SST)	4.00	EA			$797.14	$3,189	
505	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	5.00	EA			$1,762.53	$8,813	
506	Header Ozone Gas PIpe-O3 (1-inch, Exposed, 316 SST)	7.00	EA			$293.76	$2,056	
507	Ozone Off-Gas Pipe Combined-OZG (8-inch, Exposed, 316 SST)	9.00	EA			$2,350.04	$21,150	
508	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	4.00	EA			$2,537.20	$10,149	
509	Total Cooling Water Pipe (closed loop)-GCWS/GCWR (12-inch, Exposed, 304 SST)	12.00	EA			$3,188.58	$38,263	
510	Individual Generator Cooling Water Pipe (closed loop)-GCWS/GCWR (8-inch, Exposed, 304 SST)	6.00	EA			$2,125.72	$12,754	
511	Crosses							
512	End Caps							
513	Valves							
514	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	8.00	EA			$8,144.58	$65,157	
515	Wall Pipes:							
516	Influent Pipe-OZI (48-inch, Buried, Steel)	4.00	EA			$10,045.76	$40,183	
517	Effluent Pipe-OZW (48-inch, Buried, Steel)	4.00	EA			$10,045.76	$40,183	
518	Overflow Pipe-OF (96-inch, Buried, Steel)	1.00	EA			$20,091.51	$20,092	
519	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	1.00	EA			$2,150.42	$2,150	
520	Individual Ozone Contactor Gas Pipe-O3 (4-inch, Exposed, 316 SST)	4.00	EA			$1,433.61	$5,734	
521	Ozone Off-Gas Pipe Combined-OZG (8-inch, Exposed, 316 SST)	1.00	EA			$2,867.23	$2,867	

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	B	C	D	E	F	G	H	I
522	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	1.00	EA			*$1,674.29*	$1,674	
523	Allowance for Misc Items	10%				$740,656.30	$74,066	
524	Subtotal						$814,722	
525								
526	ELECTRICAL:							
527	# MCC Sections	10.00	EA			*$10,730.27*	$107,303	
528	Switchgear	0.00	EA			*$49,359.23*	$0	
529	Adjustable Frequency Drives							
530	Ozone Generators/Destruct (Active) (526 hp each)	0.00	EA			***$77,840.33***	$0	
531	Ozone Generators/Destruct (Standby) (526 hp each)	0.00	EA			***$77,840.33***	$0	
532	Cooling Water Pumps (Active) (6 hp each)	0.00	EA			***$9,717.06***	$0	
533	Cooling Water Pumps (Standby) (6 hp each)	0.00	EA			***$9,717.06***	$0	
534	Electrical Conduit & Wire	714.56	LF	217.80	m	*$12.06*	$8,617	
535	Allowance for Misc Items	10%				$115,919.49	$11,592	
536	Subtotal						$127,511	
537								
538	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
539	Item 1 Description	0.00		0.00		0.00	$0	
540	Item 2 Description	0.00		0.00		0.00	$0	
541	Item 3 Description	0.00		0.00		0.00	$0	
542	Item 4 Description	0.00		0.00		0.00	$0	
543	Item 5 Description	0.00		0.00		0.00	$0	
544	Item 6 Description	0.00		0.00		0.00	$0	
545	Item 7 Description	0.00		0.00		0.00	$0	
546	Item 8 Description	0.00		0.00		0.00	$0	
547	Item 9 Description	0.00		0.00		0.00	$0	
548	Item 10 Description	0.00		0.00		0.00	$0	
549	Item 11 Description	0.00		0.00		0.00	$0	
550	Item 12 Description	0.00		0.00		0.00	$0	
551	Item 13 Description	0.00		0.00		0.00	$0	
552	Item 14 Description	0.00		0.00		0.00	$0	
553	Item 15 Description	0.00		0.00		0.00	$0	
554	Subtotal						$0	
555								
556	Subtotal						$23,910,721	
557								
558	ALLOWANCES:		**User Override**					
559	Finishes Allowance	2.00%		$25,989,914	$519,798.29			
560	I&C Allowance	2.00%		$25,989,914.37	$519,798.29			
561	Mechanical Allowance	2.00%		$25,989,914.37	$519,798.29			
562	Electrical Allowance	2.00%		$25,989,914.37	$519,798.29			
563								
564	**Facility Cost**	**4,006**	**lb/d Ozone**	**$6,488**	**$25,989,914**			
565	**Facility Cost with Standard Additional Project Costs Added**	**4,006**	**lb/d Ozone**	**$7,884**	**$31,582,164**			
566	**Facility Cost with Standard Additional Project Costs and Contractor Markups Added**	**4,006**	**lb/d Ozone**	**$13,523**	**$54,169,062**			
567	**Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)**	**4,006**	**lb/d Ozone**	**$11,128**	**$44,577,354**			
568	**Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added**	**4,006**	**lb/d Ozone**	**$13,523**	**$54,169,062**			

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	B	C	D	E	F	G	H	I
1	***Filters***							
2								
3	**Is This Facility Included in My Project? Yes**							
4	Assumptions:							
5								
6	Based on Denver Water Reuse Project							
7	2 Basins @ 15 MGD each							
8	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
9	FILTER PARAMETRIC DESIGN APPROACH							
10	BASIS: DENVER REUSE PLANT, HDPE DUAL LATERAL UNDERDRAIN WITH MEDIA SUPPORT CAP, FRONT FLUME, & CONSTANT EFFLUENT FLOW CONTROL							
11								
12								
13	**Process User Inputs:**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
14	Is this a Seawater Desalination Application?	**No**	Y/N					
15	Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N				Fixed	
16	Input Filtration System Maximum Design Flow Rate	**160.00**	mgd	**605.67**	ML/d	Q		
17	Input Filtration System Minimum Design Flow Rate	**30.00**	mgd	**113.56**	ML/d			
18	Select HDPE Underdrain System Type	**LS**	Type			UT		LSL = Leopold Type SL; LS = Leopold Type S; TLP = Tetra Type LP; NP = IDI or GF Nozzle/Plenum Type
19	Calculate Underdrain Profile Depth	1.08	ft	329.18	mm	UPD		LSL = 0.67 ft; LS = 1.08 ft; TLP = 0.75 ft; NP = 2.5625.
20	Input Bottom Media Effective Size	**0.55**	mm			BMES		
21	Input Bottom Media Uniformity Coefficient	**1.40**	#			BMUC		
22	Input Bottom Media Depth	**12.00**	in	**304.80**	mm	BMD		
23	Select Bottom Media Material	**Sand**	Type					
24	Input Middle Media Effective Size	**1.10**	mm			MMES		
25	Input Middle Media Uniformity Coefficient	**1.50**	#			MMUC		
26	Input Middle Media Depth	**0.00**	in	**0.00**	mm	MMD		
27	Select Middle Media Material	**Anthracite**	Type					
28	Input Top Media Effective Size	**1.10**	mm			TMES		
29	Input Top Media Uniformity Coefficient	**1.50**	#			TMUC		
30	Input Top Media Depth	**60.00**	in	**1,524.00**	mm	TMD		
31	Select Top Media Material	**Anthracite**	Type					
32	Calculate Total Media Depth	6.00	ft	1828.80	mm	MD		
33	Input GAC Replacement Frequency, if Applicable (number per year)	**0.00**	#					
34	Input GAC Apparent Density (Bulk Density), if Applicable	**29.00**	lb/cf	**464.54**	kg/m3			Typically about 29 lb/cf for most GAC products.
35	Input Maximum Design Filtration Hydraulic Loading Rate	**6.00**	gpm/sf	**14.67**	m/h	FHLR		Typical Range: 3 - 10 gpm/sf
36	Input Minimum Design Filtration Hydraulic Loading Rate	**2.00**	gpm/sf	**4.89**	m/h			
37	Calculate Active Filter Area	18,518.52	sf	1720.43	m2	AFA		
38	Calculate Emtpy Bed Contact Time at Maximum Design Filtration Hydraulic Loading Rage	7.48	min			EBCT		
39	Calculate Emtpy Bed Contact Time at Minimum Design Filtration Hydraulic Loading Rage	39.90	min			EBCT		
40	Input Number of Active Filters with Maximum Design Flow Rate	**20**	#			#AF		Typical Range: ≥ 3.
41	Calculate Individual Filter Area	925.93	sf	86.02	m2	IFA		
42	Calculate Individual Filter Dimension in Direction of Underdrain Lateral	24.83	ft	7569.20	mm	IFW		For Leopold Type SL (LSL), IFW < 16 ft; For Leopold Type S (LS), IFW < 48 ft; For Tetra Type LP (TLP), IFW < 30 ft.
43	Optionial: Input Individual Filter Dimension in Direction of Underdrain Lateral (overwrites above calculation)		ft		mm			Only enter override value when matching existing conditions or accomodating site constraints.
44	Calculate Individual Filter Dimension Perpendicular to Underdrain Lateral	37.25	ft	11353.80	mm	IFL		
45	Input Number of Standby Filters with Maximum Design Flow Rate	**2**	#			#SF		Typically 1 minimum
46	Calculate Total Number of Filters	22	#			#TF		Should be even number. If not, add active or standby filter
47	Input Desired Filter Bed Expansion During Backwash	**25.00%**				BEX		Typically 20-30%.
48	Calculate Media Expansion Depth	1.20	ft	365.76	mm	EXD		
49	Input Maximum Water Temperature	77.00	degrees F	**25.00**	degrees C	MWT		
50	Input Maximum Backwash Supply Hydraulic Loading Rate	**25.00**	gpm/sf	**61.12**	m/h	BWSHLR		Calculate from CH2M Backwash Rate Program
51	Calculate Maximum Backwash Supply Flow Rate	33.30	mgd	126.06	ML/d	BWSFR		
52	Input Filter Media Clean Bed Head Loss at Maximum Design Filtration Hydraulic Loading Rate	**2.50**	ft	**762.00**	mm	CBH		Calculate from CH2M HILL Clean Bed Head Loss Program
53	Input Underdrain Head Loss at Maximum Design Filtration Hydraulic Loading Rate	**0.50**	ft	**152.40**	mm	UDH		Determine from CH2M HILL Filter Design Guide. Typically 1-foot

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	B	C	D	E	F	G	H	I
54	Input Filter Effluent Piping Head Loss from Seal Weir Back to Filter Box with FE FCV 80% Open	1.50	ft	457.20	mm	FPH		Calculate from WinHydro. Typically 2 to 4 feet
55	Input Filter Influent/Backwash Wastewater Gullet Channel Width	5.00	ft	5.00	mm	GCW		Typically 4 ft. minimum for access
56	Input Filter Influent Channel / Backwash Wastewater Channel Width	5.00	ft	5.00	mm	FI/BWCW		Typically 4 ft. minimum for access
57	Calcualte Filter Influent Isolation Gate Width	42.00	in	1066.80	mm			Typically requires 9 inches of concrete on both sides of gate.
58	Calculate Number of Isolation Gates	2	#					
59	Input Distance from Bottom of Wash Trough to Top of Expanded Media	12.00	in	304.80	mm	DTM		Typically 3 inches minimum
60	Input % Area of Wash Trough Coverage per Filter	25.00%				WT%A		Typically 25%
61	Calculate Wash Trough Coverage per Filter = IFW * IFL * WT%A / 100	231.26	sf	21.48	m2	WTC		
62	Input Wash Trough Width	3.00	ft	914.40	mm	WTW		Typically 1.5 ft minimum
63	Select Wash Trough Type	Media Retaining	Type			WTYP		Conventional or Media Retaining Type
64	Calculate Number of Wash Troughs per Filter	3	#			#WT		
65	Calculate Depth of Wash Trough	2.24	ft	683.37	mm	WTD		Includes 0.25 feet freeboard and 0.25 feet trough bottom thickness
66	Calculate Distance Between Troughs	9.42	ft	2870.20	mm	DBT		Full Size Space between each trough, and Half Size Space between each end trough and wall.
67	Calculate Distance from Top of Media to Top of Trough	4.74	ft	1445.37	mm	TMTT		
68	Calculate Ratio Distance Between Troughs: Distance from Top of Media to Top of Trough	1.99	:1			RATIO		Typically between 1.0 to 2.0 (If error, change percent coverage or trough width)
69	Select Backwash Design Basis	Time	Type					Time = Based off backwash duration. Filter Box Volumes = Based off # of filter vessel volumes for BW cycle.
70	Input Backwash Duration	8.00	min					Typically 8 to 30 minutes.
71	Input Number of Filter Box Volumes per Backwash	3.00	#					Typically target at least 3 filter box volumes.
72	Calculate Typical Backwash Volume per Event	185,008.33	gal	700.33	m3			
73	Calculate Backwash Duration		min					Typically 8 to 30 minutes.
74	Calculate Number of Filter Box Volumes per Backwash	2.49	#				Warning! Consider increasing BW duration.	Typically target at least 3 filter box volumes.
75	Include Filter Drain-Down?	Yes	Y/N					
76	Calculate Filter Drain-Down Volume per Event	36,418.97	gal	137.86	m3			
77	Input Distance from Top of Wash Trough to Top of Gullet Channel Wall	4.00	ft	1,219.20	mm	DTG		Typically 0.5 to 6 feet
78	Input Terminal Filter Head Loss Build-Up	10.00	ft	3,048.00	mm	THL		Typically 8 to 12 feet, confirm with hydraulic analysis
79	Input Freeboard Above Operating Water Surface	2.00	ft	2.00	mm	FB		Typically 1 to 3 feet
80	Calculate Gullet Channel Height	15.82	ft	4822.55	mm	GCH		
81	Calculate Gullet Channel Fill Height	2.58	ft	786.38	mm	GCF		
82	Calculate Filter Box Depth Based on Filter Seal Weir Set at the Same Elevation as the Top of the Filter Underdrain	19.08	ft	5815.58	mm	FBD		Setting Seal Weir and Top of Underdrain at Same Elevation Assures No Negative Pressure & Filter Air Binding
83	Calculate Backwash Waste Channel Height	12.32	ft	3755.75	mm	BWWCH		
84	Calculate Backwash Waste Channel Fill Height	2.58	ft	786.38	mm	BWWCF		
85	Calculate Filter Influent Channel Height	5.76	ft	1755.03	mm	FICH		Assumes top of filter influent valve = top of gullet channel
86	Input Filter Seal Weir Head	1.50	ft	1.00	mm	SWH		Typically < 2 feet
87	Calculate Filter Seal Weir Length	40.47	ft	12334.13	mm	SWL		Typically Use Trough Style Weirs to Reduce Area of Seal Weir Box
88	Input Length of Each Seal Weir Trough	2.00	ft	10.00	mm	SWTL		Typically < 20 feet to avoid intermediate structural support
89	Calculate Number of Seal Weir Troughs	10	#			#SWT		
90	Input Seal Weir Trough Width	2.00	ft	609.60	mm	SWTW		Typically 1.5 ft minimum
91	Calculate Depth of Wash Trough	3.41	ft	1040.19	mm	SWTD		Includes 0.25 feet freeboard and 0.25 feet trough bottom thickness
92	Calculate Seal Weir Box Width	40.00	ft	12192.00	mm	SWBW		
93	Calculate Seal Weir Box Depth	24.41	ft	7440.99	mm	SWBD		
94	Calculate Filter Flume Depth Below Underdrain Floor	5.00	ft	1524.00	mm	FFD		
95	Input Clear Distance Between Filter Effluent Piping in Gallery for Access	12.00	ft	3,657.60	mm	GCD1		Typically 8 ft minimum
96	Input Clear Distance Between Filter Effluent Piping & Filter Box in Gallery for Access	4.00	ft	1,828.80	mm	GCD2		Typically 3 ft minimum
97	Input Clear Distance Between Filter Effluent Piping & Filter End Wall for Access	6.00	ft	6.00	mm	GCD3		Typically 6 ft minimum
98	Calculate Filter Gallery Width	34.80	ft	10608.06	mm	FGW		
99	Input Clear Distance Between Filter Effluent Piping & Gallery Floor	2.00	ft	609.60	mm	GCD4		Typically 1 to 3 feet
100	Include Filter to Waste?	Yes	Y/N					
101	Input Filter to Waste Duration	15.00	min					Typically 10 to 30 minutes
102	Calculate Filter to Waste Volume per Event	83,333.33	gal	315.45	m3			

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	B	C	D	E	F	G	H	I
103	Calculate Total Wastewater Volume per Backwash	304,760.63	gal	1153.64	m3			Use this volume to size backwash equalization basin
104	Include Air Scour Backwash?	Yes	Y/N					
105	Input Backwash Air Scour Loading Rate	2.00	scfm/sf	0.61	m/min	ALR		Typically 2 to 4 scfm/sf
106	Calculate Air Scour Blower Capacity per Blower	1,851.00	scfm	52.41	m3/min	ASBC		
107	Input Number of Air Scour Blowers	2.00	#			NASB		Typically 1 duty and 1 standby
108	Calculate Approximate Blower Outlet Gage Pressure at Standard Conditions	8.39	psig	57.87	kPa	BOP		Includes 1 psig of air piping losses, calculate actual. Typically, total ≤ 10 psig
109	Calculate Blower Horsepower at Standard Conditions (sea level, 20 deg C, 36% RH) per Blower	82.00	hp	61.15	kW	BHP		Revise for actual elevation and air temperature range. Warning... If Blower Horsepower exceeds 200, the Blower Building may be undersized.
110	Are filters covered?	No	Y/N					
111	Include Particle Counters?	Yes	Y/N					
112	Include a Combined FE Magmeter?	No	Y/N					
113	Input Depth of Burial	0.00	ft	0.00	mm	DB		
114	Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
115	Input Over Excavation Depth	1.00	ft	304.80	mm	OEXD		
116	Mechanical Sizing Requirements:							
117	**Pipe Name**	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**
118	Air Scour Pipe	2,500.00	fpm	762.00	m/s	12.00	in	300.00
119	Filter Influent Header Pipe	5.00	fps	1.52	m/s	96.00	in	2050.00
120	Filter Influent Pipe	3.00	fps	0.91	m/s	30.00	in	750.00
121	Filter Effluent Pipe	5.00	fps	1.52	m/s	24.00	in	600.00
122	Filter Control Valve Pipe	8.00	fps	2.44	m/s	18.00	in	450.00
123	Filter Effluent Header Pipe	5.00	fps	1.52	m/s	96.00	in	2050.00
124	Filter to Waste	5.00	fps	1.52	m/s	24.00	in	600.00
125	Backwash Supply Pipe	6.00	fps	1.83	m/s	42.00	in	1050.00
126	Backwash Waste Pipe	6.00	fps	1.83	m/s	42.00	in	1050.00
127								
128	Mechanical Material Requirements:							
129	**Pipe Name**	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Diameter**	**Pipe Length**
130	Air Scour Pipe	BAW	Exposed	316 SST	None	None	12.00	1645.09
131	Filter Influent Header Pipe	FIH	Buried	DI	Cement Mortar	Tape Coating	96.00	0.00
132	Filter Influent Pipe	FIH	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	30.00	0.00
133	Filter Effluent Pipe	FE	Exposed	DI	Cement Mortar	Paint	24.00	382.84
134	Filter Effluent Pipe	FE	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	24.00	382.84
135	Filter Control Valve Pipe	FCV	Exposed	DI	Cement Mortar	Paint	18.00	264.00
136	Filter Effluent Header Pipe	FEH	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	96.00	432.75
137	Filter to Waste	FTW	Exposed	DI	Cement Mortar	Paint	24.00	209.88
138	Filter to Waste	FTW	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	24.00	867.50
139	Backwash Supply Pipe	BWS	Exposed	DI	Cement Mortar	Paint	42.00	1048.46
140	Backwash Supply Pipe	BWS	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	42.00	48.00
141	Backwash Waste Pipe	BWW	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	42.00	10.00
142								
143	Electrical User Inputs and Sizing Requirements:							
144	Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N					
145	Is there SWGR?	No						
146								**MCC**
147	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
148	Air Scour Blowers	2	82.00	No	6.00	0.00	0.00	
149	**User Defined Item #1**	**0**	**0.00**	**No**	0.00	0.00	0.00	
150	**User Defined Item #2**	**0**	**0.00**	**No**	0.00	0.00	0.00	

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	B	C	D	E	F	G	H	I
151	**User Defined Item #3**	**0**	**0.00**	**No**	0.00	0.00	0.00	
152	TOTAL		164.00		6.00	0.00	0.00	6.00
153								
154	Electrical Equipment Widths:							
155	**Equipment**	**Depth (ft)**						
156	MCC	1.67						
157	Small AFD's	0.00						
158	Large AFD's	0.00						
159	Switchgear	0.00						
160	Maximum Depth	1.67						
161								
162	Clear Distances:							
163	**Clear Distance**	**Width**	**Length**	**Comment**				
164	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
165	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
166	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
167	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
168	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
169	CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
170	CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet			
171	Contingency Length		**0.00**	Contingency length	Typically Zero			
172								
173	Electric Room Length (ft):							
174	CD1	3.00						
175	MCC	11.67						
176	CD2	1.00						
177	Small AFD's	0.00						
178	CD3	0.00						
179	Large AFD's	0.00						
180	CD4	0.00						
181	Swithgear	0.00						
182	CD5	0.00						
183	Contingency	0.00						
184	Total Length	15.67						
185								
186	Electric Room Width (ft):							
187	CD6	0.00	If there is no switchgear, this distance will be Zero.					
188	Maximum Equipment Depth	1.67						
189	CD7	3.00						
190	Total Width	4.67						
191								
192	**COST TABLE FOR MEDIA:**	**Quantity (CF)**	**$/CF (Uninstalled Cost)**	**$/CF (Escalated and Installed Cost)**				
193	Silica Sand	20,350.92	15.00	***$ 22.11***				
194	Antracite Coal	101,754.58	20.00	***$ 29.49***				
195	Garnet Sand	0.00	45.00	***$ 66.34***				
196	GAC	0.00	45.00	***$ 66.34***				
197								
198	**Estimating Dimensions:**	**Value English**	**Unit (English)**	**Value Metric**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
199	Backwash Supply Pipe Tee Length	5.50	ft	1676.40	mm	BWSTL		Lookup Value
200	Backwash Supply Pipe Tee Width	4.50	ft	1371.60	mm	BWSTW		Lookup Value
201	Backwash Supply Pipe Elbow Length	5.90	ft	1798.83	mm	BWSEL		Lookup Value
202	Backwash Supply Isolation Valve Length	1.25	ft	381.00	mm	BWSVL		Lookup Value
203	Backwash Supply - Flowmeter Reducer Length	8.00	ft	2438.40	mm	BWSFMRL		
204	Flowmeter Length	2.17	ft	660.40	mm	FML		Lookup Value
205	Filter Control Valve Length	0.67	ft	203.20	mm	FCVL		Lookup Value
206	Flowmeter - Filter Effluent Increaser Length	2.00	ft	609.60	mm	FMFERL		
207	Filter Effluent Pipe Tee Length	3.67	ft	1117.60	mm	FETL		Lookup Value
208	Filter Effluent Pipe Tee Width	2.83	ft	863.60	mm	FETW		Lookup Value
209	Filter Effluent Pipe Elbow Length	3.63	ft	1107.69	mm	FEEL		Lookup Value
210	Filter Effluent and Filter to Waste Isolation Valve Length	1.00	ft	304.80	mm	FEVL		Lookup Value
211	Filter Effluent Header Pipe Cross Length	11.00	ft	3352.80	mm	FEHCL		Lookup Value
212	Filter Effluent Header Pipe Cross Width	11.00	ft	3352.80	mm	FEHCW		Lookup Value
213	Filter to Waste Header Pipe Tee Length	3.67	ft	1117.60	mm	FTWHTL		Lookup Value
214	Filter to Waste Pipe Elbow Length	2.83	ft	863.60	mm	FTWEL		Lookup Value
215	Total Length of Individual Filter Piping	39.04	ft	11898.12	mm			
216	Filter (per Each):							
217	Slab on Grade (Includes Filter, Gulllet Channel, Filter Influent/Backwash Wastewater Channel):							
218	Length = IFL + FEWT	38.75	ft	11811.00	mm	FSOGL		
219	Width = IFW+GWT+GCW+(2*FI/BWCST)+FI/BWCW	40.50	ft	12344.40	mm	FSOGW		
220	Concrete Thickness	**24.00**	in	**551.18**	mm			Model based on 24"
221	Concrete Thickness	2.00	ft	609.60	mm	FSOGT		

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	B	C	D	E	F	G	H	I
222	Pipe Gallery Wall:							
223	Length = IFL + FEWT	38.75	ft	11811.00	mm			
224	Height = FBD + FFD	24.08	ft	7339.58	mm			
225	Concrete Thickness	**18.00**	in	**551.18**	mm			Model based on 18"
226	Concrete Thickness	1.50	ft	457.20	mm	PGWT		
227	Gullet Wall:							
228	Length = IFL	37.25	ft	11353.80	mm			
229	Height = GCH	15.82	ft	4822.55	mm			
230	Concrete Thickness	**14.00**	in	**500.38**	mm			Model based on 14"
231	Concrete Thickness	1.17	ft	355.60	mm	GWT		
232	Filter Influent / Backwash Waste Channel Walls:							
233	Number of Walls (2 per filter)	2.00	#			#W		Fixed
234	Length = IFL + FEWT	38.75	ft	11811.00	mm			
235	Height = FBD	19.08	ft	5815.58	mm			
236	Concrete Thickness	**18.00**	in	**500.38**	mm			Model based on 18"
237	Concrete Thickness	1.50	ft	457.20	mm	FI/BWCST		
238	Filter Influent / Backwash Waste Channel Lower Elevated Slab:							
239	Length = IFL + FEWT	38.75	ft	11811.00	mm			
240	Width = FI/BWCW	5.00	ft	1524.00	mm			
241	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
242	Concrete Thickness	1.00	ft	304.80	mm	FICLEST		
243	Filter Influent / Backwash Waste Channel Upper Elevated Slab:							
244	Length = IFL + FEWT	38.75	ft	11811.00	mm			
245	Width = FI/BWCW + (2 * FI/BWCWT)	8.00	ft	2438.40	mm			
246	Concrete Thickness	**9.00**	in	**228.60**	mm			Model based on 9"
247	Concrete Thickness	0.75	ft	228.60	mm	FICUEST		
248	End Walls: (For Entire Filter Complex)							This accounts for common walls on individual filters
249	Number of Walls	22.00	#					
250	Width = PGWT + IFW + GWT + GCW + (2* FI/BWCWT) + FI/BWCW	40.50	ft	12344.40	mm			
251	Height = FBD	19.08	ft	5815.58	mm			
252	Concrete Thickness	**18.00**	in	**500.38**	mm			Model based on 18"
253	Concrete Thickness	1.50	ft	457.20	mm	FEWT		
254	Common Filter Influent Channel:							
255	Slab on Grade:							
256	Length = FI/BWCW + FI/BWCST	6.50	ft	1981.20	mm			
257	Width = 2*(FSOGW+PGWT)+FGW	118.80	ft	36211.26	mm			
258	Concrete Thickness	**24.00**	in	**457.20**	mm			Model based on 24"
259	Concrete Thickness	2.00	ft	609.60	mm	FISOGT		
260	Common Filter Influent Channel Wall:							
261	Length = 2*(FSOGW+PGWT)+FGW	118.80	ft	36211.26	mm			
262	Height = FICH	5.76	ft	1755.03	mm			
263	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
264	Concrete Thickness	1.50	ft	457.20	mm	FIWCST		
265	Common Filter Influent Channel Elevated Slab:							
266	Length = 2*(FSOGW+PGWT)+FGW	118.80	ft	36211.26	mm			
267	Width = FI/BWCW + FI/BWCWT + FEWT	8.00	ft	2438.40	mm			
268	Concrete Thickness	**9.00**	in	**228.60**	mm			Model based on 9"
269	Concrete Thickness	0.75	ft	228.60	mm	FICEST		
270	Filter Gallery:							
271	Slab on Grade:							
272	Length = (#TF/2*FSOGL)+SCW	450.25	ft	137236.20	mm			
273	Width = FGW + (2*PGWT)	37.80	ft	11522.46	mm			
274	Concrete Thickness = FEPHSS + 24	120.00	in	3048.00	mm			
275	Concrete Thickness	10.00	ft	3048.00	mm	FGSOGT		
276	Filter Gallery Elevated Slab:							
277	Length = (#TF/2*FSOGL)+SCW	450.25	ft	137236.20	mm			
278	Width = FGW+(2*PGWT)	37.80	ft	11522.46	mm			
279	Concrete Thickness	**8.00**	in	**304.80**	mm			Model based on 8"
280	Concrete Thickness	0.67	ft	203.20	mm	FGEST		
281	Blower Room:							
282	Slab on Grade:							
283	Length	20.00	ft	6096.00	mm			Fixed
284	Width = FSOGW	40.50	ft	12344.40	mm			
285	Concrete Thickness	**12.00**	in	**609.60**	mm			Model based on 24"
286	Concrete Thickness	1.00	ft	304.80	mm			
287	Walls:							
288	Height = FBD	19.08	ft	5815.58	mm			
289	Concrete Thickness	**8.00**	in	**500.38**	mm			Model based on 8"
290	Concrete Thickness	0.67	ft	203.20	mm			
291	Stair Case:							
292	Slab on Grade:							
293	Length	24.00	ft	7315.20	mm			Fixed
294	Width	24.00	ft	7315.20	mm	SCW		Fixed
295	Concrete Thickness	**12.00**	in	**609.60**	mm			Model based on 24"
296	Concrete Thickness	1.00	ft	304.80	mm			
297	Walls:							
298	Height = FBD	19.08	ft	5815.58	mm			
299	Concrete Thickness	**8.00**	in	**203.20**	mm			Model based on 8"
300	Concrete Thickness	0.67	ft	203.20	mm			
301	Electrical Room:							
302	Slab on Grade:							

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	B	C	D	E	F	G	H	I
303	Length	17.00	ft	5181.60	mm			
304	Width	6.00	ft	1828.80	mm			
305	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
306	Concrete Thickness	1.00	ft	304.80	mm			
307	Walls:							
308	Height = FBD	10.00	ft	3048.00	mm			Fixed
309	Concrete Thickness	**8.00**	in	**304.80**	mm			Model based on 8"
310	Concrete Thickness	0.67	ft	203.20	mm			
311	Overall Dimensions:							
312	Total Filter SOG Length = (#TF/2*FSOGL)+FEWT+SCW+FI/BWCW+(2*FI/BWCST)+2(FSOGT)	432.75	ft	131902.20	mm	SOGL		
313	Total Filter SOG Width = 2*(FSOGW+FSOGT+PGWT)+FGW	118.80	ft	36211.26	mm	SOGW		
314	Total Filter Building Area	51412.14	sf	4776.34	m2	BA		
315	Blower Room Area	810.00	sf	75.25	m2	BRA		
316	Stair Case Area	576.00	sf	53.51	m2	SCA		
317	Electrical Room Area	102.00	sf	9.48	m2	ERA		
318	Total Building Area	52900.14	sf	4914.58	m2	TBA		
319	Filter Building Excavation Length	436.75	ft	133121.40	mm	EVD		
320	Filter Building Excavation Width	122.80	ft	37430.46	mm	EVD		
321	Stair Case Excavation Length	28.00	ft	8534.40	mm			
322	Stair Case Excavation Width	28.00	ft	8534.40	mm			
323	Blower Room Excavation Length	24.00	ft	7315.20	mm			
324	Blower Room Excavation Width	44.50	ft	13563.60	mm			
325	Electrical Room Excavation Length	21.00	ft	6400.80	mm			
326	Electrical Room Excavation Width	10.00	ft	3048.00	mm			
327	Filter Building Excavation Depth (DB + FGSOGT + FFD)	15.00	ft	4572.00	mm	EVD		
328	Stair Case Excavation Depth	15.00	ft	4572.00	mm			
329	Blower Room Excavation Depth	1.00	ft	304.80	mm			
330	Electrical Room Excavation Depth	1.00	ft	304.80	mm			
331								
332	**COST ESTIMATE**							
333	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
334	SITEWORK:							
335	Filters							
336	Excavation	38594.99	CY	29507.99	m3	***$6.72***	$259,477	
337	Imported Structural Backfill	3972.92	CY	3037.51	m3	***$50.94***	$202,387	
338	Native Backfill	4662.94	CY	3565.08	m3	***$8.27***	$38,541	
339	Haul Excess	33932.04	CY	25942.91	m3	***$8.27***	$280,458	
340	Stair Case:							
341	Excavation	1010.49	CY	772.57	m3	***$6.72***	$6,794	
342	Imported Structural Backfill	58.07	CY	44.40	m3	***$50.94***	$2,958	
343	Native Backfill	466.67	CY	356.79	m3	***$8.27***	$3,857	
344	Haul Excess	543.82	CY	415.78	m3	***$8.27***	$4,495	
345	Blower Room:							
346	Excavation	47.14	CY	36.04	m3	***$6.72***	$317	
347	Imported Structural Backfill	79.11	CY	60.48	m3	***$50.94***	$4,030	
348	Native Backfill	2.54	CY	1.94	m3	***$8.27***	$21	
349	Haul Excess	44.61	CY	34.10	m3	***$8.27***	$369	
350	Electrical Room:							
351	Excavation	10.00	CY	7.64	m3	***$6.72***	$67	
352	Imported Structural Backfill	15.56	CY	11.89	m3	***$50.94***	$792	
353	Native Backfill	1.15	CY	0.88	m3	***$8.27***	$9	
354	Haul Excess	8.85	CY	6.77	m3	***$8.27***	$73	
355	Allowance for Misc Items	5%				$804,645.08	$40,232	
356	Subtotal						$844,877	
357								
358	CONCRETE:							
359	Filters							
360	Foundation (Includes Filter, Gulllet Channel, Filter Influent/Backwash Wastewater Channel) (FSOGW * FSOGL * FOSGT) / 27 *#TF	2557.50	CY	1955.35	m3	***$541.11***	$1,383,878	
361	Pipe Gallery Wall	1140.46	CY	871.94	m3	***$880.79***	$1,004,505	
362	Gullet Wall	560.27	CY	428.35	m3	***$880.79***	$493,478	
363	Filter Influent / Backwash Waste Channel Walls	1807.30	CY	1381.78	m3	***$880.79***	$1,591,858	
364	Filter Influent / Backwash Waste Channel Lower Elevated Slab	157.87	CY	120.70	m3	***$1,333.77***	$210,562	
365	Filter Influent / Backwash Waste Channel Upper Elevated Slab	189.44	CY	144.84	m3	***$1,333.77***	$252,675	
366	End Walls	944.46	CY	722.09	m3	***$880.79***	$831,874	
367	Gullet Channel Fill	391.54	CY	299.35	m3	***$416.36***	$163,023	
368	Backwash Waste Channel Fill	391.54	CY	299.35	m3	***$416.36***	$163,023	
369	Common Filter Influent							
370	Slab on Grade	57.20	CY	43.73	m3	***$490.62***	$28,064	
371	Common Influent Channel Wall	76.01	CY	58.11	m3	***$880.79***	$66,947	
372	Common Influent Channel Elevated Slab	26.40	CY	20.18	m3	***$1,333.77***	$35,212	
373	Filter Gallery							
374	Slab on Grade	6304.06	CY	4819.80	m3	***$490.62***	$3,092,872	
375	Filter Gallery Elevated Slab	420.27	CY	321.32	m3	***$1,333.77***	$560,543	
376	Pipe Supports	14.67	CY	11.21	m3	***$41.33***		
377	Blower Room							
378	Slab on Grade	30.00	CY	22.94	m3	***$490.62***	$14,718	
379	Blower Room Walls	28.50	CY	21.79	m3	***$880.79***	$25,105	
380	Stair Case							
381	Slab on Grade	21.33	CY	16.31	m3	***$490.62***	$10,466	
382	Stair Case Walls	22.61	CY	17.29	m3	***$880.79***	$19,918	
383	Electrical Room							
384	Slab on Grade	3.78	CY	2.89	m3	***$490.62***	$1,853	
385	Electrical Room Walls	11.36	CY	8.68	m3	***$880.79***	$10,004	
386	Allowance for Misc Items	5%				$9,960,577.27	$498,029	
387	Subtotal						$10,458,606	
388								

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	B	C	D	E	F	G	H	I
389	MASONRY:	**High**						
390	CMU Filter Building	0.00	SF	0.00	m2	***$198.37***	$0	
391	Blower Room	810.00	SF	75.25	m2	***$198.37***	$160,677	
392	Electrical Room	102.00	SF	9.48	m2	***$198.37***	$20,233	
393	Subtotal	912.00					$180,911	
394								
395	METALS:							
396	Metal Guardrail with Pickets	3069.00	LF	935.43	m	***$91.60***	$281,121	
397	Filter Access Hatch	20.25	SF	1.88	m2	***$139.09***	$2,817	
398	Stairs (FBD * 12/8)	29	Risers			***$495.92***	$14,382	
399	Allowance for Misc Items	10%				$298,318.67	$29,832	
400	Subtotal						$328,151	
401								
402	THERMAL & MOISTURE PROTECTION:							
403	Concrete Liner	0.00	SF	0.00	m2	**$16.00**	$0	
404	Allowance for Misc Items	10%				$0.00	$0	
405	Subtotal						$0	
406								
407	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
408	Fabricated Slide Gates, 42-inch	2	EA			***$16,916.59***	$33,833	
409	Underdrain - Leopold Type S	20,350.92	SF	1890.66	m2	***$105.76***	$2,152,356	
410	Wash Troughs							
411	Conventional	0.00	LF	0.00	m	***$371.13***	$0	
412	Media Retaining	1,716.00	LF	523.04	m	***$841.56***	$1,444,115	
413	Media							
414	Bottom Media - Sand (ES=0.55 UC=1.4)	20,350.92	CF	576.27	m3	***$22.11***	$450,038	
415	Middle Media - Anthracite (ES=1.1 UC=1.5)	0.00	CF	0.00	m3	***$29.49***	$0	
416	Top Media - Anthracite (ES=1.1 UC=1.5)	101,754.58	CF	2881.37	m3	***$29.49***	$3,000,254	
417	Air Scour Blowers (82 hp each)	2	EA			***$143,943.69***	$287,887	
418	Allowance for Misc Items	10%				$7,368,482.69	$736,848	
419	Subtotal						$8,105,331	
420								
421	INSTRUMENTS & CONTROLS:							
422	Instruments							
423	Filter Effluent Magmeter (24-inch)	22	EA			***$31,422.24***	$691,289	
424	Combined Filter Effluent Magmeter (96-inch)	0	EA			***$108,659.86***	$0	
425	Isolation Valve Actuators	132	EA			***$6,409.82***	$846,097	
426	Control Valve Actuators	22	EA			***$6,409.82***	$141,016	
427	Turbidimeters	22	EA			***$4,956.21***	$109,037	
428	Particle Counters	22	EA			***$10,700.91***	$235,420	
429	Level Transmitters	22	EA			***$11,264.12***	$247,811	
430	Differential Pressure Transmitters	22	EA			***$11,264.12***	$247,811	
431	Filter Influent Level Transmitter	2	EA			***$11,264.12***	$22,528	
432	Air Scour Differential Pressure Transmitter	2	EA			***$11,264.12***	$22,528	
433	Air Scour Discharge Pressure Indicator Transmitter	2	EA			***$11,264.12***	$22,528	
434	Number of Analog I/O Counts	182	EA			***$264.27***	$48,203	
435	Number of Digital I/O Counts	797	EA			***$62.59***	$49,872	
436	Number of PLC's	4	EA			***$13,074.33***	$52,297	
437	I&C Conduit & Wire	116,842.50	LF	35613.59	m	***$12.06***	$1,409,001	
438	Allowance for Misc Items	10%				$4,145,437.58	$414,544	
439	Subtotal						$4,559,981	
440								
441	CONVEYING SYSTEMS:							
442	Monorail Hoist (3 Ton)	1	EA			***$4,091.32***	$4,091	
443	Hoist Rail	551.55	LF	168.11	m	***$41.33***	$22,794	
444	Allowance for Misc Items	5%				$26,885.05	$1,344	
445	Subtotal						$28,229	
446								
447	MECHANICAL:							
448	Pipe							
449	Air Scour Pipe-BAW (12-inch , Exposed , 316 SST , None , None)	1,645.09	LF	501.42	m	***$430.08***	$707,526	
450	Filter Influent Header Pipe-FIH (96-inch , Buried , DI , Cement Mortar , Tape Coating)	0.00	LF	0.00	m	***$832.31***	$0	
451	Filter Influent Pipe-FIH (30-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	0.00	LF	0.00	m	***$260.10***	$0	
452	Filter Effluent Pipe-FE (24-inch , Exposed , DI , Cement Mortar , Paint)	382.84	LF	116.69	m	***$208.08***	$79,660	
453	Filter Effluent Pipe-FE (24-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	382.84	LF	116.69	m	***$208.08***	$79,660	
454	Filter Control Valve Pipe-FCV (18-inch , Exposed , DI , Cement Mortar , Paint)	264.00	LF	80.47	m	***$156.06***	$41,200	
455	Filter Effluent Header Pipe-FEH (96-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	432.75	LF	131.90	m	***$832.31***	$360,184	
456	Filter to Waste-FTW (24-inch , Exposed , DI , Cement Mortar , Paint)	209.88	LF	63.97	m	***$208.08***	$43,672	
457	Filter to Waste-FTW (24-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	867.50	LF	264.41	m	***$208.08***	$180,508	
458	Backwash Supply Pipe-BWS (42-inch , Exposed , DI , Cement Mortar , Paint)	1,048.46	LF	319.57	m	***$364.14***	$381,784	
459	Backwash Supply Pipe-BWS (42-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	48.00	LF	14.63	m	***$364.14***	$17,479	
460	Backwash Waste Pipe-BWW (42-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	10.00	LF	3.05	m	***$364.14***	$3,641	
461	Elbows							
462	Air Scour Pipe-BAW (12-inch , 316 SST)	88	EA			***$2,536.64***	$223,224	
463	Filter Influent Header Pipe-FIH (96-inch , DI)	0	EA			***$17,469.08***	$0	
464	Filter Influent Pipe-FIH (30-inch , DI)	0	EA			***$5,459.09***	$0	
465	Filter Effluent Pipe-FE (24-inch , DI)	22	EA			***$4,367.27***	$96,080	
466	Filter Effluent Pipe-FE (24-inch , DI)	22	EA			***$4,367.27***	$96,080	
467	Filter Control Valve Pipe-FCV (18-inch , DI)	0	EA			***$3,275.45***	$0	
468	Filter Effluent Header Pipe-FEH (96-inch , DI)	0	EA			***$17,469.08***	$0	
469	Filter to Waste-FTW (24-inch , DI)	24	EA			***$4,367.27***	$104,814	
470	Filter to Waste-FTW (24-inch , DI)	0	EA			***$4,367.27***	$0	

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	B	C	D	E	F	G	H	I
471	Backwash Supply Pipe-BWS (42-inch , DI)	2	EA			$7,642.72	$15,285	
472	Backwash Supply Pipe-BWS (42-inch , DI)	2	EA			$7,642.72	$15,285	
473	Backwash Waste Pipe-BWW (42-inch , DI)	0	EA			$7,642.72	$0	
474	Tees							
475	Air Scour Pipe-BAW (12-inch , 316 SST)	22	EA			$3,525.06	$77,551	
476	Filter Influent Header Pipe-FIH (96-inch , DI)	0	EA			$29,006.98	$0	
477	Filter Influent Pipe-FIH (30-inch , DI)	0	EA			$9,064.68	$0	
478	Filter Effluent Pipe-FE (24-inch , DI)	22	EA			$7,251.74	$159,538	
479	Filter Effluent Pipe-FE (24-inch , DI)	0	EA			$7,251.74	$0	
480	Filter Control Valve Pipe-FCV (18-inch , DI)	0	EA			$5,438.81	$0	
481	Filter Effluent Header Pipe-FEH (96-inch , DI)	0	EA			$29,006.98	$0	
482	Filter to Waste-FTW (24-inch , DI)	0	EA			$7,251.74	$0	
483	Filter to Waste-FTW (24-inch , DI)	20	EA			$7,251.74	$145,035	
484	Backwash Supply Pipe-BWS (42-inch , DI)	24	EA			$12,690.55	$304,573	
485	Backwash Supply Pipe-BWS (42-inch , DI)	0	EA			$12,690.55	$0	
486	Backwash Waste Pipe-BWW (42-inch , DI)	0	EA			$12,690.55	$0	
487	Crosses							
488	Air Scour Pipe-BAW (12-inch , 316 SST)	11	EA			$4,700.08	$51,701	
489	Filter Influent Header Pipe-FIH (96-inch , DI)	0	EA			$38,675.97	$0	
490	Filter Influent Pipe-FIH (30-inch , DI)	0	EA			$12,086.24	$0	
491	Filter Effluent Pipe-FE (24-inch , DI)	0	EA			$9,668.99	$0	
492	Filter Effluent Pipe-FE (24-inch , DI)	0	EA			$9,668.99	$0	
493	Filter Control Valve Pipe-FCV (18-inch , DI)	0	EA			$7,251.74	$0	
494	Filter Effluent Header Pipe-FEH (96-inch , DI)	11	EA			$38,675.97	$425,436	
495	Filter to Waste-FTW (24-inch , DI)	0	EA			$9,668.99	$0	
496	Filter to Waste-FTW (24-inch , DI)	0	EA			$9,668.99	$0	
497	Backwash Supply Pipe-BWS (42-inch , DI)	0	EA			$16,920.74	$0	
498	Backwash Supply Pipe-BWS (42-inch , DI)	0	EA			$16,920.74	$0	
499	Backwash Waste Pipe-BWW (42-inch , DI)	0	EA			$16,920.74	$0	
500	Valves							
501	Air Scour Pipe-BAW (12-inch ,V500 - BFV)	22	EA			$10,632.76	$233,921	
502	Filter Influent Header Pipe-FIH (96-inch ,V500 - BFV)	0	EA			$85,062.12	$0	
503	Filter Influent Pipe-FIH (30-inch ,V500 - BFV)	22	EA			$26,581.91	$584,802	
504	Filter Effluent Pipe-FE (24-inch ,V500 - BFV)	22	EA			$21,265.53	$467,842	
505	Filter Effluent Pipe-FE (24-inch ,V500 - BFV)	0	EA			$21,265.53	$0	
506	Filter Control Valve Pipe-FCV (18-inch ,V500 - BFV)	22	EA			$15,949.15	$350,881	
507	Filter Effluent Header Pipe-FEH (96-inch ,V500 - BFV)	0	EA			$85,062.12	$0	
508	Filter to Waste-FTW (24-inch ,V500 - BFV)	22	EA			$21,265.53	$467,842	
509	Filter to Waste-FTW (24-inch ,V500 - BFV)	0	EA			$21,265.53	$0	
510	Backwash Supply Pipe-BWS (42-inch ,V500 - BFV)	22	EA			$37,214.68	$818,723	
511	Backwash Supply Pipe-BWS (42-inch ,V500 - BFV)	0	EA			$37,214.68	$0	
512	Backwash Waste Pipe-BWW (42-inch ,V500 - BFV)	22	EA			$37,214.68	$818,723	
513	Allowance for Misc Items	5%				$7,352,650.85	$367,633	
514	Subtotal						$7,720,283	
515								
516	ELECTRICAL:							
517	MCC's							
518	Sections	7	EA			$10,730.27	$75,112	
519	AFD's							
520	Air Scour Blowers (82 hp each)	0	EA			$19,618.40	$0	
521	Switchgear							
522	Units	0	EA			$49,359.23	$0	
523	Electrical Conduit & Wire	865.50	LF	263.80	m	$12.06	$10,437	
524	Allowance for Misc Items	5%				$85,548.92	$4,277	
525	Subtotal						$89,826	
526								
527	**USER DEFINED ESTIMATE ITEMS**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
528	Item 1 Description	0.00		0.00		0.00	$0	
529	Item 2 Description	0.00		0.00		0.00	$0	
530	Item 3 Description	0.00		0.00		0.00	$0	
531	Item 4 Description	0.00		0.00		0.00	$0	
532	Item 5 Description	0.00		0.00		0.00	$0	
533	Item 6 Description	0.00		0.00		0.00	$0	
534	Item 7 Description	0.00		0.00		0.00	$0	
535	Item 8 Description	0.00		0.00		0.00	$0	
536	Item 9 Description	0.00		0.00		0.00	$0	
537	Item 10 Description	0.00		0.00		0.00	$0	
538	Item 11 Description	0.00		0.00		0.00	$0	
539	Item 12 Description	0.00		0.00		0.00	$0	
540	Item 13 Description	0.00		0.00		0.00	$0	
541	Item 14 Description	0.00		0.00		0.00	$0	
542	Item 15 Description	0.00		0.00		0.00	$0	
543	Subtotal						$0	
544								
545	Subtotal						$32,316,195.95	
546								
547	ALLOWANCES:		**User Override**					
548	Finishes Allowance	2.00%		$35,126,300	$702,526.00			
549	Mechanical Allowance	2.00%		$35,126,300	$702,526.00			
550	I&C Allowance	2.00%		$35,126,300	$702,526.00			
551	Electrical Allowance	2.00%		$35,126,300	$702,526.00			
552						Facility Cost Name		
553	Facility Cost	**160,000,000**	**GPD**	**$0.22**	**$35,126,300**	FLCFC01		
554	Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.27**	**$42,684,425**	FLCFC02		
555	Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$0.46**	**$73,211,428**	FLCFC03		
556	Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$0.38**	**$60,247,890**	FLCFC05		
557	Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$0.46**	**$73,211,428**	FLCFC06		

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Concrete Clearwell

Is This Facility Included in My Project? Yes

If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Is this a Seawater Desalination Application?	No	Y/N					
Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	No	Y/N					
Input Maximum Plant Flow Capacity	160.00	mgd	605.67	ML/d	Qmax		
Conversion of Maximum Flow	247.56	cfs	7.01	m3/s	Qmax, cfs		
Is Clearwell to Provide Contact Time for Pathogen Inactivation by Free Chlorine?	Yes	Y/N					
Input pH Exiting Clearwell	8.00	ph units					
Input Free Chlorine Residual Exiting Clearwell	2.00	mg/L					
Input Water Temperature at Maximum Flow	33.80	degrees F	1.00	degrees C			
Input Desired Giardia Log Inactivation	1.00	log					Valid Range: 0.0 to 4.0 log.
Calculate Required Giardia Inactivation CT	111.28	mg-min/L					
Input Desired Virus Log Inactivation	2.00	log					Valid Range: 0.0 to 5.0 log.
Calculate Required Virus Inactivation CT	5.87	mg-min/L					
Calculate Controlling Required Pathogen Inactivation CT	111.28	mg-min/L					
Do you have baffling?	Yes	Y/N					
Input Type of Baffling Material	Concrete	Type				OKAY	
Input Clearwell Short-Circuiting Factor	0.75	#				OKAY	0.1 = no clearwell baffling, short distance between inlet and outlet to clearwell, high inlet and outlet flow velocities. 0.3 = no clearwell baffling, relatively long distance between inlet and outlet. 0.5 = Baffled inlet or outlet with some internal baffling. 0.7 = Well baffled clearwell with inlet and outlet place opposite to each other.
Calculate T10 Detention Time	55.64	min					
Calculate Theoretical Detention Time	74.19	min					
Calculate Disinfection Contact Volume Required	8,243,006.19	gal	31203.17	m3			
Input Storage Volume for Plant Shutdown	3,333,333.33	gal	11,829.41	m3			
Input Backwash Storage Volume	305,000.00	gal	3,293.31	m3			
Input Storage Volume for Fire Protection		gal	0.00	m3			
Input Storage Volume for Peak Hour Flow		gal	0.00	m3			
Calculate Total Clearwell Volume	11,881,339.52	gal	44975.77	m3			
Conversion of Total Clearwell Volume	1,588,304.60	cf	44975.78	m3			
Input Number of Clearwells of Equal Size	2	#					
Input Clearwell Maximum Side Water Depth	15.00	ft	4,572.00	mm	SWD		
Input Clearwell Freeboard	3.00	ft	914.40	mm	FB		
Select Circular or Rectangular Type	Rectangular	Type					
If Rectangular, Input Length to Width Ratio	2.00	:1					
Input Depth of Clearwell Burial	15.00	ft	4,572.00	mm	DB		
Input Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		
For Circular Tank, Calculate Clearwell Diameter	0.00	ft	0.00	mm			
For Rectangular Tank, Calculate Clearwell Length	325.40	ft	99182.77	mm			
For Rectangular Tank, Calculate Clearwell Width	162.70	ft	49591.38	mm			

Estimating Dimensions (per trian):	Value English	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Circular Clearwell (per Each)							
Water Volume of Each Tank	0.00	gal	0.00	m3			
Diameter	0.00	ft	0.00	mm			
Height	0.00	ft	0.00	mm			
Total Volume of Each Tank (including Freeboard)	0.00	gal	0.00	m3			
Slab on Grade Thickness	20.00	in	508.00	mm			Model based on 12"
Slab on Grade Thickness	1.67	ft	508.00	mm			
Wall Thickness	18.00	in	457.20	mm			Model based on 12"
Wall Thickness	1.50	ft	457.20	mm			
Slab on Grade Diameter	0.00	ft	0.00	mm			
Excavation Diameter	0.00	ft	0.00	mm			
Excavation Depth	0.00	ft	0.00	mm			
Rectangular Clearwell (per Each)							
Width	162.70	ft	49591.38	mm			
Length	325.40	ft	99182.77	mm			
Height = SWD + FB	18.00	ft	5486.40	mm			
Slab on Grade Thickness	17.00	in	431.80	mm			Rule: SWD in inches + 2 inches
Slab on Grade Thickness	1.42	ft	431.80	mm			
Wall Thickness	15.00	in	381.00	mm	Rectangular Clearwell Wall Thickness Override (in):		Rule: SWD in inches
Wall Thickness	1.25	ft	381.00	mm			

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Elevated Slab Thickness	15.00	in	381.00	mm			Model based on 12"
Elevated Slab Thickness	1.25	ft	381.00	mm			
Column Diameter	18.00	in	457.20	mm			Rule: 18" for SWD ≤ 30', 24" for SWD > 30'
Column Diameter	1.50	ft	457.20	mm			
Column Volume	31.81	cf	0.90	m3			
Column Volume	1.18	cy	0.90	m3			
Number of Columns (Each)	235.00	#					Rule: Columns on 15' centers
Slab on Grade Width	168.03	ft	51216.98	mm			
Slab on Grade Length	330.74	ft	100808.37	mm			
Excavation Width	172.03	ft	52436.18	mm			
Excavation Length	334.74	ft	102027.57	mm			
Excavation Depth	17.42	ft	5308.60	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Circular Clearwell							
Excavation	0	CY	0.00	m3	$6.72	$0	
Imported Structural Backfill	0	CY	0.00	m3	$50.94	$0	
Native Backfill	0	CY	0.00	m3	$8.27	$0	
Haul Excess	0	CY	0.00	m3	$8.27	$0	
Rectangular Clearwell							
Excavation	91,374	CY	69860.29	m3	$6.72	$614,313	
Imported Structural Backfill	8,531	CY	6522.64	m3	$50.94	$434,598	
Native Backfill	20,497	CY	15670.73	m3	$8.27	$169,410	
Haul Excess	70,877	CY	54189.56	m3	$8.27	$585,821	
Allowance for Misc Items	5%				$1,804,141.18	$90,207	
Subtotal						$1,894,348	
CONCRETE:							
Circular Clearwell							Budgetary Quote: (CPES will automatically add Installation Factor)
Prestressed Concrete Tank (11881340 gallons)	0	EA			$0.00	$0	
Rectangular Clearwell							
Foundation	5,832	CY	4458.85	m3	$541.11	$3,155,707	
Columns	277	CY	211.67	m3	$880.79	$243,850	
Walls	1,627	CY	1243.94	m3	$880.79	$1,433,063	
Elevated Slab	5,016	CY	3834.81	m3	$1,333.77	$6,689,826	
Concrete Baffling	6,530	CY	4992.51	m3	$880.79	$5,751,539	
Allowance for Misc Items	5%				$17,273,985.20	$863,699	
Subtotal						$18,137,684	
METALS & PLASTICS:							
Polypropylene Baffling	0	SF	0.00	m2	$13.91	$0	
Stainless Steel Baffling	0	SF	0.00	m2	$57.95	$0	
Allowance for Misc Items	5%				$0.00	$0	
Subtotal						$0	
THERMAL & MOISTURE PROTECTION:							
Concrete Liner	0	SF	0.00	m2	$16.00	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$20,032,033	
ALLOWANCES:		User Override					
Metals Allowance	1.00%		$21,539,820	$215,398			
Finishes Allowance	2.00%		$21,539,820	$430,796			
Equipment Allowance	1.00%		$21,539,820	$215,398			
I&C Allowance	2.00%		$21,539,820	$430,796			
Mechanical Allowance	5.00%		$21,539,820	$1,076,991			
Electrical Allowance	1.00%		$21,539,820	$215,398			
Facility Cost	**11,881,340**	**Gallons**	**$1.90**	**$22,616,811**			
Facility Cost with Standard Additional Project Costs Added	**11,881,340**	**Gallons**	**$2.31**	**$27,483,270**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**11,881,340**	**Gallons**	**$3.97**	**$47,138,726**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**11,881,340**	**Gallons**	**$3.26**	**$38,791,878**			
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**11,881,340**	**Gallons**	**$3.97**	**$47,138,726**			

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Granular Media Filter Backwash Supply Pump Station

Is This Facility Included in My Project? Yes

Notes to Designer:

This mini-model is based on development of either a submersible or vertical turbine pump station with pumps less than 100 and 1,000 HP each, respectively. For larger HP pumps, get project specific pump and AFD budget quotes.

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Comment	Red Flags
1.) Input Pump Station Type	Submersible	Type			TYP		
2.) Input Maximum Pump Station Flow	33.30	mgd	236.44	ML/d	Qmax		
3.) Input Number of Hours Per Day Backwash Supply Pump Station Operates	3.00	hrs					
Conversion of Maximum P.S. Flow from MGD to CFS	51.53	cfs	1459.03	L/s	Qmax, cfs		
Given: Pump Station Discharge Center Line = 0.00 ft							
4.) Input Maximum Suction Lift for Vertical Turbine Pump Station or Wetwell Operating Water Depth for Submersible Pump Station	12.00	ft	3,657.60	mm	MSL		
5.) Input Maximum Discharge Lift	40.00	ft	12,192.00	mm	MDL		
6.) Input Maximum Pump Station Yard Piping Discharge Header Velocity, and Individual Pump Discharge Lateral Velocity	5.00	fps	1.52	m/s	PSHV	Typically 2 - 7 fps	
Calculate I-P P.S. Discharge Header Pipe Size = [(Qmax, cfs/PSHV)*4/PI]^1/2*12	43.47	in	1104.06	mm	PSHD		
Use this Standard Diameter for Discharge Header Pipe Size	42.00	in	1066.80	mm	PSHDS		
Calculate Maximum PSHV using real pipe size = (Qmax, cfs * 4 / PI * 144) / PSHDS^2	5.36	fps	1.63	m/s	maxPSHV		
7.) Input Length of I-P Pump Station Force Main	250.00	ft	76,200.00	mm	LPSF	Confirm with Hydraulic Analysis	
8.) Input Equivalent Length of I-P Pump Station Force Main Minor Losses	50.00	ft	15,240.00	mm	MPSF	Preliminary assumption of MPSF = 50% * LPSF	
9.) Input Hazen Williams Pipe Friction Coefficient	120.00				HWFC	Typically HWFC =100	
Calculate Maximum High Service Water Forcemain Dynamic Headloss = (LPSF + MPSF) * 4.73 * (Q max, cfs)^1.85 / ((HWFC)^1.85 * (PSHDS / 12)^4.87	0.67	ft	202.83	mm	maxFMDH	Should be ≤ 25% of static lift. If > 25%, reduce velocity or increase static lift.	
Calculate Total Maximum Dynamic Headloss = MSL + MDL + maxFMDH	52.67	ft	16052.43	mm	maxTDH		
10.) Input Pump Efficiency	75.00%				PE	Typically 0.70 to 0.80	
Wetwell							
11.) Input Minimum Wet Well Detention Time	5.00	min				Typically minimum of 5 min for pump control	
Calculate Wetwell Operational Capacity (each)	115,630.21	gal	437.71	m3			

Input Pump Information	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	AFD? (Yes or No)	Calculate Individual Pump GPM	Calculate Individual Pump BHP
Active Pump # 1	17.00	mgd	68.14	ML/d	Yes	11805.56	209.34
Active Pump # 2	17.00	mgd	68.14	ML/d	Yes	11805.56	209.34
Active Pump # 3	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 4	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 5	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 6	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 7	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 8	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 9	0.00	mgd	0.00	ML/d	No	0.00	0.00
Active Pump # 10	0.00	mgd	0.00	ML/d	No	0.00	0.00
Calculate Total Active Pumps Capacity	34.00	mgd				23611.11	418.68
Calculate Standby Pump Capacity = Max Pump	17.00	mgd			Yes	11805.56	209.34
Calculate Total P.S. Capacity	51.00					35416.67	628.03
Calculate Total Number of Pumps (Active & Standby)	3.00						
Clearance Around Pumps (ft,)	3.50				PC	Fixed	

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Comment	Red Flags
Calculate Pump Station Dimensions Based on Hydraulic Institute Standards (based on Largest Capacity Pump):							
Calculate Distance from Inlet Pipe to Back Wall of Wet Well Behind Pumps	13.93	ft	4246.67	mm	A		
Calculate Distance from Pump Suction Centerline to Back Wall of Wet Well	2.36	ft	719.47	mm	B		
Calculate Distance from Wet Well Floor to Suction Bell	1.01	ft	308.76	mm	C		
Calculate Minimum Water Depth in Wet Well	8.28	ft	2524.38	mm	H		
Calculate Distance Between Pump Centerlines	5.00	ft	1524.00	mm	S		
Calculate Wet Well Width = S * (Total Number of Pumps)	15.00	ft	4572.00	mm	W		
Calculate Wet Well Length = Maximum of (PC * 2) or A	13.93	ft	4246.67	mm	LWW		
Wet Well Free Board	2.00	ft	609.60	mm	FB	Fixed	
Calculate Wet Well Side Water Depth = MSL + H - Discharge Flange -Elevated Slab - FB for Vertical Turbine or MSL for Submersible	12.00	ft	3657.60	mm			
Calculate Wet Well Water Volume	115,630.21	gal	437.71	m3	WWV		
Calculate Wet Well Volume to Largest Pump Capacity Ratio	9.79					Ratio should be 2 or greatee	
Wetwell Dimensions							
Calculate Pump Station Width	25.50	ft	7,772.40	mm	WWW		
Calculate Pump Station Length	50.51	ft	15,396.89	mm	WWL		
Calculate Wet Well Side Water Depth (based on pumps)	14.00	ft	4,267.20	mm	SWD		
Influent Pipe & Motorized Gate Valve:							
12.) Input Maximum Influent Pipe Velocity	4.00	fps	1.22	m/s	IPV	Typically 2 - 7 fps	

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Calculate I-P P.S.Influent Pipe Size = [(Qmax, cfs/IPV)*4/PI]^1/2*12	48.60	in	1234.38	mm	IPD		
Use this Standard Diameter for I-P P.S. Influent Pipe, and Gate Valve	48.00	in	1219.20	mm	IPDS		
Discharge Header Pipe Vault:							
13.) Input Clear Distance Around Discharge Header Pipe	**3.00**	ft	**914.40**	mm	DPC	Typically > = 3'	
14.) Input Depth of Motor Control Center Equipment	**2.00**	ft	**609.60**	mm	MCC	Typically = 1' - 2.5'	
15.) Maximum Velocity Through Discharge Header within Pump Station and Downstream Flow Meter Vault	**12.00**	fps	**3.66**	m/s	PDHV	Valid Range: ≤ 15 fps	
Calculate Discharge Header Diameter within Pump Station =[(Qmax, cfs/PDHV)*4/PI]^1/2*12	28.06	in	712.67	mm	PDHD		
Use this Standard Diameter for Discharge Header Diameter within Pump Station	30.00	in	762.00	mm	FCVSD		
Pump Station Depth of Burial:							
16.) Input Pump Station Depth of Burial	**2.00**	ft	**609.60**	mm	DB		
17.) Input Cutback Slope	**1.00**	:1 (ft:ft)				Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.	
18.) Input Over Excavation Depth	**1.00**	ft	**0.00**	mm	OEXD		

Estimating Dimensions:	**Value English**	**Unit (English)**	**Name**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Wetwell:							
Width	25.50	ft	7772.40	mm	W		
Length = LWW	50.51	ft	15396.89	mm	LWW		
Wall Height = MSL + H	14.00	ft	4267.20	mm			
Slab on Grade Width	29.50	ft	8991.60	mm			
Slab on Grade Length	54.51	ft	16616.09	mm			
Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Slab on Grade Thickness	1.00	ft	304.80	mm			
Wall Thickness	**12.00**	in	**304.80**	mm	TWWW	Model based on 12"	
Wall Thickness	1.00	ft	304.80	mm			
Discharge Header Pipe Vault							
Width	25.50	ft	7772.40	mm			
Length = Discharge Header Pipe Diameter + (Clearance Around Pipe * 2) + Depth of Motor Control Center Equipment	11.50	ft	3505.20	mm	LDHPV		
Wall Height = Discharge Header Pipe Diameter + (Clearance Around Pipe * 2)	9.50	ft	2895.60	mm	HDHPV		
Slab on Grade Width	29.50	ft	8991.60	mm			
Slab on Grade Length	13.50	ft	4114.80	mm			
Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Slab on Grade Thickness	1.00	ft	304.80	mm			
Wall Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Wall Thickness	1.00	ft	304.80	mm			
Operating Floor							
Width	25.50	ft	7772.40	mm			
Elevated Slab Width	27.50	ft	8382.00	mm			
Elevated Stab Length = LWW + LDPV + (TWWW * 3)	65.01	ft	19816.49	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Overall Dimensions:							
Building Width	27.50	ft	8382.00	mm			
Building Length	65.01	ft	19816.49	mm			
Building Depth	14.00	ft	4267.20	mm			
Excavation Width	29.50	ft	8991.60	mm			
Excavation Length	54.51	ft	16616.09	mm			
Excavation Depth	5.00	ft	1524.00	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	420.68	CY	321.63	m3	***$6.72***	$2,828	
Imported Structural Backfill	119.12	CY	91.08	m3	***$50.94***	$6,068	
Native Backfill	77.79	CY	59.48	m3	***$8.27***	$643	
Haul Excess	342.88	CY	262.15	m3	***$8.27***	$2,834	
Allowance for Misc Items	5%				$12,373.65	$619	
Subtotal						$12,992	
CONCRETE:							
Wet Well:							
Foundation	59.56	CY	45.54	m3	***$541.11***	$32,230	
Perimeter Walls	87.13	CY	66.61	m3	***$880.79***	$76,740	
Operating Floor:							
Elevated Slab (Including floor over Discharge Header Vault)	66.22	CY	50.63	m3	***$1,333.77***	$88,320	
Pump Pads	1.63	CY	1.25	m3	***$490.62***	$801	
Other Equipment Pads	1.00	CY	0.76	m3	***$490.62***	$491	
Discharge Pipe Vault:							
Slab on Grade	14.75	CY	11.28	m3	***$490.62***	$7,237	
Walls	19.88	CY	15.20	m3	***$880.79***	$17,510	
Allowance for Misc Items	5%				$223,328.29	$11,166	
Subtotal						$234,495	

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MASONRY:	**Moderate**						
CMU Building	1787.91	SF	166.10	m2	***$165.31***	$295,551	
Subtotal						$295,551	
METALS:							
Checker Plate Over Intake Pipe Gate = (Diameter of Influent Pipe +2') * (2 Feet Wide) (sf)	12.00	SF	1.11	m2	***$90.92***	$1,091	
Checker Plate Over Discharge Pipe Header = ((Discharge Pipe Diameter * 2) * ("S" * Total Number of Pumps)	105.00	SF	9.75	m2	***$90.92***	$9,546	
Ladder	14.00	VLF	4.27	VLM	***$125.74***	$1,760	
Allowance for Misc Items	10%				$12,397.81	$1,240	
Subtotal						$13,638	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Size of Sluice Gate (per side in inches)	48.00	in	1219.20	mm			
Sluice Gate	1.00	EA			***$12,484.16***	$12,484	
Pumps:							
Active Pump # 1	209.34	hp	156.11	kW	***$967.89***	$202,619	
Active Pump # 2	209.34	hp	156.11	kW	***$967.89***	$202,619	
Active Pump # 3	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 4	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 5	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 6	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 7	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 8	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 9	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 10	0.00	hp	0.00	kW	***$0.00***	$0	
Standby Pump	209.34	hp	156.11	kW	***$967.89***	$202,619	
AFD's							
Active Pump # 1	209.34	hp	156.11	kW	***$173.48***	$36,317	
Active Pump # 2	209.34	hp	156.11	kW	***$173.48***	$36,317	
Active Pump # 3	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 4	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 5	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 6	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 7	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 8	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 9	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 10	0.00	hp	0.00	kW	***$0.00***	$0	
Standby Pump	209.34	hp	156.11	kW	***$173.48***	$36,317	
Allowance for Misc Items	10%				$716,806.90	$71,681	
Subtotal						$800,972	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$1,357,647	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$2,715,295	$54,306			
I&C Allowance	8.00%		$2,715,295	$217,224			
Mechanical Allowance	25.00%		$2,715,295	$678,824			
Electrical Allowance	15.00%		$2,715,295	$407,294			
Facility Cost	**628**	**Total Pump HP**	**$4,323.54**	**$2,715,295**			
Facility Cost with Standard Additional Project Costs Added	**628**	**Total Pump HP**	**$5,253.84**	**$3,299,545**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**628**	**Total Pump HP**	**$9,011.28**	**$5,659,310**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**628**	**Total Pump HP**	**$7,415.65**	**$4,657,216**			
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**628**	**Total Pump HP**	**$9,011.28**	**$5,659,310**			

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Liquid Chemical Storage & Feed - (Aluminum Sulfate (Alum))
Located in Stand Alone Chemical Building

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Aluminum Sulfate (Alum)**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	48.50%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Al2(SO4)3-14H2O		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.34		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	5.42	lb/gal	649.90	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**30.00**	mgd	**113.56**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**75.00**	mgd	**283.91**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**605.67**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**2.50**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**5.00**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**15.00**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**4**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	625.91	lb/d	283.91	kg/d			
Average as "dry" chemical	3,129.53	lb/d	1419.53	kg/d			
Maximum as "dry" chemical	20,028.96	lb/d	9084.98	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	1.20	gph	4.55	L/h			
Average at feed concentration	6.01	gph	22.75	L/h			
Maximum at feed concentration	38.47	gph	145.62	L/h			
Calculate Chemical Metering Pump Flow Turndown	32.00	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	625.91	lb/d	283.91	kg/d			
Average	3,129.53	lb/d	1419.53	kg/d			
Maximum	20,028.96	lb/d	9084.98	kg/d			
Max Flow Average Dose Daily Usage	6,676.32	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	36,928.76	gal	139.79	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,024.02	gal	15.23	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	6,036.04	gal	22.85	m3			
Maximum of Above Delivery and Storage Volumes	4,936.66	cf	139.79	m3			
BULK TANKS:							
29.) Input Number of Tanks	**4**	#					
30.) Input Tank Diameter	**10.00**	ft	**3,048.00**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	15.71	ft	4789.59	mm			
Use this Tank Height (Liquid Height * 1.2)	19.00	ft	5791.20	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	9,302.38	gal	35.21	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	11,162.85	gal	42.26	m3			
31.) Input Number of Rows of Tanks	**2**	#					
Calculate Number of Tanks per Row	2	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	30.23	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**Yes**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**1**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	3,692.88	gal	13.98	m3			
Convert Day Tank Volume (per each)	493.67	cf	13.98	m3			
Calculate Day Tank Diameter (per each)	7.00	ft	2133.60	mm	DTD		
Calculate Day Tank Height (per each)	14.00	ft	4267.20	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	2	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	4	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**3**	#					
Calculate Total Number of Metering Pumps	8	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**Yes**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here	**18**	#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	None						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	44.00	ft	13411.20	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	10,912.00	gal	41.31	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	13,395.42	gal	50.71	m3			
Calculate 30% of All Tank Volume	13,395.42	gal	50.71	m3			
Calculate Maximum Volume + Fire Flow Volume	24,307.42	gal	92.01	m3			
Tank Pads Volume	942.48	cf	26.69	m3			
Tank Pads Volume	7,050.22	gal	26.69	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	31,357.65	gal	118.70	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	4,191.91	cf	118.70	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	685.80	mm			
49.) Input Depth of Burial	1.75	ft	533.40	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	6.50	in	150.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	4.00	in	100.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	44.00	8.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	44.00	8.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	106.00	32.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	106.00	32.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N
53.) Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	26.00	0.50	No	52.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**13.00**		**52.00**	**0.00**	**0.00**	**52.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	1.67

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	15.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	19.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Width	4.67						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.37***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	1						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	TRUE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	44.00	ft	13411.20	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	4	#					
Diameter of Bulk Tank	10.00	ft	3048.00	mm			
Volume of Each Bulk Tank	11162.85	gal	42.26	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	1	#					
Diameter of Day Tank	7.00	ft					
Volume of Each Day Tank	4030.38	gal	15.26	m3			
Number of Transfer Pumps	2	#					
Transfer Pump Capacity (each)	201.52	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	8	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	44.00	ft	13411.20	mm			
Width	8.00	ft	2438.40	mm			
Area	352.00	sf	32.70	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	20.33	ft	6197.60	mm			
Width	6.00	ft	1828.80	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	44.00	ft	13411.20	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	2728.00	sf	253.44	m2			
Corridor Area Length	44.00	ft	13411.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	352.00	sf	32.70	m2			
Electrical Area Length	20.33	ft	6197.60	mm			
Electrical Area Width	6.00	ft	1828.80	mm			
Electrical Room Area	122.00	sf	11.33	m2			
Chemical Facility Area	3202.00	sf	297.48	m2			
Covered Chemical Area (Building)	3202.00	sf	297.48	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	3324.00	sf	308.81	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	522.81	CY	399.72	m3	***$6.72***	$3,515	
Imported Structural Backfill	237.19	CY	181.34	m3	***$50.94***	$12,083	
Native Backfill	51.72	CY	39.54	m3	***$8.27***	$427	
Haul Excess	471.09	CY	360.17	m3	***$8.27***	$3,894	
Allowance for Misc Items	5%				$19,918.69	$996	
Subtotal						$20,915	
CONCRETE:							
Slab on Grade	85.90	CY	65.68	m3	***$490.62***	$42,145	
Containment Walls	11.78	CY	9.00	m3	***$880.79***	$10,374	
Bulk Tank Pads	68.42	CY	52.31	m3	***$490.62***	$33,566	
Day Tank Pads	3.52	CY	2.69	m3	***$490.62***	$1,727	
Transfer Pump Pads	1.33	CY	1.02	m3	***$490.62***	$654	
Metering Pump Pads	5.33	CY	4.08	m3	***$490.62***	$2,617	
Corridor							
Slab on Grade	12.22	CY	9.34	m3	***$490.62***	$5,996	
Electrical Room							
Slab on Grade	4.52	CY	3.45	m3	***$490.62***	$2,217	
Allowance for Misc Items	5%				$99,295.66	$4,965	
Subtotal						$104,260	
MASONRY:	**Moderate**						
Chemical Building	3080.00	SF	286.14	m2	***$198.37***	$610,970	
Electrical Room	122.00	SF	11.33	m2	***$165.31***	$20,167	
Subtotal	3202.00					$631,137	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	4	EA			***$26,489.89***	$105,960	
Day Tank	1	EA			***$11,442.30***	$11,442	
Transfer Pump	2	EA			***$10,658.90***	$21,318	
Metering Pump	8	EA			***$10,658.90***	$85,271	
Allowance for Misc Items	10%				$223,990.84	$22,399	
Subtotal						$246,390	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	4	EA			***$1,043.16***	$4,173	
Chemical Tank Beacons	4	EA			***$1,043.16***	$4,173	
Day Tank Differential Pressure Transmitter	1	EA			***$1,043.16***	$1,043	
Drum or Tote Weigh Scale	0	EA			***$1,390.89***	$0	
Metering Pump Discharge Pressure Switch	8	EA			***$695.44***	$5,564	
Magmeter	4	EA			***$695.44***	$2,782	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	21	EA			***$264.27***	$5,550	
Number of Digital I/O Counts	70	EA			***$62.59***	$4,381	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	1012.00	LF	308.46	m	***$12.06***	$12,204	
Allowance for Misc Items	10%				$68,242.47	$6,824	
Subtotal						$75,067	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	44.00	LF	13.41	m	***$42.14***	$1,854	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	44.00	LF	13.41	m	***$28.95***	$1,274	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	106.00	LF	32.31	m	***$13.11***	$1,390	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	106.00	LF	32.31	m	***$13.11***	$1,390	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	8	EA			***$146.80***	$1,174	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	8	EA			***$84.65***	$677	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	32	EA			***$10.06***	$322	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	32	EA			***$10.06***	$322	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	2	EA			***$218.62***	$437	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	2	EA			***$124.01***	$248	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	8	EA			***$10.47***	$84	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	8	EA			***$10.47***	$84	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	2	EA			***$72.81***	$146	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	2	EA			***$42.28***	$85	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$1,341.93***	$5,368	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$757.94***	$3,032	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	16	EA			***$57.14***	$914	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	16	EA			***$57.14***	$914	
Allowance for Misc Items	10%				$16,608.36	$1,661	
Subtotal						$21,397	
ELECTRICAL:							

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# MCC Sections	9	#			***$10,730.27***	$96,572	
Switchgear	0	EA			***$49,359.23***	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			***$8,931.12***	$0	
User Defined Item #1	0	EA			***$8,865.56***	$0	
User Defined Item #2	0	EA			***$8,865.56***	$0	
User Defined Item #3	0	EA			***$8,865.56***	$0	
Electrical Conduit & Wire	1144.00	LF	348.69	m	***$12.06***	$13,795	
Allowance for Misc Items	10%				$110,367.88	$11,037	
Subtotal						$121,405	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$1,231,929	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$1,368,810	$27,376			
I&C Allowance	2.00%		$1,368,810	$27,376			
Mechanical Allowance	4.00%		$1,368,810	$54,752			
Electrical Allowance	2.00%		$1,368,810	$27,376			
					Facility Cost Name		
Facility Cost	**3,202**	**Building SF**	**$427.49**	**$1,368,810**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**3,202**	**Building SF**	**$519.47**	**$1,663,337**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**3,202**	**Building SF**	**$890.98**	**$2,852,921**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**3,202**	**Building SF**	**$733.22**	**$2,347,755**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**3,202**	**Building SF**	**$890.98**	**$2,852,921**	CFLFC06		

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Liquid Chemical Storage & Feed - (Liquid Polymer)
Located in Chemical Building A

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Liquid Polymer**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	100.00%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Polymer		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.10		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	9.18	lb/gal	1100.00	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**30.00**	mgd	**113.56**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**75.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**605.67**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**0.25**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**0.75**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**1.50**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**4**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	62.59	lb/d	28.39	kg/d			
Average as "dry" chemical	469.43	lb/d	212.93	kg/d			
Maximum as "dry" chemical	2,002.90	lb/d	908.50	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.07	gph	0.27	L/h			
Average at feed concentration	0.53	gph	2.02	L/h			
Maximum at feed concentration	2.27	gph	8.60	L/h			
Calculate Chemical Metering Pump Flow Turndown	32.00	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	62.59	lb/d	28.39	kg/d			
Average	469.43	lb/d	212.93	kg/d			
Maximum	2,002.90	lb/d	908.50	kg/d			
Max Flow Average Dose Daily Usage	1,001.45	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	3,272.73	gal	12.39	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,901.99	gal	18.56	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	7,352.99	gal	27.83	m3			
Maximum of Above Delivery and Storage Volumes	982.95	cf	27.83	m3			
BULK TANKS:							
29.) Input Number of Tanks	**1**	#					
30.) Input Tank Diameter	**10.00**	ft	**3,048.00**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	12.52	ft	3814.67	mm			
Use this Tank Height (Liquid Height * 1.2)	16.00	ft	4876.80	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	7,833.58	gal	29.65	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	9,400.30	gal	35.58	m3			
31.) Input Number of Rows of Tanks	**1**	#					
Calculate Number of Tanks per Row	1	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	71.81	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**Yes**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**1**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	218.18	gal	0.83	m3			
Convert Day Tank Volume (per each)	29.17	cf	0.83	m3			
Calculate Day Tank Diameter (per each)	3.00	ft	914.40	mm	DTD		
Calculate Day Tank Height (per each)	6.00	ft	1828.80	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	2	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	4	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**0**	#					
Calculate Total Number of Metering Pumps	5	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	A						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	29.00	ft	8839.20	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm		Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension	
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	7,192.00	gal	27.22	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	11,280.36	gal	42.70	m3			
Calculate 30% of All Tank Volume	2,820.09	gal	10.68	m3			
Calculate Maximum Volume + Fire Flow Volume	18,472.36	gal	69.93	m3			
Tank Pads Volume	235.62	cf	6.67	m3			
Tank Pads Volume	1,762.56	gal	6.67	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	20,234.91	gal	76.60	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	2,705.01	cf	76.60	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	685.80	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	1.50	in	40.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	29.00	8.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	29.00	8.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	91.00	20.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	91.00	20.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N
53.) Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	0.00	0.50	No	0.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	0.00
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	0.00

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	0.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	0.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	0.00						
CD7	3.00						
Total Width	0.00						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.42***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	1						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	TRUE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	29.00	ft	8839.20	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	1	#					
Diameter of Bulk Tank	10.00	ft	3048.00	mm			
Volume of Each Bulk Tank	9400.30	gal	35.58	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	1	#					
Diameter of Day Tank	3.00	ft					
Volume of Each Day Tank	317.26	gal	1.20	m3			
Number of Transfer Pumps	2	#					
Transfer Pump Capacity (each)	15.86	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	5	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	29.00	ft	8839.20	mm			
Width	8.00	ft	2438.40	mm			
Area	232.00	sf	21.55	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	0.00	ft	0.00	mm			
Width	0.00	ft	0.00	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	29.00	ft	8839.20	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	1798.00	sf	167.04	m2			
Corridor Area Length	29.00	ft	8839.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	232.00	sf	21.55	m2			
Electrical Area Length	0.00	ft	0.00	mm			
Electrical Area Width	0.00	ft	0.00	mm			
Electrical Room Area	0.00	sf	0.00	m2			
Chemical Facility Area	2030.00	sf	188.59	m2			
Covered Chemical Area (Building)	2030.00	sf	188.59	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	2030.00	sf	188.59	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	345.03	CY	263.80	m3	***$6.72***	$2,320	
Imported Structural Backfill	150.37	CY	114.97	m3	***$50.94***	$7,660	
Native Backfill	44.92	CY	34.34	m3	***$8.27***	$371	
Haul Excess	300.12	CY	229.46	m3	***$8.27***	$2,481	
Allowance for Misc Items	5%				$12,831.58	$642	
Subtotal						$13,473	
CONCRETE:							
Slab on Grade	57.18	CY	43.72	m3	***$490.62***	$28,054	
Containment Walls	6.67	CY	5.10	m3	***$880.79***	$5,872	
Bulk Tank Pads	17.10	CY	13.08	m3	***$490.62***	$8,392	
Day Tank Pads	1.43	CY	1.09	m3	***$490.62***	$699	
Transfer Pump Pads	1.33	CY	1.02	m3	***$490.62***	$654	
Metering Pump Pads	3.33	CY	2.55	m3	***$490.62***	$1,635	
Corridor							
Slab on Grade	8.06	CY	6.16	m3	***$490.62***	$3,952	
Electrical Room							
Slab on Grade	0.00	CY	0.00	m3	***$490.62***	$0	
Allowance for Misc Items	5%				$49,259.06	$2,463	
Subtotal						$51,722	
MASONRY:	**Moderate**						
Chemical Building	2030.00	SF	188.59	m2	***$198.37***	$402,685	
Electrical Room	0.00	SF	0.00	m2	***$165.31***	$0	
Subtotal	2030.00					$402,685	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	1	EA			***$22,771.38***	$22,771	
Day Tank	1	EA			***$3,608.62***	$3,609	
Transfer Pump	2	EA			***$10,658.90***	$21,318	
Metering Pump	5	EA			***$10,658.90***	$53,294	
Allowance for Misc Items	10%				$100,992.28	$10,099	
Subtotal						$111,092	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	1	EA			***$1,043.16***	$1,043	
Chemical Tank Beacons	1	EA			***$1,043.16***	$1,043	
Day Tank Differential Pressure Transmitter	1	EA			***$1,043.16***	$1,043	
Drum or Tote Weigh Scale	0	EA			***$1,390.89***	$0	
Metering Pump Discharge Pressure Switch	5	EA			***$695.44***	$3,477	
Magmeter	4	EA			***$695.44***	$2,782	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	14	EA			***$264.27***	$3,700	
Number of Digital I/O Counts	45	EA			***$62.59***	$2,817	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	406.00	LF	123.75	m	***$12.06***	$4,896	
Allowance for Misc Items	10%				$49,174.79	$4,917	
Subtotal						$54,092	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	29.00	LF	8.84	m	***$15.75***	$457	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	29.00	LF	8.84	m	***$13.11***	$380	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	91.00	LF	27.74	m	***$13.11***	$1,193	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	91.00	LF	27.74	m	***$13.11***	$1,193	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	8	EA			***$22.49***	$180	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	8	EA			***$10.06***	$80	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	20	EA			***$10.06***	$201	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	20	EA			***$10.06***	$201	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	2	EA			***$29.39***	$59	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	2	EA			***$10.47***	$21	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	5	EA			***$10.47***	$52	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	5	EA			***$10.47***	$52	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	2	EA			***$11.75***	$24	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$173.94***	$696	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$57.14***	$229	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	10	EA			***$57.14***	$571	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	10	EA			***$57.14***	$571	
Allowance for Misc Items	10%				$5,357.86	$536	
Subtotal						$6,731	
ELECTRICAL:							

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# MCC Sections	0	#			$10,730.27	$0	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	0.00	LF	0.00	m	$12.06	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$651,153	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$723,503	$14,470			
I&C Allowance	2.00%		$723,503	$14,470			
Mechanical Allowance	4.00%		$723,503	$28,940			
Electrical Allowance	2.00%		$723,503	$14,470			
					Facility Cost Name		
Facility Cost	**2,030**	**Building SF**	**$356.41**	**$723,503**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**2,030**	**Building SF**	**$433.09**	**$879,179**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**2,030**	**Building SF**	**$742.83**	**$1,507,950**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**2,030**	**Building SF**	**$611.30**	**$1,240,937**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**2,030**	**Building SF**	**$742.83**	**$1,507,950**	CFLFC06		

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Liquid Chemical Storage & Feed - (Liquid Polymer)
Located in Chemical Building A

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Liquid Polymer**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	100.00%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Polymer		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.10		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	9.18	lb/gal	1100.00	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**30.00**	mgd	**56.78**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**75.00**	mgd	**283.91**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**605.67**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**0.05**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**0.10**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**0.25**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**2**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	12.52	lb/d	5.68	kg/d			
Average as "dry" chemical	62.59	lb/d	28.39	kg/d			
Maximum as "dry" chemical	333.82	lb/d	151.42	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.03	gph	0.11	L/h			
Average at feed concentration	0.14	gph	0.54	L/h			
Maximum at feed concentration	0.76	gph	2.87	L/h			
Calculate Chemical Metering Pump Flow Turndown	26.67	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	12.52	lb/d	5.68	kg/d			
Average	62.59	lb/d	28.39	kg/d			
Maximum	333.82	lb/d	151.42	kg/d			
Max Flow Average Dose Daily Usage	133.53	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	436.36	gal	1.65	m3			
28.) Choose Chemical Delivery Method	**Tote**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	300.00	gal	1.14	m3			Assumes 300 gal per Tote.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Bulk Delivery Volume	300.00	gal	1.14	m3			
Maximum of Above Delivery and Storage Volumes	58.33	cf	1.65	m3			
BULK TANKS:							
29.) Input Number of Tanks	**1**	#					
30.) Input Tank Diameter	**12.00**	ft	**3,657.60**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	0.00	ft	0.00	mm			
Use this Tank Height (Liquid Height * 1.2)	0.00	ft	0.00	mm			Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	0.00	gal	0.00	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate volume of Each Bulk Tank	0.00	gal	0.00	m3			
31.) Input Number of Rows of Tanks	**1**	#					
Calculate Number of Tanks per Row	1	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	41.25	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	2	#					
34.) Input Number of Rows of Totes or Drums	**2**	#					
Calculate Number of Totes or Drums per Row	1	#					
Length of Each Tote	4.00	ft	1219.20	mm			Fixed
Width of Each Tote	4.00	ft	1219.20	mm			Fixed
Diameter of Each Drum	2.50	ft	762.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**No**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**2**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	0.00	gal	0.00	m3			
Convert Day Tank Volume (per each)	0.00	cf	0.00	m3			
Calculate Day Tank Diameter (per each)	0.00	ft	0.00	mm	DTD		
Calculate Day Tank Height (per each)	0.00	ft	0.00	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	0	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	2	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**0**	#					
Calculate Total Number of Metering Pumps	3	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	A						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	19.00	ft	5791.20	mm			
Calculate Containment Area Width	35.00	ft	10668.00	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	35.00	ft	10,668.00	mm			
Calculate Fire Sprinkler Water Volume	2,660.00	gal	10.07	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	360.00	gal	1.36	m3			
Calculate 30% of All Tank Volume	180.00	gal	0.68	m3			
Calculate Maximum Volume + Fire Flow Volume	3,020.00	gal	11.43	m3			
Tank Pads Volume	150.00	cf	4.25	m3			
Tank Pads Volume	1,122.08	gal	4.25	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	4,142.08	gal	15.68	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	553.72	cf	15.68	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	2,438.40	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		
Mechanical Sizing Requirements:							
Pipe Name	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Mechanical Material Requirements:							
Pipe Name	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Length**	**# Elbows**
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	54.00	12.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	54.00	12.00
						L+W	#MP*4
Electrical User Inputs and Sizing Requirements:							
52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N					
53.) Is there SWGR?	No						
Electrical Equipment Lengths:							**MCC**
Item	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
Metering Pumps	0.00	0.50	No	0.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**
Electrical Equipment Widths:							
Equipment	**Depth (ft)**						
MCC	0.00						
Small AFD's	0.00						
Large AFD's	0.00						
Switchgear	0.00						
Maximum Depth	0.00						
Clear Distances:							
Clear Distance	**Width**	**Length**	**Comment**				
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet			
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot			
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero			
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero			

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	0.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	0.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	0.00						
CD7	3.00						
Total Width	0.00						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$0.00***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	0						
Is Day Tank Required? (1 = Yes, 0 = No)	0						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	FALSE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	1					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	0.00	ft	0.00	mm			
Length of Module (Tote)	19.00	ft	5791.20	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tote)	35.00	ft	10668.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	0	#					
Diameter of Bulk Tank	12.00	ft	3657.60	mm			
Volume of Each Bulk Tank	0.00	gal	0.00	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	0	#					
Diameter of Day Tank	0.00	ft					
Volume of Each Day Tank	0.00	gal	0.00	m3			
Number of Transfer Pumps	0	#					
Transfer Pump Capacity (each)	0.00	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	3	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	19.00	ft	5791.20	mm			
Width	8.00	ft	2438.40	mm			
Area	152.00	sf	14.12	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	0.00	ft	0.00	mm			
Width	0.00	ft	0.00	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	19.00	ft	5791.20	mm			
Containment Area Width	35.00	ft	10668.00	mm			
Containment Area	665.00	sf	61.78	m2			
Corridor Area Length	19.00	ft	5791.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	152.00	sf	14.12	m2			
Electrical Area Length	0.00	ft	0.00	mm			
Electrical Area Width	0.00	ft	0.00	mm			
Electrical Room Area	0.00	sf	0.00	m2			
Chemical Facility Area	817.00	sf	75.90	m2			
Covered Chemical Area (Building)	817.00	sf	75.90	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	817.00	sf	75.90	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	150.12	CY	114.78	m3	***$6.72***	$1,009	
Imported Structural Backfill	60.52	CY	46.27	m3	***$50.94***	$3,083	
Native Backfill	28.13	CY	21.51	m3	***$8.27***	$232	
Haul Excess	121.99	CY	93.27	m3	***$8.27***	$1,008	
Allowance for Misc Items	5%				$5,332.99	$267	
Subtotal						$5,600	
CONCRETE:							
Slab on Grade	22.75	CY	17.39	m3	***$490.62***	$11,160	
Containment Walls	4.06	CY	3.10	m3	***$880.79***	$3,572	
Bulk Tank Pads	0.00	CY	0.00	m3	***$490.62***	$0	
Day Tank Pads	0.00	CY	0.00	m3	***$490.62***	$0	
Transfer Pump Pads	0.00	CY	0.00	m3	***$490.62***	$0	
Metering Pump Pads	2.00	CY	1.53	m3	***$490.62***	$981	
Corridor							
Slab on Grade	5.28	CY	4.04	m3	***$490.62***	$2,589	
Electrical Room							
Slab on Grade	0.00	CY	0.00	m3	***$490.62***	$0	
Allowance for Misc Items	5%				$18,302.71	$915	
Subtotal						$19,218	
MASONRY:	**High**						
Chemical Building	817.00	SF	75.90	m2	***$198.37***	$162,066	
Electrical Room	0.00	SF	0.00	m2	***$198.37***	$0	
Subtotal	817.00					$162,066	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	0	EA			***$0.00***	$0	
Day Tank	0	EA			***$0.00***	$0	
Transfer Pump	0	EA			***$0.00***	$0	
Metering Pump	3	EA			***$10,658.90***	$31,977	
Allowance for Misc Items	10%				$31,976.69	$3,198	
Subtotal						$35,174	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	0	EA			***$1,043.16***	$0	
Chemical Tank Beacons	0	EA			***$1,043.16***	$0	
Day Tank Differential Pressure Transmitter	0	EA			***$1,043.16***	$0	
Drum or Tote Weigh Scale	2	EA			***$1,390.89***	$2,782	
Metering Pump Discharge Pressure Switch	3	EA			***$695.44***	$2,086	
Magmeter	2	EA			***$695.44***	$1,391	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	9	EA			***$264.27***	$2,378	
Number of Digital I/O Counts	21	EA			***$62.59***	$1,314	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	171.00	LF	52.12	m	***$12.06***	$2,062	
Allowance for Misc Items	10%				$40,387.94	$4,039	
Subtotal						$44,427	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	***$13.11***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	***$13.11***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	54.00	LF	16.46	m	***$13.11***	$708	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	54.00	LF	16.46	m	***$13.11***	$708	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			***$10.06***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			***$10.06***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	12	EA			***$10.06***	$121	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	12	EA			***$10.06***	$121	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			***$10.47***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			***$10.47***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	3	EA			***$10.47***	$31	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	3	EA			***$10.47***	$31	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			***$5.65***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			***$5.65***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			***$57.14***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			***$57.14***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	6	EA			***$57.14***	$343	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	6	EA			***$57.14***	$343	
Allowance for Misc Items	10%				$2,428.48	$243	
Subtotal						$2,671	
ELECTRICAL:							

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# MCC Sections	0	#			$10,730.27	$0	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	0.00	LF	0.00	m	$12.06	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$280,514	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$311,682	$6,234			
I&C Allowance	2.00%		$311,682	$6,234			
Mechanical Allowance	4.00%		$311,682	$12,467			
Electrical Allowance	2.00%		$311,682	$6,234			
					Facility Cost Name		
Facility Cost	**817**	**Building SF**	**$381.50**	**$311,682**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**817**	**Building SF**	**$463.58**	**$378,747**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**817**	**Building SF**	**$795.13**	**$649,619**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**817**	**Building SF**	**$654.33**	**$534,591**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**817**	**Building SF**	**$795.13**	**$649,619**	CFLFC06		

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Liquid Chemical Storage & Feed - (Sodium Hypochlorite)
Located in Chemical Building A

Is This Facility Included in My Project? No

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Sodium Hypochlorite**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	12.50%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Cl2		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.21		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	1.26	lb/gal	151.25	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**30.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**75.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**605.67**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**1.00**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**1.50**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**2.00**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**2**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**30.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**75.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**160.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**1.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**1.50**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**2.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**2**	#					
16.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	250.36	lb/d	113.56	kg/d			
Average as "dry" chemical	938.86	lb/d	425.86	kg/d			
Maximum as "dry" chemical	2,670.53	lb/d	1211.33	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	4.13	gph	15.64	L/h			
Average at feed concentration	15.50	gph	58.66	L/h			
Maximum at feed concentration	44.08	gph	166.85	L/h			
Calculate Chemical Metering Pump Flow Turndown	10.67	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	250.36	lb/d	113.56	kg/d			
Average as "dry" chemical	938.86	lb/d	425.86	kg/d			
Maximum as "dry" chemical	2,670.53	lb/d	1211.33	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	4.13	gph	15.64	L/h			
Average at feed concentration	15.50	gph	58.66	L/h			
Maximum at feed concentration	44.08	gph	166.85	L/h			
Calculate Chemical Metering Pump Flow Turndown	10.67	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							

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Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	500.72	lb/d	227.12	kg/d			
Average	1,877.72	lb/d	851.72	kg/d			
Maximum	5,341.06	lb/d	2422.66	kg/d			
Max Flow Average Dose Daily Usage	4,005.79	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	95,206.61	gal	360.40	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,456.36	gal	16.87	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	6,684.54	gal	25.30	m3			
Maximum of Above Delivery and Storage Volumes	12,727.27	cf	360.40	m3			
BULK TANKS:							
29.) Input Number of Tanks	**3**	#					
30.) Input Tank Diameter	**10.00**	ft	**3,048.00**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	54.02	ft	16464.15	mm			
Use this Tank Height (Liquid Height * 1.2)	65.00	ft	19812.00	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	31,823.92	gal	120.47	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	38,188.71	gal	144.56	m3			
31.) Input Number of Rows of Tanks	**2**	#					
Calculate Number of Tanks per Row	2	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	30.08	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**Yes**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**2**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	2,115.70	gal	8.01	m3			
Convert Day Tank Volume (per each)	282.83	cf	8.01	m3			
Calculate Day Tank Diameter (per each)	6.00	ft	1828.80	mm	DTD		
Calculate Day Tank Height (per each)	12.00	ft	3657.60	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	2	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	4	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	2	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**2**	#					
Calculate Total Number of Metering Pumps	8	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	A						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	44.00	ft	13411.20	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	10,912.00	gal	41.31	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	45,826.45	gal	173.47	m3			
Calculate 30% of All Tank Volume	34,369.84	gal	130.10	m3			
Calculate Maximum Volume + Fire Flow Volume	56,738.45	gal	214.78	m3			
Tank Pads Volume	706.86	cf	20.02	m3			
Tank Pads Volume	5,287.67	gal	20.02	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	62,026.12	gal	234.79	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	8,291.69	cf	234.79	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	685.80	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	7.00	in	150.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	4.00	in	100.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	44.00	8.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	44.00	8.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	106.00	32.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	106.00	32.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
53.) Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	0.00	0.50	No	0.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	0.00
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	0.00

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	0.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	0.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	0.00						
CD7	3.00						
Total Width	0.00						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.19***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	1						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	TRUE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	44.00	ft	13411.20	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	3	#					
Diameter of Bulk Tank	10.00	ft	3048.00	mm			
Volume of Each Bulk Tank	38188.71	gal	144.56	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	2	#					
Diameter of Day Tank	6.00	ft					
Volume of Each Day Tank	2538.08	gal	9.61	m3			
Number of Transfer Pumps	2	#					
Transfer Pump Capacity (each)	253.81	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	8	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	44.00	ft	13411.20	mm			
Width	8.00	ft	2438.40	mm			
Area	352.00	sf	32.70	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	0.00	ft	0.00	mm			
Width	0.00	ft	0.00	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	44.00	ft	13411.20	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	2728.00	sf	253.44	m2			
Corridor Area Length	44.00	ft	13411.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	352.00	sf	32.70	m2			
Electrical Area Length	0.00	ft	0.00	mm			
Electrical Area Width	0.00	ft	0.00	mm			
Electrical Room Area	0.00	sf	0.00	m2			
Chemical Facility Area	3080.00	sf	286.14	m2			
Covered Chemical Area (Building)	3080.00	sf	286.14	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	3080.00	sf	286.14	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	505.10	CY	386.18	m3	***$6.72***	$3,396	
Imported Structural Backfill	228.15	CY	174.43	m3	***$50.94***	$11,622	
Native Backfill	51.72	CY	39.54	m3	***$8.27***	$427	
Haul Excess	453.38	CY	346.63	m3	***$8.27***	$3,747	
Allowance for Misc Items	5%				$19,192.84	$960	
Subtotal						$20,152	
CONCRETE:							
Slab on Grade	83.71	CY	64.00	m3	***$490.62***	$41,069	
Containment Walls	8.33	CY	6.37	m3	***$880.79***	$7,340	
Bulk Tank Pads	51.31	CY	39.23	m3	***$490.62***	$25,175	
Day Tank Pads	5.82	CY	4.45	m3	***$490.62***	$2,854	
Transfer Pump Pads	1.33	CY	1.02	m3	***$490.62***	$654	
Metering Pump Pads	5.33	CY	4.08	m3	***$490.62***	$2,617	
Corridor							
Slab on Grade	12.22	CY	9.34	m3	***$490.62***	$5,996	
Electrical Room							
Slab on Grade	0.00	CY	0.00	m3	***$490.62***	$0	
Allowance for Misc Items	5%				$85,705.68	$4,285	
Subtotal						$89,991	
MASONRY:	**Moderate**						
Chemical Building	3080.00	SF	286.14	m2	***$198.37***	$610,970	
Electrical Room	0.00	SF	0.00	m2	***$165.31***	$0	
Subtotal	3080.00					$610,970	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	3	EA			***$83,507.14***	$250,521	
Day Tank	2	EA			***$8,293.95***	$16,588	
Transfer Pump	2	EA			***$10,658.90***	$21,318	
Metering Pump	8	EA			***$10,658.90***	$85,271	
Allowance for Misc Items	10%				$373,698.30	$37,370	
Subtotal						$411,068	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	3	EA			***$1,043.16***	$3,129	
Chemical Tank Beacons	3	EA			***$1,043.16***	$3,129	
Day Tank Differential Pressure Transmitter	2	EA			***$1,043.16***	$2,086	
Drum or Tote Weigh Scale	0	EA			***$1,390.89***	$0	
Metering Pump Discharge Pressure Switch	8	EA			***$695.44***	$5,564	
Magmeter	4	EA			***$695.44***	$2,782	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	21	EA			***$264.27***	$5,550	
Number of Digital I/O Counts	68	EA			***$62.59***	$4,256	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	968.00	LF	295.05	m	***$12.06***	$11,673	
Allowance for Misc Items	10%				$66,543.53	$6,654	
Subtotal						$73,198	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (7-inch, Exposed, PVC)	44.00	LF	13.41	m	***$44.78***	$1,970	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	44.00	LF	13.41	m	***$28.95***	$1,274	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	106.00	LF	32.31	m	***$13.11***	$1,390	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	106.00	LF	32.31	m	***$13.11***	$1,390	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (7-inch, Exposed, PVC)	8	EA			***$159.23***	$1,274	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	8	EA			***$84.65***	$677	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	32	EA			***$10.06***	$322	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	32	EA			***$10.06***	$322	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (7-inch, Exposed, PVC)	2	EA			***$237.54***	$475	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	2	EA			***$124.01***	$248	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	8	EA			***$10.47***	$84	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	8	EA			***$10.47***	$84	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (7-inch, Exposed, PVC)	2	EA			***$78.91***	$158	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	2	EA			***$42.28***	$85	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$1,458.73***	$5,835	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$757.94***	$3,032	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	16	EA			***$57.14***	$914	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	16	EA			***$57.14***	$914	
Allowance for Misc Items	10%				$17,225.06	$1,723	
Subtotal						$22,192	
ELECTRICAL:							

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# MCC Sections	0	#			$10,730.27	$0	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	0.00	LF	0.00	m	$12.06	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$1,238,930	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$1,376,588	$27,532			
I&C Allowance	2.00%		$1,376,588	$27,532			
Mechanical Allowance	4.00%		$1,376,588	$55,064			
Electrical Allowance	2.00%		$1,376,588	$27,532			
					Facility Cost Name		
Facility Cost	**3,080**	**Building SF**	**$446.94**	**$1,376,588**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**3,080**	**Building SF**	**$543.11**	**$1,672,789**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**3,080**	**Building SF**	**$931.54**	**$2,869,132**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**3,080**	**Building SF**	**$766.59**	**$2,361,095**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**3,080**	**Building SF**	**$931.54**	**$2,869,132**	CFLFC06		

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On-Site Sodium Hypochlorite Generation

Is This Facility Included in My Project? Yes

Assumptions:

1. Generator & Day Tank Containment Area must be Covered; Salt Storage is Outside

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comments
Flow Rates:							
1.) Input Plant Flow Minimum (mgd)	**30.00**	mgd	**0.00**	ML/d			
2.) Input Plant Flow Average (mgd)	**75.00**	mgd	**0.00**	ML/d			
3.) Input Plant Flow Maximum (mgd)	**160.00**	mgd	**605.67**	ML/d			
CHEMICAL SYSTEM DOSAGE INFORMATION:							
Percent Active Sodium Hypochlorite Generated	0.80%						Fixed
Generated Sodium Hypochlorite Specific Gravity	1.00						Fixed
Active Chemical Form for Dosage Basis	Cl2						
Active Chemical Concentration, lb/gallon	0.07						Fixed
4.) Input Chemical Doses:							
Minimum (mg/L)	**2.00**	mg/L					
Average (mg/L)	**3.00**	mg/L					
Maximum (mg/L)	**4.00**	mg/L					
5.) Input **% of Total Chlorine Dosage Applied Upstream of Rapid Mixing**	**0.00%**						
6.) Input **% of Total Chlorine Dosage Applied Upstream of Filtration**	**0.00%**						
7.) Input **% of Total Chlorine Dosage Applied Downstream of Filtration**	**50.00%**						
8.) Input **% of Total Chlorine Dosage Applied Downstream of Clearwell**	**50.00%**						
Calculate Number of Simultaneous Application Points	2.00	#					
Whole Plant Chemical Usage:							
Calculate **Minimum Sodium Hypochlorite** (lb/d)	500.72	lb/d	227.12	kg/d			
Calculate **Average Sodium Hypochlorite** (lb/d)	1,877.72	lb/d	851.72	kg/d			
Calculate **Maximum Sodium Hypochlorite** (lb/d)	5,341.06	lb/d	2422.66	kg/d			
9.) Input **Sodium Hypochlorite Generator Capacity** (lb/d, each)	**2,000.00**	lb/d	**907.18**	kg/d			ChlorTec Standard Sizes
Calculate **Number of Sodium Hypochlorite Generators** (each)	3.00	#					
Calculate **Generator Equipment Length** (each)	3.81	ft	1160.00	mm	GL		
Calculate **Generator Equipment Width** (each)	3.81	ft	1160.00	mm	GW		
Calculate **Transformer / Rectifier Length** (ft)	5.58	ft	1700.00	mm	TL		
Calculate **Transformer / Rectifier Width** (ft)	5.58	ft	1700.00	mm	TW		
10.) Input **Clear Distance Around Electrical Equipment** (ft)	**4.00**	ft	**1,219.20**	mm	CDEE		
Calculate **Minimum Salt** (lb/d)	1,752.53	lb/d	794.94	kg/d			
Calculate **Average Salt** (lb/d)	6,572.00	lb/d	2981.01	kg/d			
Calculate **Maximum Salt** (lb/d)	18,693.70	lb/d	8479.32	kg/d			
Calculate Annual Salt Use (Max Flow and Avg Dose) (tons/year)	731.06	tons/yr					
30% Brine Flow from Salt Saturator to Generator Feed Proportioning Pumping							
Calculate **Maximum 30% Brine Flow for Batch Production to Each Generator** (gpm)	1.94	gpm	0.12	L/s			
Calculate **Total 30% Brine Flow for Batch Production** (gpm)	5.82	gpm	0.37	L/s			
Softened Potable Water Flow from Flow Proportioning Pumping to Generators							
Calculate **Maximum Softened Potable Water Flow for Batch Production** (gpm each generator)	19.42	gpm	1.22	L/s			
Calculate **Total Softened Potable Water Flow for Batch Production** (gpm)	58.25	gpm	3.67	L/s			
3% Brine Flow to Generators							
Calculate **Maximum 3% Brine Flow For Batch Production to Each Generator** (gpm)	21.36	gpm	1.35	L/s			
Calculate **Total 3% Brine Flow for Batch Production** (gpm)	64.07	gpm	4.04	L/s			
Chemical Metering Rates:							
Upstream of Rapid Mixing							
Calculate **Minimum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Chemical Metering Pump Flow Turndown**	0.00	#					Should be < 20, If > = 20, proceed with caution
Upstream of Filtration							
Calculate **Minimum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			

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Calculate **Chemical Metering Pump Flow Turndown**	0.00	#					Should be < 20, If > = 20, proceed with caution
Downstream of Filtration							
Calculate **Minimum Sodium Hypochlorite** (gph)	156.25	gph	591.47	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	585.94	gph	2218.01	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	1,666.67	gph	6309.02	L/h			
Calculate **Chemical Metering Pump Flow Turndown**	10.67	#					Should be < 20, If > = 20, proceed with caution
Downstream of Clearwell							
Calculate **Minimum Sodium Hypochlorite** (gph)	156.25	gph	591.47	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	585.94	gph	2218.01	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	1,666.67	gph	6309.02	L/h			
Calculate **Chemical Metering Pump Flow Turndown**	10.67	#					Should be < 20, If > = 20, proceed with caution
Note to Designer: Review pump selection to accommodate Pump Discharge Back Pressure (psi)							
11.) Input Number of Days of Salt Storage at Average Flow/Dose (days)	**30.00**	days					
Calculate **Salt Storage Volume @ Avg. Flow/Dose** (gallons)	21,499.41	gal	81.38	m3			Assumes density of brine solution to be 70 lb/cf.
Calculate **Bulk Delivery Volume * 1.5** (gallons)	7,213.36	gal	27.31	m3			Assumes density of brine solution to be 70 lb/cf.
Maximum of Above 2 Volumes (gallons)	21,499.41	gal	81.38	m3			
SALT STORAGE/BRINE TANKS:							
12.) Input **Salt Storage/Brine Tank Volume** (gallons, each)	**11,300.00**	gal	42.78	m3			Bryneer Standard Sizes
Calculate **Number of Salt Storage/Brine Tanks** (each)	2.00	#					Typically, 2 minimum
Calculate **Height of Tanks** (ft)	22.83	ft	6958.58	mm			
Calculate **Diameter of Tanks** (ft)	12.00	ft	3657.60	mm	STD		
13.) Input **Clear Distance Around Brine Tanks, Generators, and Day Tanks** (ft)	**4.00**	ft	**1,219.20**	mm	CDT		
SODIUM HYPOCHLORITE DAY TANKS:							
Upstream of Rapid Mixing							
Calculate **Day Tank Volume** (per each, gallons)	0.00	gal	0.00	m3			
Convert **Day Tank Volume** (per each, cf)	0.00	cf	0.00	m3			
Calculate **Day Tank Diameter** (per each, ft)	0.00	ft	0.00	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	0.00	ft	0.00	mm			Assumption: H = 2 * D
Upstream of Filtration							
Calculate **Day Tank Volume** (per each, gallons)	0.00	gal	0.00	m3			
Convert **Day Tank Volume** (per each, cf)	0.00	cf	0.00	m3			
Calculate **Day Tank Diameter** (per each, ft)	0.00	ft	0.00	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	0.00	ft	0.00	mm			Assumption: H = 2 * D
Downstream of Filtration							
Calculate **Day Tank Volume** (per each, gallons)	40,000.00	gal	151.42	m3			
Convert **Day Tank Volume** (per each, cf)	5,347.22	cf	151.42	m3			
Calculate **Day Tank Diameter** (per each, ft)	15.04	ft	4585.12	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	30.09	ft	9170.25	mm			Assumption: H = 2 * D
Downstream of Clearwell							
Calculate **Day Tank Volume** (per each, gallons)	40,000.00	gal	151.42	m3			
Convert **Day Tank Volume** (per each, cf)	5,347.22	cf	151.42	m3			
Calculate **Day Tank Diameter** (per each, ft)	15.04	ft	4585.12	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	30.09	ft	9170.25	mm			Assumption: H = 2 * D
BRINE TRANSFER & METERING PUMPS:							
Calculate **Number of Brine Transfer Pumps** (each)	3	#					
Calculate **Number of Active Metering Pumps** (each)	2	#					Rule: One active metering pump per each application point.
14.) Input **Number of Standby Metering Pumps** (each)	**2**	#					
Calculate **Total Number of Metering Pumps** (each)	4	#					
15.) Input **Clear Distance Around Transfer and Metering Pumps**	**4.00**	ft	**1,219.20**	mm	CDP		
Length of Transfer and Metering Pumps (ft, Fixed)	3.00	ft	914.40	mm	LP		Fixed. Conservatively assumes Pulsafeeder metering pump type.
SODIUM HYPOCHLORITE CONTAINMENT AREA:							
Width of Stair Access (ft, fixed)	4.00	ft	1219.20	mm	WS		Fixed
Calculate **Containment Area Length** (ft)	80.55	ft	24550.57	mm	CAL		
Calculate **Containment Area Width** (ft)	34.04	ft	10376.32	mm	CAW		
Calculate **Fire Sprinkler Water Volume** (gal) (0.2 gpm/sf for 20 min.)	10,968.20	gal	41.52	m3			
Calculate **120% of One Storage Tank Volume** (gal)	48,000.00	gal	181.70	m3			
Calculate **30% of All Tank Volume** (gal)	24,000.00	gal	90.85	m3			
Maximum of Above 2 Volumes (gal)	48,000.00	gal	181.70	m3			
Calculate **Maximum Volume + Fire Flow Volume** (gal)	58,968.20	gal	223.22	m3			
Calculate **Maximum Volume + Fire Flow Volume** (cf)	7,882.90	cf	223.22	m3			

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Calculate **Containment Wall Height (including 6" Freeboard)** (ft)	3.37	ft	1028.65	mm	CWH		120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
SALT STORAGE AREA:							
Calculate **Salt Storage Area Length** (ft)	36.00	ft	10972.80	mm	SAL		
Calculate **Salt Storage Area Width** (ft)	20.00	ft	6096.00	mm	SAW		
Calculate **Salt Storage Area** (sf)	720.00	sf	66.89	m2			
GENERATOR RECTIFIER AREA:							
16.) Input Clear Distance Around Generator Rectifiers (ft)	**4.00**	ft	**1,219.20**	mm	CDR		
Calculate **Generator Rectifier Area Length** (ft)	32.73	ft	9976.80	mm	RRL		
Calculate **Generator Rectifier Area Width** (ft)	11.81	ft	3598.40	mm	RRW		
Calculate **Generator Rectifier Area** (sf)	386.43	sf	35.90	m2			
COST TABLE FOR TANKS AND PUMPS	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP							
Polyethylene (PE)	***$ 2.50***						
Phenolic Lined Steel (PLS)	***$ 6.77***						
Chemical Feed Pumps (Cost per Each)	***$ 8,527.12***						

Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
Building:							
Length	80.55	ft	24550.57	mm	CAL		
Width	34.04	ft	10376.32	mm	CAW		
Area	2742.05	sf	254.74	m2			
Slab on Grade Length	84.55	ft	25769.77	mm			
Slab on Grade Width	38.04	ft	11595.52	mm			
Containment Wall Height	3.37	ft	1028.65	mm	CWH		
Slab on Grade Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Slab on Grade Thickness	1.00	ft	304.80	mm			
Containment Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Containment Wall Thickness	1.00	ft	304.80	mm			
Generator / Rectifier Area:							
Length	32.73	ft	9976.80	mm	RRL		
Width	11.81	ft	3598.40	mm	RRW		
Area	386.43	sf	35.90	m2			
Slab on Grade Length	34.73	ft	10586.40	mm			
Slab on Grade Width	15.81	ft	4817.60	mm			
Slab on Grade Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Slab on Grade Thickness	1.00	ft	304.80	mm			
Salt Storage Slab:							
Length	36.00	ft	10972.80	mm	SAL		
Width	20.00	ft	6096.00	mm	SAW		
Slab on Grade Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Slab on Grade Thickness	1.00	ft	304.80	mm			
Overall Dimensions:							
Building:							
Excavation Length	88.55	ft	26988.97	mm			
Excavation Width	42.04	ft	12814.72	mm			
Excavation Depth	5.37	ft	1638.25	mm			
Generator / Rectifier Area:							
Excavation Length	38.73	ft	11805.60	mm			
Excavation Width	19.81	ft	6036.80	mm			
Excavation Depth	2.00	ft	609.60	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Building:							
Excavation	986.50	CY	754.24	m3	***$6.72***	$6,632	
Imported Structural Backfill	137.88	CY	105.42	m3	***$50.94***	$7,024	
Native Backfill	139.72	CY	106.83	m3	***$8.27***	$1,155	
Haul Excess	846.78	CY	647.41	m3	***$8.27***	$6,999	
Generator / Rectifier Room:							
Excavation	73.36	CY	56.08	m3	***$6.72***	$493	
Imported Structural Backfill	28.41	CY	21.72	m3	***$50.94***	$1,447	
Native Backfill	8.67	CY	6.63	m3	***$8.27***	$72	
Haul Excess	64.68	CY	49.45	m3	***$8.27***	$535	
Allowance for Misc Items	5%				$24,356.73	$1,218	
Subtotal						$25,575	
CONCRETE:							
Building Slab on Grade	119.13	CY	91.08	m3	***$490.62***	$58,445	
Generator / Rectifier Room	20.33	CY	15.55	m3	***$490.62***	$9,975	

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Containment Walls	28.65	CY	21.90	m3	***$880.79***	$25,231	
Salt Storage Slab on Grade	26.67	CY	20.39	m3	***$490.62***	$13,083	
Allowance for Misc Items	5%				$106,734.76	$5,337	
Subtotal						$112,071	
MASONRY:	**High**						
CMU Building	3128.48	SF	290.65	m2	***$198.37***	$620,587	
Subtotal						$620,587	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Sodium Hypochlorite Generators (2000 lb/day each)	3	EA			***$998,844.80***	$2,996,534	
Metering Pump	4	EA			***$10,658.90***	$42,636	
Day Tanks:							
Upstream of Rapid Mixing (0 gallons each)	0	EA			***$0.00***	$0	
Upstream of Filtration (0 gallons each)	0	EA			***$0.00***	$0	
Downstream of Filtration (40000 gallons each)	1	EA			***$76,391.01***	$76,391	
Downstream of Clearwell (40000 gallons each)	1	EA			***$76,391.01***	$76,391	
Allowance for Misc Items	10%				$3,191,952.00	$319,195	
Subtotal						$3,511,147	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$4,269,380	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$5,473,564	$109,471			
I&C Allowance	5.00%		$5,473,564	$273,678			
Mechanical Allowance	10.00%		$5,473,564	$547,356			
Electrical Allowance	5.00%		$5,473,564	$273,678			
Facility Cost	**5,341**	**PPD**	**$1,024.81**	**$5,473,564**			
Facility Cost with Standard Additional Project Costs Added	**5,341**	**PPD**	**$1,245.32**	**$6,651,311**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**5,341**	**PPD**	**$2,135.94**	**$11,408,188**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**5,341**	**PPD**	**$1,757.73**	**$9,388,142**			
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**5,341**	**PPD**	**$2,135.94**	**$11,408,188**			

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Liquid Chemical Storage & Feed - (Sodium Hydroxide (50%))
Located in Stand Alone Chemical Building

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Sodium Hydroxide (50%)**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	50.00%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	NaOH		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.54		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	6.43	lb/gal	770.00	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**30.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**75.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**605.67**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**5.00**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**10.00**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**25.00**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**1**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	1,251.81	lb/d	567.81	kg/d			
Average as "dry" chemical	6,259.05	lb/d	2839.06	kg/d			
Maximum as "dry" chemical	33,381.60	lb/d	15141.64	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	8.12	gph	30.73	L/h			
Average at feed concentration	40.58	gph	153.63	L/h			
Maximum at feed concentration	216.45	gph	819.35	L/h			
Calculate Chemical Metering Pump Flow Turndown	26.67	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	1,251.81	lb/d	567.81	kg/d			
Average	6,259.05	lb/d	2839.06	kg/d			
Maximum	33,381.60	lb/d	15141.64	kg/d			
Max Flow Average Dose Daily Usage	13,352.64	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	62,337.66	gal	235.97	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	3,501.42	gal	13.25	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	5,252.14	gal	19.88	m3			
Maximum of Above Delivery and Storage Volumes	8,333.33	cf	235.97	m3			
BULK TANKS:							
29.) Input Number of Tanks	**4**	#					
30.) Input Tank Diameter	**12.00**	ft	**3,657.60**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	18.42	ft	5614.63	mm			
Use this Tank Height (Liquid Height * 1.2)	23.00	ft	7010.40	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	16,215.51	gal	61.38	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	19,458.62	gal	73.66	m3			
31.) Input Number of Rows of Tanks	**2**	#					
Calculate Number of Tanks per Row	2	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	31.21	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**No**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**2**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	0.00	gal	0.00	m3			
Convert Day Tank Volume (per each)	0.00	cf	0.00	m3			
Calculate Day Tank Diameter (per each)	0.00	ft	0.00	mm	DTD		
Calculate Day Tank Height (per each)	0.00	ft	0.00	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	0	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	1	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**0**	#					
Calculate Total Number of Metering Pumps	2	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**No**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	None						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	36.00	ft	10972.80	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm			
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	8,928.00	gal	33.80	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	23,350.34	gal	88.39	m3			
Calculate 30% of All Tank Volume	23,350.34	gal	88.39	m3			
Calculate Maximum Volume + Fire Flow Volume	32,278.34	gal	122.19	m3			
Tank Pads Volume	1,357.17	cf	38.43	m3			
Tank Pads Volume	10,152.32	gal	38.43	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	42,430.66	gal	160.62	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	5,672.15	cf	160.62	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm			120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	2,438.40	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	98.00	8.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	98.00	8.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N					
53.) Is there SWGR?	No						

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	2.00	0.50	No	4.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**1.00**		**4.00**	**0.00**	**0.00**	**4.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	1.67

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	8.33

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CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	12.33						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Width	4.67						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.26***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						

Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	0						
Tank Truck without Day Tank (True or False)	TRUE						
Tank Truck with Day Tank (True or False)	FALSE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	36.00	ft	10972.80	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	4	#					
Diameter of Bulk Tank	12.00	ft	3657.60	mm			
Volume of Each Bulk Tank	19458.62	gal	73.66	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	0	#					
Diameter of Day Tank	0.00	ft					
Volume of Each Day Tank	0.00	gal	0.00	m3			
Number of Transfer Pumps	0	#					
Transfer Pump Capacity (each)	0.00	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	2	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	36.00	ft	10972.80	mm			
Width	8.00	ft	2438.40	mm			
Area	288.00	sf	26.76	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	13.67	ft	4165.60	mm			
Width	6.00	ft	1828.80	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	36.00	ft	10972.80	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	2232.00	sf	207.36	m2			
Corridor Area Length	36.00	ft	10972.80	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	288.00	sf	26.76	m2			
Electrical Area Length	13.67	ft	4165.60	mm			
Electrical Area Width	6.00	ft	1828.80	mm			
Electrical Room Area	82.00	sf	7.62	m2			
Chemical Facility Area	2602.00	sf	241.73	m2			
Covered Chemical Area (Building)	2602.00	sf	241.73	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	2684.00	sf	249.35	m2			
Excavation Depth	3.50	ft	1066.80	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	431.64	CY	330.01	m3	***$6.72***	$2,902	
Imported Structural Backfill	192.74	CY	147.36	m3	***$50.94***	$9,819	
Native Backfill	48.09	CY	36.77	m3	***$8.27***	$397	
Haul Excess	383.54	CY	293.24	m3	***$8.27***	$3,170	
Allowance for Misc Items	5%				$16,288.03	$814	
Subtotal						$17,102	
CONCRETE:							
Slab on Grade	71.38	CY	54.58	m3	***$490.62***	$35,022	

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Containment Walls	10.89	CY	8.33	m3	$880.79	$9,591	
Bulk Tank Pads	89.36	CY	68.32	m3	$490.62	$43,842	
Day Tank Pads	0.00	CY	0.00	m3	$490.62	$0	
Transfer Pump Pads	0.00	CY	0.00	m3	$490.62	$0	
Metering Pump Pads	1.33	CY	1.02	m3	$490.62	$654	
Corridor							
Slab on Grade	10.00	CY	7.65	m3	$490.62	$4,906	
Electrical Room							
Slab on Grade	3.04	CY	2.32	m3	$490.62	$1,490	
Allowance for Misc Items	5%				$95,504.59	$4,775	
Subtotal						$100,280	
MASONRY:	Moderate						
Chemical Building	2520.00	SF	234.12	m2	$198.37	$499,885	
Electrical Room	82.00	SF	7.62	m2	$165.31	$13,555	
Subtotal	2602.00					$513,440	
METALS:							
Canopy	0.00	SF	0.00	m2	$41.80	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							Budgetary Quote: (CPES will automatically add Installation Factor)
Bulk Tank	4	EA			$43,991.71	$175,967	
Day Tank	0	EA			$0.00	$0	
Transfer Pump	0	EA			$0.00	$0	
Metering Pump	2	EA			$10,658.90	$21,318	
Allowance for Misc Items	10%				$197,284.63	$19,728	
Subtotal						$217,013	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	4	EA			$1,043.16	$4,173	
Chemical Tank Beacons	4	EA			$1,043.16	$4,173	
Day Tank Differential Pressure Transmitter	0	EA			$1,043.16	$0	
Drum or Tote Weigh Scale	0	EA			$1,390.89	$0	
Metering Pump Discharge Pressure Switch	2	EA			$695.44	$1,391	
Magmeter	1	EA			$695.44	$695	
Sump Pump Float Switch	1	EA			$347.72	$348	
Eyewash	1	EA			$1,043.16	$1,043	
Number of Analog I/O Counts	9	EA			$264.27	$2,378	
Number of Digital I/O Counts	24	EA			$62.59	$1,502	
Number of Local Panels	1	EA			$13,074.33	$13,074	
Number of PLCs	1	EA			$13,908.86	$13,909	
I&C Conduit & Wire	468.00	LF	142.65	m	$12.06	$5,644	
Allowance for Misc Items	10%				$48,329.88	$4,833	
Subtotal						$53,163	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	$13.11	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	$13.11	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	98.00	LF	29.87	m	$13.11	$1,285	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	98.00	LF	29.87	m	$13.11	$1,285	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			$10.06	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			$10.06	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	8	EA			$10.06	$80	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	8	EA			$10.06	$80	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			$10.47	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			$10.47	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			$10.47	$21	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			$10.47	$21	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			$5.65	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			$5.65	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			$5.65	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			$5.65	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			$57.14	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			$57.14	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			$57.14	$229	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			$57.14	$229	
Allowance for Misc Items	10%				$3,252.28	$325	
Subtotal						$3,578	
ELECTRICAL:							
# MCC Sections	5	#			$10,730.27	$53,651	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	72.00	LF	21.95	m	$12.06	$868	
Allowance for Misc Items	10%				$54,519.59	$5,452	
Subtotal						$59,972	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	

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Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$975,905	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$1,084,339	$21,687			
I&C Allowance	2.00%		$1,084,339	$21,687			
Mechanical Allowance	4.00%		$1,084,339	$43,374			
Electrical Allowance	2.00%		$1,084,339	$21,687			
					Facility Cost Name		
Facility Cost	**2,602**	**Building SF**	**$416.73**	**$1,084,339**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**2,602**	**Building SF**	**$506.40**	**$1,317,656**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**2,602**	**Building SF**	**$868.57**	**$2,260,017**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**2,602**	**Building SF**	**$714.77**	**$1,859,836**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**2,602**	**Building SF**	**$868.57**	**$2,260,017**	CFLFC06		

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Combination Wastewater Surge Basin and Floating Plate Decanter Clarification (Large System ≥ 5 MGD)

PROCESS DESIGN CRITERIA

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Is System to Handle Granular Media Filter Backwash Wastewater?	Yes	Y/N					
Is System to Handle Clarification Chemical Sludge?	No	Y/N					
Granular Media Filtration Backwash Wastewater:							
Input Volume of Backwash Wastewater Per Backwash	186,000.00	gal	2,468.09	m3			
Input Volume of Filter Drain Down Per Backwash	37,000.00	gal	238.48	m3			Typically either difference between operating water surface and top of wash trough for surface wash; or difference between water surface and 6-inches above top of media for air scour.
Input Volume of Filter to Waste Per Backwash	84,000.00	gal	594.31	m3			Typically 15 to 30 minutes at design filtration rate.
Input Total Number of Filters	22.00	#					
Input Backwash Turnaround Time From Off-Line to Back On-Line	60.00	min					Typically 20 to 40 minutes
Calculate Maximum Number of Backwashes Feasible Per Day	24.00	#					Assumes only backwash 1 filter at a time. This is typical.
Input Design Maximum Number of Backwashes Per Filter Per Day	0.67	#					Typically 1 to 2
Calculate Design Maximum Number of Backwashes Per Day	14.67	#					
Input Design Maximum Number of Consecutive Backwashes	2.00	#					
Calculate Maximum Design Backwash Wastewater Batch Volume	614,000.00	gal	2324.24	m3			
Calculate Number of Daily Backwash Wastewater Batches Per Day	7.33	#					
Input Maximum Backwash Wastewater Flow Rate	33.30	mgd	236.69	ML/d			
Clarification Chemical Sludge (Not for Softening Applications):							
Input Plant Flow Rate	0.00	mgd		ML/d			
Input Raw Water Turbidity	2.00	NTU					
Input Fraction of Turbidity to Contribute to Solids	1.50	mg/L/NTU					Typically 1 to 2
Input Raw Water Color		CU					
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Input Alum Dose	5.00	mg/L					
Input Fraction of Alum to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3.3H2O
Input Ferric Chloride Dose		mg/L					
Fraction of Ferric Chloride to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3.3H2O
Input Total Polymer Dose (coagulation, flocculation, filter aids)		mg/L					
Input Raw Water Iron		mg/L					
Input Iron Factor	2.00						Typical Value = 2
Input Raw Water Manganese		mg/L					
Input Manganese Factor	2.00						Typical Value = 2
Input PAC Dose		mg/L					
Calculate Solids Removed	0.00	mg/L					
Calculate Dry Residual Solids Produced	0.00	lb/d	0.00	kg/d			
Input % Dry Solids in Sludge Exiting Clarifier	0.25%						Typically 0.25% to 0.75%
Calculate Maximum Daily Volume of Clarification Sludge	0	gal	0.00	m3			
Input Number of Times Per Day Sludge Collection Equipment Operates	12.00	#					
Input Duration of Each Sludge Equipment Event in Minutes	60.00	min					
Calculate Clarification Sludge Volume Per Collection Event	0.00	gal	0.00	m3			
Calculate Clarification Sludge Flow Per Collection Event	0.00	gpm	0.00	m3/hr			
Calculate Combined Maximum Daily Volume of Wastewater	4,502,666.67	gal	17044.45	m3			
Calculate Combined Maximum Wastewater Episodic Batch Volume	614,000.00	gal	2324.24	m3			
Calculate Combined Maximum Wastewater Episodic Batch Flow Rate	23,126.04	gpm	5252.50	m3/hr			
Input Surge Basin Influent Velocity	5.00	fps	1.52	m/s			Typically 3 to 7 fps
Standard Diameter for Surge Basin Influent Pipe	48.00	in	1219.20	mm	IP		
Input Surge Basin Overflow Weir Head	1.00	ft	304.80	mm	OFH		
Calculate Surge Basin Over Flow Weir Length	15.47	ft	4716.17	mm	OFWL		
Calculate Overflow Weir Box Width	15.47	ft	4716.17	mm	OFBW		
Calculate Overflow Weir Box Length	6.00	ft	1828.80	mm	OFBL		
Floating Plate Decanter System Sizing:							
Will Backwash Equalization Basin contain Floating Decanters?	Yes	Y/N					
Will Backwash Equalization Basin contain Sludge Collectors?	Yes	Y/N					
Input Settling Time in Surge Basin Prior to Initiation of Decant Pumping	0.00	min					Typically 0 to 60 minutes
Input Plate Width	3.50	ft	304.80	mm	PW		Typically 3.5 feet
Input Plate Length	6.00	ft	304.80	mm	PL		Typically 6 feet
Plate Angle (fix @ 55 degrees)	55.00	degrees			PA		Fixed
Conversion of Plate Angle from Degrees to Radians	0.96	radians			PAR		
Effective Plate Area	95.00%				EPA		Typically 0.95
Calculate Projected Effective Plate Area (each) PEPA = PL * PW * cos PAR * EPA	11.44	sf	1.06	m2	PEPA		
Calculate Decanter Flow Rate	3,126.85	gpm	710.19	m3/hr	DFR		
Projected Plate Hydraulic Loading Rate	0.35	gpm/sf	0.75	m/h	HLR		Valid Range: < = 0.40 gpm/sf
Calculate Total Number of Plates #P = DFR / HLR / PEPA	790.00	#			#P		
Input Number of Decanter Units	10.00	#					Target 100-200 plates per decanter in next row
Calculate Number of Plates Per Decanter	79.00						Typically 100-200 plates per decanter

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Input Number of Plate Rows per Decanter	2.00	#			6.8		Either 1 or 2
Calculate Number of Plates Per Row	40.00	#					Typically 50-100 plates per row
Calculate Floating Decanter Unit Width	13.50	ft	4114.80	mm			
Calculate Floating Decanter Unit Length	11.24	ft	3426.40	mm			Allow 2.024" per plate
Input Floating Decanter Travel	15.00	ft	3,048.00	mm	FDT		Typically 6 to 15 feet
Decanter Equipment Profile Depth	5.91	ft	1802.87	mm			Plate depth + 1 foot
Clear Depth Beneath Decanter in Low Position to Accommodate Sludge Collectors	3.00	ft	914.40	mm	CL		Fixed
Freeboard Above High Water Surface	3.00	ft	914.40	mm	FB		Typically 2 feet
Equalization Basin Sizing:							
Input Floating Decanter Distance from Back Wall of Surge Basin	12.00	ft		mm	FDBW		Typically 12 feet
Input Distance Between Floating Decanters and Surge Basin Side Walls	4.00	ft		mm	FDS		Typically 4 feet
If Floating Decanters are not included, Input Sidewater Depth in Equalization Basin	15.00	ft	4,572.00	mm			
Calculate Required Surge Basin Storage Area	5,471.99	sf	508.36	m2			
Input Surge Basin Length to Width Ratio	2.00	:1					typically 2:1 or 3:1
Calculate Surge Basin Depth at Basin Midpoint	26.91	ft	8203.67	mm	WHMP		
Input Number of Rows of Decanter Units	2.00	#					
Calculate Number of Decanter Units Per Row	5.00	#					
Calculate Surge Basin Minimum Width for Decanter Units	99.50						
Calculate Surge Basin Minimum Length for Decanter Units	54.48						
Calculate Surge Basin Width	52.31	ft	15943.10	mm	ISBW	**ERROR!! Change criteria to increase width**	
Calculate Surge Basin Length	104.61	ft	31886.19	mm	ISBL		
Input Slope of Surge Basin	8.00%						Typically zero slope or 8%
Calculate Surge Basin Depth at Basin Inlet	22.73	ft	6928.22	mm	WHI		
Calculate Surge Basin Depth at Basin Outlet	31.10	ft	9479.11	mm	WHO		
Submerged Traveling Sludge Collector Sizing:							
Input Number of Sludge Collectors	3.00	#					
Calculate Sludge Collector Width	16.60	ft	5060.37	mm	SCW		Acceptable range of values is 8' - 30'.
Calculate Required Sludge Collector Waste Pumping Capacity	450.00	gpm	102.21	m3/hr			Fix at 150 gpm per collector
Number of Submersible Sludge Collector Waste Pumps	2.00	#					Fix at 1 active and 1 standby
Input Sludge Collector Submersible Pump Total Dynamic Head	60.00	ft	18,288.00	mm			
Input Sludge Collector Submersible Pump Efficiency	75.00%						
Calculate Sludge Collector Submersible Pump Horsepower	9.09	hp	6.78	kW			
Equalization Basin Mixing:							
Will Submersible Mixers be included in Surge Basin without Floating Decanters & Traveling Sludge Collection?	No	Y/N					
Input Desired Mixing Intensity	50.00	sec-1					typically 50 sec-1
Input wire to water rapid mix energy input efficiency	60.00%				E		
Input Minimum Water Temperature	32.00	degrees F	0.00	degrees C			Valid Range: 0 - 40 deg C.
Dynamic (Absolute) Viscosity of Water	0.000037	lb•s/sf	0.001792	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
Calculate Volume of Water to be Mixed	0.00	cf	0.00	m3	V		
Calculate Mixer Power	0.00	hp	0.00	kW	HP1		
Recycle Pumps							
Input Number of Decanter Submersible Duty Pumps	2.00	#					
Number of Standby Decant Submersible Pump	1.00	#					Fix at 1
Calculate Capacity of Decanter Submersible Pumps	1,563.43	gpm	355.09	m3/hr			
Input Decanter Submersible Pump Total Dynamic Head	60.00	ft	18,288.00	mm			
Input Decanter Submersible Pump Efficiency	75.00%						
Calculate Decanter Submersible Pump Horsepower	31.58	hp	23.55	kW			
Filter to Waste Basin Entry Air Gap							
Input Filter to Waste Basin Influent Air Gap Weir Head	1.00	ft	304.80	mm	H		For information the Filter Box Area (sf) is:
Input Filter to Waste Design Flow Rate	12.38	cfs	0.66	m3/s	FTWQ		
Calculate Filter to Waste Basin Influent Air Gap Weir Length	3.72	ft	1133.04	mm	WL		
Calculate Filter to Waste Influent Box Width	3.72	ft	1133.04	mm	FTWBW		
Calculate Filter to Waste Influent Box Length	6.00	ft	1828.80	mm	FTWBW		
Input Pumping Systems Pipe Support Height	3.00	ft	914.40	mm	PSH		Typically 3 Feet
Input Pumping Systems Pipe Depth of Cover	5.00	ft	1,524.00	mm	PDC		Typically 3 to 5 Feet
Are Pumping Facilities Covered?	No	Y/N					
Input Depth of Burial (as compared to the Surge Basin Depth at Basin Midpoint)	15.00	ft	4,572.00	mm	DB		Suggest choosing a depth of burial such that 3'-6" of wall remains above grade
Input Cutback Slope	1.50	:1 (ft:ft)					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Backwash Waste	7.00	fps	2.13	m/s	42.00	1050.00	
Filter to Waste	7.00	fps	2.13	m/s	20.00	500.00	
Backwash Waste Recycle Header	7.00	fps	2.13	m/s	14.00	350.00	
Backwash Waste Recycle Lateral	7.00	fps	2.13	m/s	10.00	250.00	
Backwash Waste Sludge Header	5.00	fps	1.52	m/s	8.00	200.00	
Backwash Waste Sludge Lateral	5.00	fps	1.52	m/s	8.00	200.00	

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows

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Backwash Waste	BWW	Encased	Steel	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Filter to Waste	FTW	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Backwash Waste Recycle Header	BWRH	Exposed	Steel	Cement Mortar	Paint	26.15	1.00
Backwash Waste Recycle Header	BWRH	Encased	Steel	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Backwash Waste Recycle Lateral	BWRL	Exposed	DI	Cement Mortar	Paint	95.74	6.00
Backwash Waste Sludge Header	BWSH	Exposed	Steel	Cement Mortar	Paint	26.15	1.00
Backwash Waste Sludge Header	BWSH	Encased	Steel	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Backwash Waste Sludge Lateral	BWSL	Exposed	Steel	Cement Mortar	Paint	63.83	4.00

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Basin Mixer	0.00	0.00	**Yes**	0.00	0.00	0.00	
Sludge Pumps (Active)	1.00	9.09	**No**	2.00	0.00	0.00	
Sludge Pumps (Standby)	1.00	9.09	**No**	2.00	0.00	0.00	
Traveling Solids Removal Mechanisms	3.00	1.00	**No**	6.00	0.00	0.00	
Recycle Pumps (Active)	2.00	31.58	**No**	6.00	0.00	0.00	
Recycle Pumps (Standby)	1.00	31.58	**No**	3.00	0.00	0.00	
TOTAL		**115.93**		**19.00**	**0.00**	**0.00**	**19.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet
CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		**0.00**	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	13.33
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**17.33**

Electric Room Width (ft):

CD6	0.00
Maximum Equipment Depth	1.67
CD7	3.00
Total Width	**4.67**

If there is no switchgear, this distance will be Zero.

Estimating Dimensions:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Surge Basin:							
Width	55.81	ft	17009.90	mm	W		
Length	114.86	ft	35010.39	mm	L		
Wall Height - Inlet	22.73	ft	6928.22	mm	WHI		
Wall Height - Midpoint	26.91	ft	8203.67	mm	WHMP		
Wall Height at Midpoint Above Ground	11.91	ft	3631.67	mm			
Wall Height - Outlet	31.10	ft	9479.11	mm	WHO		
Influent Channel Width	5.00	ft	1524.00	mm	ICW		
Slab on Grade Width	59.81	ft	18229.10	mm			
Slab on Grade Length	119.23	ft	36341.45	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Influent Channel Wall Thickness	**21.00**	in	**533.40**	mm	TIW	Model based on 18"	
Influent Channel Wall Thickness	1.75	ft	533.40	mm			
Perimeter Wall Thickness	**21.00**	in	**533.40**	mm	TPW	Model based on 19"	
Perimeter Wall Thickness	1.75	ft	533.40	mm			

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Backwash Recycle Sump:							
Width	15.00	ft	4572.00	mm			
Length	8.00	ft	2438.40	mm			
Wall Height	34.10	ft	10393.51	mm			
Slab on Grade Width	17.00	ft	5181.60	mm			
Slab on Grade Length	12.00	ft	3657.60	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Elevated Slab Width	18.50	ft	5638.80	mm			
Elevated Slab Length	11.50	ft	3505.20	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 10"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Wall Thickness	**21.00**	in	**533.40**	mm		Model based on 18"	
Wall Thickness	1.75	ft	533.40	mm			
Backwash Sludge Sump:							
Width	10.00	ft	3048.00	mm			
Length	8.00	ft	2438.40	mm			
Wall Height	34.10	ft	10393.51	mm			
Slab on Grade Width	12.00	ft	3657.60	mm			
Slab on Grade Length	12.00	ft	3657.60	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Elevated Slab Width	13.50	ft	4114.80	mm			
Elevated Slab Length	11.50	ft	3505.20	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 10"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Wall Thickness	**21.00**	in	**533.40**	mm		Model based on 18"	
Wall Thickness	1.75	ft	533.40	mm			
Dry Pit:							
Width	23.81	ft	7256.30	mm			
Length	8.00	ft	2438.40	mm			
Wall Height	34.10	ft	10393.51	mm			
Slab on Grade Width	25.81	ft	7865.90	mm			
Slab on Grade Length	12.00	ft	3657.60	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Elevated Slab Width	27.31	ft	8323.10	mm			
Elevated Slab Length	11.50	ft	3505.20	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 10"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Wall Thickness	**21.00**	in	**533.40**	mm		Model based on 18"	
Wall Thickness	1.75	ft	533.40	mm			
Pipe Vault:							
Width	55.81	ft	17009.90	mm			
Length	14.00	ft	4267.20	mm			
Wall Height	19.91	ft	6070.07	mm			
Slab on Grade Width	56.81	ft	17314.70	mm			
Slab on Grade Length	14.00	ft	4267.20	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			
Slab on Grade Thickness	1.50	ft	457.20	mm			
Wall Thickness	**12.00**	in	**304.80**	mm			
Wall Thickness	1.00	ft	304.80	mm			
Electrical Room:							
Width	4.67	ft	1422.40	mm			
Length	17.33	ft	5283.20	mm			
Slab on Grade Width	6.67	ft	2032.00	mm			
Slab on Grade Length	21.33	ft	6502.40	mm			
Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 32"	
Slab on Grade Thickness	1.00	ft	304.80	mm			
Excavation Dimensions:							
Influent Channel, Surge Basin:							
Excavation Width	63.81	ft	19448.30	mm			
Excavation Length	123.23	ft	37560.65	mm			
Excavation Depth	19.00	ft	5791.20	mm			
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well:							
Excavation Width	63.81	ft	19448.30	mm			
Excavation Length	16.00	ft	4876.80	mm			
Excavation Depth	25.18	ft	7676.25	mm			
Pipe Vault:							
Excavation Width	63.81	ft	19448.30	mm			
Excavation Length	14.00	ft	4267.20	mm			
Excavation Depth	8.50	ft	2590.80	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Excavation							
Influent Channel, Surge Basin & Decant Pump	9014.41	CY	6892.01	m3	***$6.72***	$60,605	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	1697.98	CY	1298.20	m3	***$6.72***	$11,416	
Pipe Vault	521.33	CY	398.59	m3	***$6.72***	$3,505	

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Imported Structural Backfill							
Influent Channel, Surge Basin & Decant Pump	582.44	CY	445.31	m3	***$50.94***	$29,670	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	75.62	CY	57.82	m3	***$50.94***	$3,852	
Pipe Vault	66.17	CY	50.59	m3	***$50.94***	$3,371	
Native Backfill							
Influent Channel, Surge Basin & Decant Pump	2515.41	CY	1923.17	m3	***$8.27***	$20,791	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	563.79	CY	431.05	m3	***$8.27***	$4,660	
Pipe Vault	184.25	CY	140.87	m3	***$8.27***	$1,523	
Haul Excess							
Influent Channel, Surge Basin & Decant Pump	6499.01	CY	4968.85	m3	***$8.27***	$53,716	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	1134.19	CY	867.15	m3	***$8.27***	$9,374	
Pipe Vault	337.08	CY	257.72	m3	***$8.27***	$2,786	
Allowance for Misc Items	5%				$205,268.60	$10,263	
Subtotal						$215,532	
CONCRETE:							
Surge Basin:							
Foundation	528.21	CY	403.84	m3	***$541.11***	$285,816	
Perimeter Walls	502.88	CY	384.48	m3	***$880.79***	$442,938	
Influent Channel Wall	82.22	CY	62.86	m3	***$880.79***	$72,417	
Concrete Curb (8" X 8")	229.73	LF	70.02	m	***$41.64***	$9,565	
Backwash Recycle Sump:							
Slab on Grade	15.11	CY	11.55	m3	***$490.62***	$7,414	
Walls	83.99	CY	64.21	m3	***$880.79***	$73,974	
Elevated Slab	7.88	CY	6.02	m3	***$1,333.77***	$10,510	
Backwash Sludge Sump:							
Slab on Grade	10.67	CY	8.16	m3	***$490.62***	$5,233	
Walls	61.88	CY	47.31	m3	***$880.79***	$54,507	
Elevated Slab	5.75	CY	4.40	m3	***$1,333.77***	$7,669	
Dry Pit:							
Slab on Grade	22.94	CY	17.54	m3	***$490.62***	$11,254	
Walls	122.91	CY	93.97	m3	***$880.79***	$108,262	
Elevated Slab	11.63	CY	8.89	m3	***$1,333.77***	$15,513	
Pipe Vault:							
Lower Elevated Slab	44.18	CY	33.78	m3	***$1,333.77***	$58,930	
Upper Elevated Slab	44.18	CY	33.78	m3	***$1,333.77***	$58,930	
Walls	92.65	CY	70.84	m3	***$880.79***	$81,607	
Electrical Room Slab on Grade	5.27	CY	4.03	m3	***$490.62***	$2,584	
Allowance for Misc Items	5%				$1,307,121.61	$65,356	
Subtotal						$1,372,478	
MASONRY:	**Moderate**						
Pump Sumps and Pipe Vault	0.00	SF	0.00	m2	***$165.31***	$0	
Electrical Room	80.89	SF	7.51	m2	***$165.31***	$13,371	
Subtotal	80.89					$13,371	
METALS:							
Influent Channel:							
Grating	279.03	SF	25.92	m2	***$90.92***	$25,369	
Surge Basin:							
Grating	4.00	SF	0.37	m2	***$90.92***	$364	
Backwash Recycle Sump:							
Grating	4.00	SF	0.37	m2	***$90.92***	$364	
Backwash Sludge Sump:							
Grating	4.00	SF	0.37	m2	***$90.92***	$364	
Dry Pit:							
Ladder	34.10	VLF	10.39	VLM	***$125.74***	$4,288	
Pipe Vault:							
Grating	4.00	SF	0.37	m2	***$90.92***	$364	
Stairs	16.00	RISERS			***$495.92***	$7,935	
Allowance for Misc Items	10%				$39,046.33	$3,905	
Subtotal						$42,951	
DOORS & WINDOWS:							
Backwash Recycle Sump:							
Aluminum Access Hatch (10' x 5')	1.00	EA			***$5,569.28***	$5,569	
Backwash Sludge Sump:							
Aluminum Access Hatch (3' x 3')	1.00	EA			***$1,389.82***	$1,390	
Dry Pit:							
Aluminum Access Hatch (3' x 3')	1.00	EA			***$1,389.82***	$1,390	
Pipe Vault:							
Aluminum Access Hatch (3' x 3')	2.00	EA			***$1,389.82***	$2,780	
Allowance for Misc Items	5%				$11,128.57	$556	
Subtotal						$11,685	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Floating Decanter Plate System	9039.85	SF	839.83	m2	***$115.38***	$1,042,990	
Traveling Solids Removal Mechanism	3.00	EA			***$105,762.11***	$317,286	
Washwater Decant Pump (Submersible Pump)	3.00	EA			***$38,347.83***	$115,043	
Sludge Pump (Submersible Pump)	2.00	EA			***$17,560.95***	$35,122	
Mixers	0.00	HP	0.00	kW	***$2,499.83***	$0	
Allowance for Misc Items	10%				$1,510,441.43	$151,044	
Subtotal						$1,661,486	
I&C:							
Instruments							
Backwash Waste Recycle Header Magmeter (BWRH, 14 inch)	1.00	EA			$18,661.80	$18,662	
Isolation Valve Actuators (Electric)	5.00	EA			***$6,409.82***	$32,049	
Level Transmitters	1.00	EA			***$11,264.12***	$11,264	
Number of Analog I/O Counts	6.00	EA			***$264.27***	$1,586	
Number of Digital I/O Counts	30.00	EA			***$62.59***	$1,878	
Number of Local Panels	1.00	EA			***$13,074.33***	$13,074	
Number of PLC's	1.00	EA			***$13,908.86***	$13,909	
I&C Conduit Wire	390.65	LF	119.07	m	***$12.06***	$4,711	
Allowance for Misc Items	5%				$97,132.34	$4,857	
Subtotal						$101,989	
MECHANICAL:							
Pipe:							
Backwash Waste (BWW, 42 inch, Steel)	0.00	LF	0.00	m	***$970.77***	$0	
Filter to Waste (FTW, 20 inch, DI)	0.00	LF	0.00	m	***$173.40***	$0	

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Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	26.15	LF	7.97	m	$323.59	$8,463
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	0.00	LF	0.00	m	$323.59	$0
Backwash Waste Recycle Lateral (BWRL, 10 inch, DI)	95.74	LF	29.18	m	$86.70	$8,301
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	26.15	LF	7.97	m	$184.91	$4,836
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	0.00	LF	0.00	m	$184.91	$0
Backwash Waste Sludge Lateral (BWSL, 8 inch, Steel)	63.83	LF	19.46	m	$184.91	$11,803
Elbows:						
Backwash Waste (BWW, 42 inch, Steel)	0.00	EA			$5,846.39	$0
Filter to Waste (FTW, 20 inch, DI)	0.00	EA			$3,639.39	$0
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	1.00	EA			$1,948.80	$1,949
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	0.00	EA			$1,948.80	$0
Backwash Waste Recycle Lateral (BWRL, 10 inch, DI)	6.00	EA			$1,819.70	$10,918
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	1.00	EA			$1,113.60	$1,114
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	0.00	EA			$1,113.60	$0
Backwash Waste Sludge Lateral (BWSL, 8 inch, Steel)	4.00	EA			$1,113.60	$4,454
Tee:						
Backwash Waste (BWW, 42 inch, Steel)	0.00	EA			$13,320.29	$0
Filter to Waste (FTW, 20 inch, DI)	0.00	EA			$6,043.12	$0
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	2.00	EA			$4,440.10	$8,880
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	0.00	EA			$4,440.10	$0
Backwash Waste Recycle Lateral (BWRL, 10 inch, DI)	0.00	EA			$3,021.56	$0
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	1.00	EA			$2,537.20	$2,537
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	0.00	EA			$2,537.20	$0
Backwash Waste Sludge Lateral (BWSL, 8 inch, Steel)	0.00	EA			$2,537.20	$0
Valves:						
Backwash Waste (BWW, 42 inch, Steel)	0.00	EA			$42,759.05	$0
Filter to Waste (FTW, 20 inch, DI)	0.00	EA			$17,721.27	$0
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	0.00	EA			$14,253.02	$0
Backwash Waste Recycle Header (BWRH, 14 inch, Steel)	0.00	EA			$14,253.02	$0
Backwash Waste Recycle Lateral (BWRL, 10 inch, DI)	3.00	EA			$8,860.64	$26,582
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	0.00	EA			$8,144.58	$0
Backwash Waste Sludge Header (BWSH, 8 inch, Steel)	0.00	EA			$8,144.58	$0
Backwash Waste Sludge Lateral (BWSL, 8 inch, Steel)	2.00	EA			$8,144.58	$16,289
Allowance for Misc Items	5%				$106,125.96	$5,306
Subtotal						$111,432
ELECTRICAL:						
# MCC Sections	8.00	EA			$10,730.27	$85,842
Switchgear	0.00	EA			$49,359.23	$0
Adjustable Frequency Drives						
Basin Mixer	0.00	EA			$8,865.56	$0
Sludge Pumps (Active)	0.00	EA			$10,057.67	$0
Sludge Pumps (Standby)	0.00	EA			$10,057.67	$0
Recycle Pumps (Active)	0.00	EA			$13,007.28	$0
Recycle Pumps (Standby)	0.00	EA			$13,007.28	$0
Electrical Conduit & Wire	446.45	LF	136.08	m	$12.06	$5,384
Allowance for Misc Items	5%				$91,225.92	$4,561
Subtotal						$95,787
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**
Item 1 Description	0.00		0.00		0.00	$0
Item 2 Description	0.00		0.00		0.00	$0
Item 3 Description	0.00		0.00		0.00	$0
Item 4 Description	0.00		0.00		0.00	$0
Item 5 Description	0.00		0.00		0.00	$0
Item 6 Description	0.00		0.00		0.00	$0
Item 7 Description	0.00		0.00		0.00	$0
Item 8 Description	0.00		0.00		0.00	$0
Item 9 Description	0.00		0.00		0.00	$0
Item 10 Description	0.00		0.00		0.00	$0
Item 11 Description	0.00		0.00		0.00	$0
Item 12 Description	0.00		0.00		0.00	$0
Item 13 Description	0.00		0.00		0.00	$0
Item 14 Description	0.00		0.00		0.00	$0
Item 15 Description	0.00		0.00		0.00	$0
Subtotal						$0
Subtotal						$3,626,711.07
ALLOWANCES:		**User Override**				
Finishes Allowance	2.00%		$4,168,633	$83,372.67		
I&C Allowance	3.00%		$4,168,633.42	$125,059.00		
Mechanical Allowance	5.00%		$4,168,633.42	$208,431.67		
Electrical Allowance	3.00%		$4,168,633.42	$125,059.00		
					Facility Cost Name	
Facility Cost	**4,502,667**	**Gallons**	**$0.93**	**$4,168,633**	SDLFC01	
Facility Cost with Standard Additional Project Costs Added	**4,502,667**	**Gallons**	**$1.13**	**$5,065,598**	SDLFC02	
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**4,502,667**	**Gallons**	**$1.93**	**$8,688,407**	SDLFC03	
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**4,502,667**	**Gallons**	**$1.59**	**$7,149,952**	SDLFC05	
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**4,502,667**	**Gallons**	**$1.93**	**$8,688,407**	SDLFC06	

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Gravity Thickener

PROCESS DESIGN CRITERIA

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Solids Production:							
Input Plant Flow Rate	160.00	mgd	605.67	ML/d			
Input Raw Water Turbidity	2.00	NTU					
Input Fraction of Turbidity to Contribute to Solids	1.00	mg/L/NTU					Typically 1 to 2
Input Raw Water Color	10.00	CU					
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Input Alum Dose	5.00						
Input Fraction of Alum to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3.3H2O
Input Ferric Chloride Dose		mg/L					
Fraction of Ferric Chloride to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3.3H2O
Input Total Polymer Dose (coagulation, flocculation, filter aids)		mg/L					
Input Raw Water Iron		mg/L					
Input Iron Factor	2.00						Typical Value = 2
Input Raw Water Manganese		mg/L					
Input Manganese Factor	2.00						Typical Value = 2
Input PAC Dose		mg/L					
Input Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 2 for lime softening.
Input Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Non-Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 1 for soda ash softening.
Calculate Solids Removed	4.70	mg/L					
Calculate Dry Residual Solids Produced	6,275.74	lb/d	2846.63	kg/d			
Optional: Input Daily Dry Solids Production (overwrites above calculations) (dry)		lb/d		kg/d			
Gravity Thickener Sizing & Sludge Storage:							
Input Number of On-Line Thickeners	1	#					
Input Number of Standby Thickeners	1	#					Typically 1
Input % Dry Solids in Sludge to Thickeners	1.00%						Typically 0.25% tyo 0.75%
Calculate Total Sludge Flow Rate	75,200.00	gpd	284.66	m3/d			
Calculate Sludge Flow to Each Thickener	75,200.00	gpd	284.66	m3/d			
Calculate Dry Solids Flow to Each Thickener	6,275.74	lb/d	2846.63	kg/d			
Input Thickener Hydraulic Loading Rate	300.00	gpd/sf	12.23	m/d			Typically 100 to 300 gpd/sf for metal salt coagulant sludges
Input Thickener Solids Loading Rate	10.00	lb/d/sf	48.82	kg/d/m2			Typically 5 to 10 lb/sf/d
Calculate Thickener Diameter, Each Based on Hydraulic Loading Rate	17.87	ft	5445.26	mm			
Calculate Thickener Diameter, Each Based on Solids Loading Rate	28.27	ft	8615.94	mm			
Calculate Thickener Diameter, Each (maximum of above)	28.27	ft	8615.94	mm			
Input Thickened Sludge % Dry Solids	0.25%						Typically 2% to 5% for metal salt coagulant sludges treated with polymer
Calculate Thickened Sludge Density	62.49	lb/cf	1000.98	kg/m3			Assumes density of dried solids of 145 lb/cf.
Input Days of Thickened Sludge Storage in Thickener	3.00	days					Typically 0 to 3 days (long weekend)
Calculate Thickened Sludge Storage Depth	192.03	ft	58531.91	mm			If Sludge Storage depth is greater than desired: 1.) Reduce days of storage or 2.) Decrease controlling thickener loading rate criteria input.
Calculate Total Thickened Sludge Storage Volume	901,518.10	gal	3412.62	m3			
Input Clear Water Depth Above Sludge Line	8.00	ft	2,438.40	mm			Typically 8 to 11 feet
Input Free Board	3.00	ft	914.40	mm			Typically 1 to 3 feet
Calculate Total Thickener Depth	203.03	ft	61884.71	mm			
Input Thickener Wall Height Above Grade	3.00	ft	914.40	mm			
Calculate Wall Burial Depth	200.03	ft	60970.31	mm	DB		
Gravity Thickener Peripheral Weir Launder Sizing:							
Calculate Total Flow Rate of all Thickeners	0.08	mgd	284.66	m3/d	QT		
Calculate Flow Rate of Each Active Thickener	0.08	mgd	284.66	m3/d	Q, mgd		
Convert Each Thickener Flow Rate	0.12	cfs	3.29	L/s	Q, cfs		
Input Velocity in Launder	5.00	fps	1.52	m/s	V		Typically < 5 fps
Calculate Area (Q, cfs / V)	0.02	sf	0.00	m2			
Launder Freeboard	1.00	ft	304.80	mm			Fixed
Input Launder Width	2.00	ft	609.60	mm			
Calculate Launder Height Excluding Freeboard	0.01	ft	3.55	mm			
Calculate Launder Height Including Freeboard	1.01	ft	308.35	mm			Should be ≤ 5 ft.
Thickened Sludge Pump Sizing:							
Calculate Thickened Sludge Flow from Each Thickener	300,506.03	gpd	1137.54	m3/d			
Calculate Thickener Decant Flow from Each Thickener	(225,306.03)	gpd	(852.88)	m3/d			
Number of Progressive Cavity Thickened Sludge Pumps per Thickener	2	#					Fixed: 1 duty and 1 standby
Calculate Number of Thickened Sludge Pumps	4	#					
Calculate Thickened Sludge Pump Capacity, Each	208.68	gpm	789.96	L/min			
Input Thickened Sludge Pump Total Dynamic Head (TDH)	60.00	ft	18,288.00	mm			

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Calculate Thickened Sludge Pump Horsepower (each)	4.22	hp	3.14	kW			
Input Distance between Thickener and Sludge Pump Pad	16.00	ft	4,876.80	mm			Minimum of 10 ft
Input Sludge Pump Length (progressive cavity)	8.50	ft	2,590.80	mm			Typically 8.5 ft
Input Sludge Pump Width (progressive cavity)	2.00	ft	609.60	mm			Typically 2.0 ft
Input Stagger Distance Between Sludge Pump Centerlines - Length	8.50	ft	2,590.80	mm			Typically equal to sludge pump length
Input Distance Between Sludge Pump Centerlines (width) and Around Pumps for Access	4.50	ft	1,371.60	mm			Typically 4.5 ft for access
Include the Cost of a Building Over Sludge Pump Station?	Yes	Y/N					
Input Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Unthickened Sludge Influent Pipe	3.00	fps	0.91	m/s	4.00	in	100.00
Decant Pipe	5.00	fps	1.52	m/s	4.00	in	100.00
Thickened Sludge Suction Pipe	3.00	fps	0.91	m/s	6.00	in	150.00
Thickened Sludge Discharge Pipe	3.00	fps	0.91	m/s	6.00	in	150.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Comments	Red Flags
Unthickened Sludge Influent Pipe	USP	Buried	DI	Cement Mortar	Tape Coating		
Unthickened Sludge Influent Pipe	USP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Unthickened Sludge Influent Pipe	USP	Submerged	DI	Cement Mortar	Fusion Bonded Epoxy		
Decant Pipe	DSP	Buried	DI	Cement Mortar	Tape Coating		
Decant Pipe	DSP	Exposed	DI	Cement Mortar	Paint		
Decant Pipe	DSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Exposed	Steel	Cement Mortar	Paint		
Thickened Sludge Discharge Pipe	TSDP	Exposed	DI	Cement Mortar	Paint		

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Thickened Sludge Pumps (Active)	2.00	4.22	Yes	0.00	8.00	4.00	
Thickened Sludge Pumps (Standby)	2.00	4.22	No	4.00	0.00	0.00	
Gravity Thickener Rake Mechanism	2.00	1.00	No	4.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**18.9**		**8.00**	**8.00**	**4.00**	**20.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	13.33
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**17.33**

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Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zerc					
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Width	**4.67**						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
Total Number of Thickeners	2.00	#					
Gravity Thickener (dimensions per each):							
Perimeter Wall Inside Diameter	28.27	ft	8615.94	mm			
Perimeter Wall Outside Diameter	30.27	ft	9225.54	mm			
Perimeter Wall Height	203.03	ft	61884.71	mm			
Wall Footer Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Wall Footer Thickness	1.33	ft	406.40	mm			
Slab on Grade Thickness	**6.00**	in	**152.40**	mm			Model based on 6"
Slab on Grade Thickness	0.50	ft	152.40	mm			
Center Cone Outside Diameter	6.17	ft	1879.60	mm			Fixed
Center Cone Inside Diameter	3.50	ft	1066.80	mm			Fixed
Center Cone Slab on Grade Thickness	**16.00**	in		mm			Model based on 16"
Center Cone Slab on Grade Thickness	1.33	ft	406.40	mm			
Center Cone Wall Height	**2.33**	ft	**59.18**	mm			Model based on 2.33'
Center Cone Wall Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Center Cone Wall Thickness	1.33	ft	406.40	mm			
Launder Elevated Slab Width	**2.00**	ft	**50.80**	mm			Model based on 2'
Launder Elevated Slab Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Launder Elevated Slab Thickness	1.00	ft	304.80	mm			
Launder Wall Diameter	24.27	ft	7396.74	mm			
Launder Wall Height	1.01	ft	308.35	mm			
Launder Wall Thickness	**8.00**	in	**203.20**	mm			Model based on 8"
Launder Wall Thickness	0.67	ft	203.20	mm			
Perimeter Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Perimeter Wall Thickness	1.00	ft	304.80	mm			
Floor Slope Factor	1.03						Fixed
Side Slope Depth Factor	0.23						Fixed
Side Slope Factor	4.29						Fixed
Excavation Diameter	39.27	ft	11968.74	mm			
Cone Excavation Depth	6.57	ft	2003.22	mm			
Perimeter Wall Excavation Depth (Includes Over Excavation)	202.37	ft	61681.51	mm			
Thickened Sludge Pump Slab:							
Length	26.00	ft	7924.80	mm			Fixed
Width	30.50	ft	9296.40	mm			
Slab on Grade Length	28.00	ft	8534.40	mm			
Slab on Grade Width	32.50	ft	9906.00	mm			
Slab Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Slab Thickness	1.33	ft	406.40	mm			
Excavation Length	32.00	ft	9753.60	mm			
Excavation Width	36.50	ft	11125.20	mm			
Excavation Depth	3.33	ft	1016.00	mm			
Electrical Room:							
Length	17.33	ft	5283.20	mm			
Width	4.67	ft	1422.40	mm			
Slab on Grade Length	19.33	ft	5892.80	mm			
Slab on Grade Width	6.67	ft	2032.00	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
Slab on Grade Thickness	1.50	ft	457.20	mm			
Excavation Length	23.33	ft	7112.00	mm			
Excavation Width	10.67	ft	3251.20	mm			
Excavation Depth	3.50	ft	1066.80	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Gravity Thickener:							
Excavation	334,898.77	CY	256048.49	m3	***$6.72***	$2,251,548	
Imported Structural Backfill	184.33	CY	140.93	m3	***$50.94***	$9,390	
Native Backfill	280,666.63	CY	214585.05	m3	***$8.27***	$2,319,790	
Haul Excess	54,232.14	CY	41463.45	m3	***$8.27***	$448,244	
Thickened Sludge Pump Slab:							
Excavation	208.86	CY	159.68	m3	***$8.33***	$1,739	
Imported Structural Backfill	100.94	CY	77.17	m3	***$50.94***	$5,142	
Native Backfill	42.28	CY	32.33	m3	***$8.27***	$349	
Haul Excess	166.58	CY	127.36	m3	***$8.27***	$1,377	
Electrical Room:							
Excavation	62.05	CY	47.44	m3	***$8.33***	$517	
Imported Structural Backfill	23.05	CY	17.62	m3	***$50.94***	$1,174	
Native Backfill	23.14	CY	17.69	m3	***$8.27***	$191	
Haul Excess	38.91	CY	29.75	m3	***$8.27***	$322	
Allowance for Misc Items	5%				$5,039,783.59	$251,989	
Subtotal						$5,291,773	
CONCRETE:							
Gravity Thickener:							
Wall Footers	51.65	CY	39.49	m3	***$541.11***	$27,950	
Slanted Slab on Grade	23.88	CY	18.26	m3	***$541.11***	$12,922	
Slanted Floor Grout (2" thick)	1,289.54	SF	119.80	m2	***$23.76***	$30,640	
Center Cone Slab on Grade	2.95	CY	2.26	m3	***$541.11***	$1,596	
Center Cone Walls	4.46	CY	3.41	m3	***$499.64***	$2,227	
Perimeter Walls	1,430.08	CY	1093.38	m3	***$707.82***	$1,012,239	
Launder Elevated Slab	13.16	CY	10.06	m3	***$832.73***	$10,956	
Launder Wall	3.81	CY	2.91	m3	***$832.73***	$3,172	
Concrete Fill	***2.19***	CY	1.68	m3	***$374.73***	$822	
Thickened Sludge Pump Slab:						$0	
Slab on Grade	44.94	CY	34.36	m3	***$490.62***	$22,047	
Electrical Room:						$0	
Slab on Grade	7.16	CY	5.47	m3	***$541.11***	$3,875	
Allowance for Misc Items	5%				$1,128,445.04	$56,422	

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Subtotal						$1,184,867	
METALS:							
Gravity Thickener:							
Walkway Grating (3' wide, steel support beams supplied by mechanism mfr)	181.61	SF	16.87	m2	***$90.92***	$16,511	
Walkway Handrail	121.07	LF	36.90	m	***$90.92***	$11,007	
Stairway	9	Risers			***$495.92***	$4,463	
Allowance for Misc Items	10%				$31,981.92	$3,198	
Subtotal						$35,180	
MASONRY:	**High**						
Thickened Sludge Pump Building	793.00	SF	73.67	m2	***$198.37***	$157,305	
Electrical Room	80.89	SF	7.51	m2	***$198.37***	$16,046	
Subtotal	873.89					$173,351	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Gravity Thickener Drive Mechanism (1 hp each)	2	EA			***$103,316.51***	$206,633	
Thickened Sludge Pumps (Active, Progressive Cavity Pumps 4 hp each)	2	EA			***$13,764.35***	$27,529	
Thickened Sludge Pumps (Standby, Progressive Cavity Pumps 4 hp each)	2	EA			***$13,764.35***	$27,529	
Allowance for Misc Items	10%				$234,161.73	$23,416	
Subtotal						$285,107	
I&C:							
Instruments							
Thickened Sludge Discharge Pipe Magmeter (TSDP, 6 inch)	2	EA			***$10,405.05***	$20,810	
Isolation Valve Actuators (Electric)	6	EA			***$6,409.82***	$38,459	
Level Transmitters	2	EA			***$10,730.27***	$21,461	
Number of Analog I/O Counts	5	EA			***$264.27***	$1,321	
Number of Digital I/O Counts	36	EA			***$62.59***	$2,253	
Number of Local Panels	2	EA			***$13,074.33***	$26,149	
Number of PLC's	1	EA			***$13,908.86***	$13,909	
I&C Conduit Wire	742.68	LF	226.37	m	***$12.06***	$8,956	
Allowance for Misc Items	5%				$133,317.58	$6,666	
Subtotal						$139,983	
MECHANICAL:							
Pipe:							
Unthickened Sludge Influent Pipe (USP, Buried, 4 inch, DI)	400.07	LF	121.94	m	***$34.68***	$13,874	
Unthickened Sludge Influent Pipe (USP, Encased, 4 inch, DI)	0.00	LF	0.00	m	***$34.68***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 4 inch, DI)	34.27	LF	10.44	m	***$34.68***	$1,188	
Decant Pipe (DSP, Buried, 4 inch, DI)	7.33	LF	2.24	m	***$34.68***	$254	
Decant Pipe (DSP, Exposed, 4 inch, DI)	400.07	LF	121.94	m	***$34.68***	$13,874	
Decant Pipe (DSP, Encased, 4 inch, DI)	0.00	LF	0.00	m	***$34.68***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 6 inch, DI)	60.27	LF	18.37	m	***$52.02***	$3,135	
Thickened Sludge Suction Pipe (TSSP, Exposed, 6 inch, Steel)	52.50	LF	16.00	m	***$138.68***	$7,281	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 6 inch, DI)	48.00	LF	14.63	m	***$52.02***	$2,497	
Elbows:							
Unthickened Sludge Influent Pipe (USP, Buried, 4 inch, DI)	2	EA			***$727.88***	$1,456	
Unthickened Sludge Influent Pipe (USP, Encased, 4 inch, DI)	0	EA			***$727.88***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 4 inch, DI)	6	EA			***$727.88***	$4,367	
Decant Pipe (DSP, Buried, 4 inch, DI)	0	EA			***$727.88***	$0	
Decant Pipe (DSP, Exposed, 4 inch, DI)	2	EA			***$727.88***	$1,456	
Decant Pipe (DSP, Encased, 4 inch, DI)	0	EA			***$727.88***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 6 inch, DI)	0	EA			***$1,091.82***	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 6 inch, Steel)	2	EA			***$835.20***	$1,670	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 6 inch, DI)	2	EA			***$1,091.82***	$2,184	
End Caps:							
Unthickened Sludge Influent Pipe (USP, Buried, 4 inch, DI)	0	EA			***$180.64***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 4 inch, DI)	0	EA			***$180.64***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 4 inch, DI)	0	EA			***$180.64***	$0	
Decant Pipe (DSP, Buried, 4 inch, DI)	0	EA			***$180.64***	$0	
Decant Pipe (DSP, Exposed, 4 inch, DI)	0	EA			***$180.64***	$0	
Decant Pipe (DSP, Encased, 4 inch, DI)	0	EA			***$180.64***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 6 inch, DI)	4	EA			***$270.96***	$1,084	
Thickened Sludge Suction Pipe (TSSP, Exposed, 6 inch, Steel)	0	EA			***$270.96***	$0	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 6 inch, DI)	2	EA			***$270.96***	$542	
Tee:							
Unthickened Sludge Influent Pipe (USP, Buried, 4 inch, DI)	0	EA			***$1,208.62***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 4 inch, DI)	0	EA			***$1,208.62***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 4 inch, DI)	0	EA			***$1,208.62***	$0	
Decant Pipe (DSP, Buried, 4 inch, DI)	0	EA			***$1,208.62***	$0	
Decant Pipe (DSP, Exposed, 4 inch, DI)	2	EA			***$1,208.62***	$2,417	
Decant Pipe (DSP, Encased, 4 inch, DI)	0	EA			***$1,208.62***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 6 inch, DI)	2	EA			***$1,812.94***	$3,626	
Thickened Sludge Suction Pipe (TSSP, Exposed, 6 inch, Steel)	2	EA			***$1,902.90***	$3,806	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 6 inch, DI)	2	EA			***$1,812.94***	$3,626	
Valves:							
Unthickened Sludge Influent Pipe (USP, Buried, 4 inch, DI)	0	EA			***$3,544.25***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 4 inch, DI)	0	EA			***$3,544.25***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 4 inch, DI)	2	EA			***$3,544.25***	$7,089	
Decant Pipe (DSP, Buried, 4 inch, DI)	0	EA			***$3,544.25***	$0	
Decant Pipe (DSP, Exposed, 4 inch, DI)	0	EA			***$3,544.25***	$0	
Decant Pipe (DSP, Encased, 4 inch, DI)	0	EA			***$3,544.25***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 6 inch, DI)	0	EA			***$5,316.38***	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 6 inch, Steel)	2	EA			***$6,108.44***	$12,217	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 6 inch, DI)	2	EA			***$5,316.38***	$10,633	
Allowance for Misc Items	5%				$98,275.55	$4,914	
Subtotal						$103,189	
ELECTRICAL:							
# MCC Sections	8	EA			***$10,730.27***	$85,842	
Switchgear	0	EA			***$49,359.23***	$0	
Adjustable Frequency Drives							
Thickened Sludge Pumps (Active) (4 hp each)	2	EA			***$9,418.39***	$18,837	
Thickened Sludge Pumps (Standby) (4 hp each)	0	EA			***$9,418.39***	$0	
Gravity Thickener Rake Mechanism (1 hp each)	0	EA			***$8,996.69***	$0	
Electrical Conduit & Wire	204.54	LF	62.34	m	***$12.06***	$2,466	
Allowance for Misc Items	10%				$107,145.41	$10,715	
Subtotal						$117,860	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	

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Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$7,331,310	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$8,625,071	$172,501			
I&C Allowance	4.00%		$8,625,071	$345,003			
Mechanical Allowance	5.00%		$8,625,071	$431,254			
Electrical Allowance	4.00%		$8,625,071	$345,003			
					Facility Cost Name		
Facility Cost	**150,400**	**GPD**	**$57.35**	**$8,625,071**	SGTFC01		
Facility Cost with Standard Additional Project Costs Added	**150,400**	**GPD**	**$69.69**	**$10,480,927**	SGTFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**150,400**	**GPD**	**$119.53**	**$17,976,665**	SGTFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**150,400**	**GPD**	**$98.36**	**$14,793,540**	SGTFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**150,400**	**GPD**	**$119.53**	**$17,976,665**	SGTFC06		

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Gravity Thickener

PROCESS DESIGN CRITERIA

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Solids Production:							
Input Plant Flow Rate	160.00	mgd	605.67	ML/d			
Input Raw Water Turbidity	2.00	NTU					
Input Fraction of Turbidity to Contribute to Solids	1.00	mg/L/NTU					Typically 1 to 2
Input Raw Water Color	10.00	CU					
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Input Alum Dose	5.00						
Input Fraction of Alum to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3.3H2O
Input Ferric Chloride Dose		mg/L					
Fraction of Ferric Chloride to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3.3H2O
Input Total Polymer Dose (coagulation, flocculation, filter aids)		mg/L					
Input Raw Water Iron		mg/L					
Input Iron Factor	2.00						Typical Value = 2
Input Raw Water Manganese		mg/L					
Input Manganese Factor	2.00						Typical Value = 2
Input PAC Dose		mg/L					
Input Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 2 for lime softening.
Input Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Non-Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 1 for soda ash softening.
Calculate Solids Removed	4.70	mg/L					
Calculate Dry Residual Solids Produced	6,275.74	lb/d	2846.63	kg/d			
Optional: Input Daily Dry Solids Production (overwrites above calculations) (dry)		lb/d		kg/d			
Gravity Thickener Sizing & Sludge Storage:							
Input Number of On-Line Thickeners	1	#					
Input Number of Standby Thickeners	1	#					Typically 1
Input % Dry Solids in Sludge to Thickeners	0.25%						Typically 0.25% tyo 0.75%
Calculate Total Sludge Flow Rate	300,800.00	gpd	1138.65	m3/d			
Calculate Sludge Flow to Each Thickener	300,800.00	gpd	1138.65	m3/d			
Calculate Dry Solids Flow to Each Thickener	6,275.74	lb/d	2846.63	kg/d			
Input Thickener Hydraulic Loading Rate	300.00	gpd/sf	44,005.50	m/d			Typically 100 to 300 gpd/sf for metal salt coagulant sludges
Input Thickener Solids Loading Rate	10.00	lb/d/sf	4.54	kg/d/m2			Typically 5 to 10 lb/sf/d
Calculate Thickener Diameter, Each Based on Hydraulic Loading Rate	35.73	ft	10890.51	mm			
Calculate Thickener Diameter, Each Based on Solids Loading Rate	28.27	ft	8615.94	mm			
Calculate Thickener Diameter, Each (maximum of above)	35.73	ft	10890.51	mm			
Input Thickened Sludge % Dry Solids	4.00%						Typically 2% to 5% for metal salt coagulant sludges treated with polymer
Calculate Thickened Sludge Density	63.86	lb/cf	1022.86	kg/m3			Assumes density of dried solids of 145 lb/cf.
Input Days of Thickened Sludge Storage in Thickener	3.00	days					Typically 0 to 3 days (long weekend)
Calculate Thickened Sludge Storage Depth	7.35	ft	2240.73	mm			If Sludge Storage depth is greater than desired: 1.) Reduce days of storage or 2.) Decrease controlling thickener loading rate criteria input.
Calculate Total Thickened Sludge Storage Volume	55,139.52	gal	208.73	m3			
Input Clear Water Depth Above Sludge Line	10.00	ft	3,048.00	mm			Typically 8 to 11 feet
Input Free Board	3.00	ft	914.40	mm			Typically 1 to 3 feet
Calculate Total Thickener Depth	20.35	ft	6203.13	mm			
Input Thickener Wall Height Above Grade	1.00	ft	304.80	mm			
Calculate Wall Burial Depth	19.35	ft	5898.33	mm	DB		
Gravity Thickener Peripheral Weir Launder Sizing:							
Calculate Total Flow Rate of all Thickeners	0.30	mgd	1138.65	m3/d	QT		
Calculate Flow Rate of Each Active Thickener	0.30	mgd	1138.65	m3/d	Q, mgd		
Convert Each Thickener Flow Rate	0.47	cfs	13.18	L/s	Q, cfs		
Input Velocity in Launder	5.00	fps	1.52	m/s	V		Typically < 5 fps
Calculate Area (Q, cfs / V)	0.09	sf	0.01	m2			
Launder Freeboard	1.00	ft	304.80	mm			Fixed
Input Launder Width	2.00	ft	609.60	mm			
Calculate Launder Height Excluding Freeboard	0.05	ft	14.19	mm			
Calculate Launder Height Including Freeboard	1.05	ft	318.99	mm			Should be ≤ 5 ft.
Thickened Sludge Pump Sizing:							
Calculate Thickened Sludge Flow from Each Thickener	18,379.84	gpd	69.58	m3/d			
Calculate Thickener Decant Flow from Each Thickener	282,420.16	gpd	1069.08	m3/d			
Number of Progressive Cavity Thickened Sludge Pumps per Thickener	2	#					Fixed: 1 duty and 1 standby
Calculate Number of Thickened Sludge Pumps	4	#					
Calculate Thickened Sludge Pump Capacity, Each	12.76	gpm	48.32	L/min			
Input Thickened Sludge Pump Total Dynamic Head (TDH)	100.00	ft	30,480.00	mm			

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Calculate Thickened Sludge Pump Horsepower (each)	0.43	hp	0.32	kW			
Input Distance between Thickener and Sludge Pump Pad	16.00	ft	4,876.80	mm			Minimum of 10 ft
Input Sludge Pump Length (progressive cavity)	8.50	ft	2,590.80	mm			Typically 8.5 ft
Input Sludge Pump Width (progressive cavity)	2.00	ft	609.60	mm			Typically 2.0 ft
Input Stagger Distance Between Sludge Pump Centerlines - Length	8.50	ft	2,590.80	mm			Typically equal to sludge pump length
Input Distance Between Sludge Pump Centerlines (width) and Around Pumps for Access	4.50	ft	1,371.60	mm			Typically 4.5 ft for access
Include the Cost of a Building Over Sludge Pump Station?	Yes	Y/N					
Input Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Unthickened Sludge Influent Pipe	3.00	fps	0.91	m/s	6.00	in	150.00
Decant Pipe	5.00	fps	1.52	m/s	6.00	in	150.00
Thickened Sludge Suction Pipe	3.00	fps	0.91	m/s	2.00	in	50.00
Thickened Sludge Discharge Pipe	3.00	fps	0.91	m/s	2.00	in	50.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Comments	Red Flags
Unthickened Sludge Influent Pipe	USP	Buried	DI	Cement Mortar	Tape Coating		
Unthickened Sludge Influent Pipe	USP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Unthickened Sludge Influent Pipe	USP	Submerged	DI	Cement Mortar	Fusion Bonded Epoxy		
Decant Pipe	DSP	Buried	DI	Cement Mortar	Tape Coating		
Decant Pipe	DSP	Exposed	DI	Cement Mortar	Paint		
Decant Pipe	DSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Exposed	Steel	Cement Mortar	Paint		
Thickened Sludge Discharge Pipe	TSDP	Exposed	DI	Cement Mortar	Paint		

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	No	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Thickened Sludge Pumps (Active)	2.00	0.43	Yes	0.00	6.00	4.00	
Thickened Sludge Pumps (Standby)	2.00	0.43	No	4.00	0.00	0.00	
Gravity Thickener Rake Mechanism	2.00	1.00	No	4.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**3.7**		**8.00**	**6.00**	**4.00**	**18.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	10.00
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**14.00**

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Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zerc					
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Width	**4.67**						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
Total Number of Thickeners	2.00	#					
Gravity Thickener (dimensions per each):							
Perimeter Wall Inside Diameter	35.73	ft	10890.51	mm			
Perimeter Wall Outside Diameter	37.73	ft	11500.11	mm			
Perimeter Wall Height	20.35	ft	6203.13	mm			
Wall Footer Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Wall Footer Thickness	1.33	ft	406.40	mm			
Slab on Grade Thickness	**6.00**	in	**152.40**	mm			Model based on 6"
Slab on Grade Thickness	0.50	ft	152.40	mm			
Center Cone Outside Diameter	6.17	ft	1879.60	mm			Fixed
Center Cone Inside Diameter	3.50	ft	1066.80	mm			Fixed
Center Cone Slab on Grade Thickness	**16.00**	in		mm			Model based on 16"
Center Cone Slab on Grade Thickness	1.33	ft	406.40	mm			
Center Cone Wall Height	**2.33**	ft	**59.18**	mm			Model based on 2.33'
Center Cone Wall Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Center Cone Wall Thickness	1.33	ft	406.40	mm			
Launder Elevated Slab Width	**2.00**	ft	**50.80**	mm			Model based on 2'
Launder Elevated Slab Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Launder Elevated Slab Thickness	1.00	ft	304.80	mm			
Launder Wall Diameter	31.73	ft	9671.31	mm			
Launder Wall Height	1.05	ft	318.99	mm			
Launder Wall Thickness	**8.00**	in	**203.20**	mm			Model based on 8"
Launder Wall Thickness	0.67	ft	203.20	mm			
Perimeter Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Perimeter Wall Thickness	1.00	ft	304.80	mm			
Floor Slope Factor	1.03						Fixed
Side Slope Depth Factor	0.23						Fixed
Side Slope Factor	4.29						Fixed
Excavation Diameter	46.73	ft	14243.31	mm			
Cone Excavation Depth	7.44	ft	2268.07	mm			
Perimeter Wall Excavation Depth (Includes Over Excavation)	21.68	ft	6609.53	mm			
Thickened Sludge Pump Slab:							
Length	26.00	ft	7924.80	mm			Fixed
Width	30.50	ft	9296.40	mm			
Slab on Grade Length	28.00	ft	8534.40	mm			
Slab on Grade Width	32.50	ft	9906.00	mm			
Slab Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Slab Thickness	1.33	ft	406.40	mm			
Excavation Length	32.00	ft	9753.60	mm			
Excavation Width	36.50	ft	11125.20	mm			
Excavation Depth	3.33	ft	1016.00	mm			
Electrical Room:							
Length	14.00	ft	4267.20	mm			
Width	4.67	ft	1422.40	mm			
Slab on Grade Length	16.00	ft	4876.80	mm			
Slab on Grade Width	6.67	ft	2032.00	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
Slab on Grade Thickness	1.50	ft	457.20	mm			
Excavation Length	20.00	ft	6096.00	mm			
Excavation Width	10.67	ft	3251.20	mm			
Excavation Depth	3.50	ft	1066.80	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Gravity Thickener:							
Excavation	7,733.79	CY	5912.91	m3	***$6.72***	$51,995	
Imported Structural Backfill	261.05	CY	199.58	m3	***$50.94***	$13,298	
Native Backfill	3,835.17	CY	2932.20	m3	***$8.27***	$31,699	
Haul Excess	3,898.62	CY	2980.71	m3	***$8.27***	$32,223	
Thickened Sludge Pump Slab:							
Excavation	208.86	CY	159.68	m3	***$8.33***	$1,739	
Imported Structural Backfill	100.94	CY	77.17	m3	***$50.94***	$5,142	
Native Backfill	42.28	CY	32.33	m3	***$8.27***	$349	
Haul Excess	166.58	CY	127.36	m3	***$8.27***	$1,377	
Electrical Room:							
Excavation	54.35	CY	41.55	m3	***$8.33***	$453	
Imported Structural Backfill	19.75	CY	15.10	m3	***$50.94***	$1,006	
Native Backfill	20.87	CY	15.96	m3	***$8.27***	$172	
Haul Excess	33.48	CY	25.60	m3	***$8.27***	$277	
Allowance for Misc Items	5%				$139,730.44	$6,987	
Subtotal						$146,717	
CONCRETE:							
Gravity Thickener:							
Wall Footers	64.39	CY	49.23	m3	***$541.11***	$34,841	
Slanted Slab on Grade	38.15	CY	29.17	m3	***$541.11***	$20,645	
Slanted Floor Grout (2" thick)	2,060.27	SF	191.41	m2	***$23.76***	$48,953	
Center Cone Slab on Grade	2.95	CY	2.26	m3	***$541.11***	$1,596	
Center Cone Walls	4.46	CY	3.41	m3	***$499.64***	$2,227	
Perimeter Walls	178.69	CY	136.62	m3	***$707.82***	$126,480	
Launder Elevated Slab	16.63	CY	12.71	m3	***$832.73***	$13,848	
Launder Wall	5.15	CY	3.94	m3	***$832.73***	$4,290	
Concrete Fill	***2.77***	CY	2.12	m3	***$374.73***	$1,039	
Thickened Sludge Pump Slab:						$0	
Slab on Grade	44.94	CY	34.36	m3	***$490.62***	$22,047	
Electrical Room:						$0	
Slab on Grade	5.93	CY	4.53	m3	***$541.11***	$3,207	
Allowance for Misc Items	5%				$279,172.59	$13,959	

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Subtotal						$293,131	
METALS:							
Gravity Thickener:							
Walkway Grating (3' wide, steel support beams supplied by mechanism mfr)	226.38	SF	21.03	m2	***$90.92***	$20,582	
Walkway Handrail	150.92	LF	46.00	m	***$90.92***	$13,721	
Stairway	3	Risers			***$495.92***	$1,488	
Allowance for Misc Items	10%				$35,791.20	$3,579	
Subtotal						$39,370	
MASONRY:	**Moderate**						
Thickened Sludge Pump Building	793.00	SF	73.67	m2	***$165.31***	$131,087	
Electrical Room	65.33	SF	6.07	m2	***$165.31***	$10,800	
Subtotal	858.33					$141,887	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Gravity Thickener Drive Mechanism (1 hp each)	2	EA			***$128,008.60***	$256,017	
Thickened Sludge Pumps (Active, Progressive Cavity Pumps 0 hp each)	2	EA			***$6,953.63***	$13,907	
Thickened Sludge Pumps (Standby, Progressive Cavity Pumps 0 hp each)	2	EA			***$6,953.63***	$13,907	
Allowance for Misc Items	10%				$269,924.46	$26,992	
Subtotal						$310,824	
I&C:							
Instruments							
Thickened Sludge Discharge Pipe Magmeter (TSDP, 2 inch)	2	EA			***$6,718.91***	$13,438	
Isolation Valve Actuators (Electric)	6	EA			***$6,409.82***	$38,459	
Level Transmitters	2	EA			***$10,730.27***	$21,461	
Number of Analog I/O Counts	5	EA			***$264.27***	$1,321	
Number of Digital I/O Counts	36	EA			***$62.59***	$2,253	
Number of Local Panels	2	EA			***$13,074.33***	$26,149	
Number of PLC's	1	EA			***$13,908.86***	$13,909	
I&C Conduit Wire	817.30	LF	249.11	m	***$12.06***	$9,856	
Allowance for Misc Items	5%				$126,845.19	$6,342	
Subtotal						$133,187	
MECHANICAL:							
Pipe:							
Unthickened Sludge Influent Pipe (USP, Buried, 6 inch, DI)	38.70	LF	11.80	m	***$52.02***	$2,013	
Unthickened Sludge Influent Pipe (USP, Encased, 6 inch, DI)	0.00	LF	0.00	m	***$52.02***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 6 inch, DI)	37.73	LF	11.50	m	***$52.02***	$1,963	
Decant Pipe (DSP, Buried, 6 inch, DI)	4.00	LF	1.22	m	***$52.02***	$208	
Decant Pipe (DSP, Exposed, 6 inch, DI)	38.70	LF	11.80	m	***$52.02***	$2,013	
Decant Pipe (DSP, Encased, 6 inch, DI)	0.00	LF	0.00	m	***$52.02***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 2 inch, DI)	67.73	LF	20.64	m	***$17.34***	$1,174	
Thickened Sludge Suction Pipe (TSSP, Exposed, 2 inch, Steel)	46.50	LF	14.17	m	***$46.23***	$2,150	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 2 inch, DI)	48.00	LF	14.63	m	***$17.34***	$832	
Elbows:							
Unthickened Sludge Influent Pipe (USP, Buried, 6 inch, DI)	2	EA			***$1,091.82***	$2,184	
Unthickened Sludge Influent Pipe (USP, Encased, 6 inch, DI)	0	EA			***$1,091.82***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 6 inch, DI)	6	EA			***$1,091.82***	$6,551	
Decant Pipe (DSP, Buried, 6 inch, DI)	0	EA			***$1,091.82***	$0	
Decant Pipe (DSP, Exposed, 6 inch, DI)	2	EA			***$1,091.82***	$2,184	
Decant Pipe (DSP, Encased, 6 inch, DI)	0	EA			***$1,091.82***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 2 inch, DI)	0	EA			***$363.94***	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 2 inch, Steel)	2	EA			***$278.40***	$557	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 2 inch, DI)	2	EA			***$363.94***	$728	
End Caps:							
Unthickened Sludge Influent Pipe (USP, Buried, 6 inch, DI)	0	EA			***$270.96***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 6 inch, DI)	0	EA			***$270.96***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 6 inch, DI)	0	EA			***$270.96***	$0	
Decant Pipe (DSP, Buried, 6 inch, DI)	0	EA			***$270.96***	$0	
Decant Pipe (DSP, Exposed, 6 inch, DI)	0	EA			***$270.96***	$0	
Decant Pipe (DSP, Encased, 6 inch, DI)	0	EA			***$270.96***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 2 inch, DI)	4	EA			***$90.32***	$361	
Thickened Sludge Suction Pipe (TSSP, Exposed, 2 inch, Steel)	0	EA			***$90.32***	$0	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 2 inch, DI)	2	EA			***$90.32***	$181	
Tee:							
Unthickened Sludge Influent Pipe (USP, Buried, 6 inch, DI)	0	EA			***$1,812.94***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 6 inch, DI)	0	EA			***$1,812.94***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 6 inch, DI)	0	EA			***$1,812.94***	$0	
Decant Pipe (DSP, Buried, 6 inch, DI)	0	EA			***$1,812.94***	$0	
Decant Pipe (DSP, Exposed, 6 inch, DI)	2	EA			***$1,812.94***	$3,626	
Decant Pipe (DSP, Encased, 6 inch, DI)	0	EA			***$1,812.94***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 2 inch, DI)	2	EA			***$604.31***	$1,209	
Thickened Sludge Suction Pipe (TSSP, Exposed, 2 inch, Steel)	2	EA			***$634.30***	$1,269	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 2 inch, DI)	2	EA			***$604.31***	$1,209	
Valves:							
Unthickened Sludge Influent Pipe (USP, Buried, 6 inch, DI)	0	EA			***$5,316.38***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 6 inch, DI)	0	EA			***$5,316.38***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 6 inch, DI)	2	EA			***$5,316.38***	$10,633	
Decant Pipe (DSP, Buried, 6 inch, DI)	0	EA			***$5,316.38***	$0	
Decant Pipe (DSP, Exposed, 6 inch, DI)	0	EA			***$5,316.38***	$0	
Decant Pipe (DSP, Encased, 6 inch, DI)	0	EA			***$5,316.38***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 2 inch, DI)	0	EA			***$1,772.13***	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 2 inch, Steel)	2	EA			***$2,036.15***	$4,072	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 2 inch, DI)	2	EA			***$1,772.13***	$3,544	
Allowance for Misc Items	5%				$48,659.52	$2,433	
Subtotal						$51,092	
ELECTRICAL:							
# MCC Sections	6	EA			***$10,730.27***	$64,382	
Switchgear	0	EA			***$49,359.23***	$0	
Adjustable Frequency Drives							
Thickened Sludge Pumps (Active) (0 hp each)	2	EA			***$8,921.91***	$17,844	
Thickened Sludge Pumps (Standby) (0 hp each)	0	EA			***$8,921.91***	$0	
Gravity Thickener Rake Mechanism (1 hp each)	0	EA			***$8,996.69***	$0	
Electrical Conduit & Wire	219.46	LF	66.89	m	***$12.06***	$2,646	
Allowance for Misc Items	10%				$84,871.89	$8,487	
Subtotal						$93,359	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	

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Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$1,209,569	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$1,423,022	$28,460			
I&C Allowance	4.00%		$1,423,022	$56,921			
Mechanical Allowance	5.00%		$1,423,022	$71,151			
Electrical Allowance	4.00%		$1,423,022	$56,921			
					Facility Cost Name		
Facility Cost	**601,600**	**GPD**	**$2.37**	**$1,423,022**	SGTFC01		
Facility Cost with Standard Additional Project Costs Added	**601,600**	**GPD**	**$2.87**	**$1,729,214**	SGTFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**601,600**	**GPD**	**$4.93**	**$2,965,912**	SGTFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**601,600**	**GPD**	**$4.06**	**$2,440,738**	SGTFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**601,600**	**GPD**	**$4.93**	**$2,965,912**	SGTFC06		

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Centrifuge Solids Dewatering Facility

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Dry Solids Production							
Input Design Plant Flow Rate	160.00	mgd	605.67	ML/d			Enter plant flow rate for which dewatering equipment/system shall be sized.
Input Average Annual Plant Flow Rate	75.00	mgd	283.91	ML/d			Enter plant flow rate for calculating average annual production of solids.
Input Design Raw Water Turbidity	2.00	NTU					Enter raw water turbidity for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Turbidity	2.00	NTU					Enter raw water turbidity for calculating average annual productio of solids.
Input Fraction of Turbidity to Contribute to Solids	1.00	mg/L/NTU					Typically 1 to 2
Input Design Raw Water Color	10.00	CU					Enter raw water color for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Color	10.00	CU					Enter raw water color for calculating average annual production of solids.
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Select Coagulant Used for Raw Water	Aluminum Sulfate	Type					
Input Design Coagulant Dose	5.00	mg/L					Enter coagulant dose for which dewatering equipment/system shall be sized.
Input Average Annual Coagulant Dose	5.00	mg/L					Enter coagulant dose for calculating average annual production of solids.
Fraction of Coagulant to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3*3H2O.
Optional: Input Fraction of Coagulant to Contribute to Solids (overwrites above calculations)							
Input Total Design Polymer Dose (coagulation, flocculation, filter aids)		mg/L					Enter polymer dose for which dewatering equipment/system shall be sized.
Input Total Average Annual Polymer Dose (coagulation, flocculation, filter aids)		mg/L					Enter polymer dose for calculating average annual production of solids.
Input Design Raw Water Iron		mg/L					Enter raw water iron for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Iron		mg/L					Enter raw water iron for calculating average annual production of solids.
Input Iron Factor that Contrinbutes to Solids	2.00						Typical Value = 2
Input Design Raw Water Manganese		mg/L					Enter raw water manganese for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Manganese		mg/L					Enter raw water manganese for calculating average annual productio of solids.
Input Manganese Factor that Contrinbutes to Solids	2.00						Typical Value = 2
Input Design PAC Dose		mg/L					Enter PAC dose for which dewatering equipment/system shall be sized.
Input Average Annual PAC Dose		mg/L					Enter PAC dose for calculating average annual production of solids.
Input Design Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter carbonate hardness removed for which dewatering equipment/system shall be sized.
Input Average Annual Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter carbonate hardness removed for calculating average annual production of solids.
Input Carbonate Hardness Factor that Contributes to Solids	1.00	(mg of softening solids produced per mg of hardness removed)					Typical Value: 1 for sodium hydroxide softening; 2 for lime softening.
Input Design Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter non-carbonate hardness removed for which dewatering equipment/system shall be sized.
Input Average Annual Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter non-carbonate hardness removed for calculating average annual production of solids.
Input Non-Carbonate Hardness Factor that Contributes to Solids	1.00	(mg of softening solids produced per mg of hardness removed)					Typical Value: 1 for sodium hydroxide softening; 1 for soda ash softening.
Calculate Design Solids Removed	4.70	mg/L					

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Calculate Design Daily Dry Solids Production	9,093.41	lb/d	4124.70	kg/d			Calculated on a dry weight basis.
Optional: Input Design Daily Dry Solids Production (overwrites above calculations)	**9,093.41**	lb/d	**8,688.53**	kg/d			Overrides cell above. Calculated on a dry weight basis.
Calculate Average Annual Solids Removed	4.70	mg/L					
Calculate Average Annual Daily Dry Solids Production	3,535.83	lb/d	1603.83	kg/d			Calculated on a dry weight basis.
Optional: Input Average Annual Daily Dry Solids Production (overwrites above calculations)	**3,535.83**	lb/d	**1,594.27**	kg/d			Overrides cell above. Calculated on a dry weight basis.
Centrifuge Dewatering Sizing							
Input % Dry Solids in Sludge to Centrifuges	**2.00%**						Typically from Gravity Thickener at 2% to 5%
Input Number of Days per Week Centrifuges Will Be Operated	**5.00**	days					1 to 7, often 5 days
Input Number of Hours per Day Centrifuges Will Be Operated	**8.00**	hours					1 to 24, often 8 hours
Calculate Required Gravity Thickener Dry Solids Storage (dry)	24,249.09	lb	10999.20	kg			
Calculate Thickened Sludge Density	63.12	lb/cf	1011.07	kg/m3			Assumes density of dried solids of 145 lb/cf.
Calculate Required Gravity Thickener Sludge Storage Volume	19,208.99	cf	543.94	m3			
Calculate Required Gravity Thickener Sludge Storage Volume	143,693.22	gal	543.94	m3			For Information, see cell C34 in the Gravity Thickener model for the volume (in gallons) of sludge.
Calculate Required Centrifuge Dewatering Rate	157.16	gpm	35.70	m3/hr			
Input Number of Duty Centrifuges	**2**	#					Toggle number of duty centrifuges to select optimum centrifuge configuration.
Input Number of Standby Centrifuges	**1**	#					Typically 0 or 1.
Total Number of centrifuges	3	#					
Loading, hydraulic (each)	78.58	gpm	17.85	m3/hr			
Loading, dry solids (each)	795.67	lb/hr	360.91	kg/hr			
Centrifuge Selection							
Input Sludge Type	**Alum**						
Case No.	1.00						Number used for selection of centrifuge
Expected Feed Solids	2.5-3.5% DS						
Polymer Consumption	15-25 lb/ton DS						DS = dry solids
Cake Solids	18-23% DS						DS = dry solids
Capture Efficiency	95.00%	`					
Centrifuge Selection	3.00						Number used for selection of centrifuge
Model No. (Andritz)	D4						The service numbers for each model have a level of conservativism already in them.
Capacity	60	gpm	13.63	m3/hr			Contact Andritz for actual model selection. There are several versions of each model that changes the capacity ranges for each.
Bowl Diameter	16.92	in	429.77	mm			
Length	152.00	in	3860.80	mm			
Width	41.00	in	1041.40	mm			
Height	59.00	in	1498.60	mm			
Power, Main Drive	50.00	hp	37.28	kW			
Power, Back Drive	10.00	hp	7.46	kW			
Weight	7,094.00	lb	3217.78	kg			Be sure to provide access to the centrifuges on the second floor
Chemical Storage and Feed							
Input Chemical Name	**Liquid Polymer**	Type					Typically Liquid Polymer, but if Dry Polymer is used, use the Dry Polymer Model
Is this Chemical System to be Included?	**Yes**	Y/N					
Input Percent Active Chemical	**40.00%**						If Liquid Polymer, typically 30% to 50%
Input Bulk Chemical Specific Gravity	**1.10**	#					If Liquid Polymer, typically 1.1
Active Chemical Concentration, lb/gallon	3.67	lb/gal	440.00	kg/m3			
Choose Chemical Delivery Method	**Tote**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums), gallons	300.00	gal	1.14	m3			
Input Number of Simultaneous Application Points	**1**	#					
CHEMICAL DOSES:							
Input Minimum Dose (per ton of dry solids)	**15.00**	lb/t	**7.50**	kg/t			Typically 5 to 15 lb dry polymer per ton of dry solids (2.5 to 7.5 kg/t).
Input Average Dose (per ton of dry solids)	**20.00**	lb/t	**10.00**	kg/t			Typically 10 to 20 lb dry polymer per ton of dry solids (5.0 to 10.0 kg/t).
Input Maximum Dose (per ton of dry solids)	**25.00**	lb/t	**12.50**	kg/t			Typically 15 to 25 lb dry polymer per ton of dry solids (7.5 to 12.5 kg/t).
Minimum Chemical Usage	95.48	lb/d	43.31	kg/d			Usage rate on operating days.
Average Chemical Usage	127.31	lb/d	57.75	kg/d			Usage rate on operating days.
Maximum Chemical Usage	159.13	lb/d	72.18	kg/d			Usage rate on operating days.
Chemical Metering Rates per Simultaneous Operating Pump:							
Minimum Rate	3.25	gph	12.30	L/h			Usage rate when operating.
Average Rate	4.33	gph	16.41	L/h			Usage rate when operating.
Maximum Rate	5.42	gph	20.51	L/h			Usage rate when operating.
Calculate Chemical Metering Pump Flow Turndown (should be < 20, if > 20, proceed with caution)	1.67	:1					Should be < 20, If ≥ 20, proceed with caution.
Input Number of Days of Storage at Avg. Flow/Dose for Chemical	**30.00**	days					Includes non-operating days.
Calculate Number of Operating Days of Storage	21.43	days					Includes only operating days.
Calculate Storage Volume for Pretreatment @ Avg. Flow/Dose	742.93	gal	2.81	m3			
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	0.00	gal	0.00	m3			
Maximum of Above Two Volumes	742.93	gal	2.81	m3			

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Maximum Volume in	99.32	cf	2.81	m3			
BULK TANKS:							
Input Number of Tanks	1	#					
Input Tank Diameter	10.00	ft	3,048.00	mm			
Calculate Height of Tanks	0.00	ft	0.00	mm			
Use this Tank Height (Liquid Height * 1.2)	0.00	ft	0.00	mm			
Input Number of Rows of Tanks	1	#					
Calculate Number of Tanks per Row	0	#					
Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	FRP	Type					
Input Clear Distance Around BulkTanks, Totes or Drums	4.00	ft	1,219.20	mm	CDT		
TOTES & DRUMS:							
Calculate Number of Totes or Drums	3	each					
Will Totes or Drums be Stored by Stacking on Top of Each Other?	No	Y/N					
Input Number of Rows of Totes or Drum Pallets	1	#					
Calculate Number of Totes or Drum Pallets on Floor per Row	3.00	#					
Length of Each Tote	4.00	ft	1219.20	mm			Fixed
Width of Each Tote	4.00	ft	1219.20	mm			Fixed
Length and Width of Each Drum Pallet	5.00	ft	1524.00	mm			Fixed
CHEMICAL FEED SYSTEMS:							
Select Chemical Feed Method	Polymer Blend Unit	Type					If using polymer, a Polymer Blend Unit is recommended
Calculate Number of Active Chemical Feed Systems	1	#					
Input Number of Standby Chemical Feed Systems	1	#					
Calculate Total Number of Chemical Feed Systems	2	#					
Input Clear Distance Around Chemical Feed Systems	4.00	ft	1,219.20	mm			
Length of Chemical Feed Systems	2.50	ft	762.00	mm			
Width of Chemical Feed Systems	3.33	ft	1015.90	mm			
Width of Stair Access	3.50	ft	1066.80	mm			Fixed
CONTAINMENT AREA:							
Calculate Containment Area Internal Length	28.00	ft	8534.40	mm			
Calculate Containment Area Internal Width	26.00	ft	7924.80	mm			
Calculate Fire Sprinkler Water Volume (0.2 gpm/sf for 20 min.)	2,912.00	gal	11.02	m3			
Calculate 120% of One Storage Tank Volume	360.00	gal	1.36	m3			
Calculate 30% of All Tank Volume	90.00	gal	0.34	m3			
Maximum of Above Two Volumes	360.00	gal	1.36	m3			
Calculate Maximum Volume + Fire Flow Volume	3,272.00	gal	12.39	m3			
Calculate Maximum Volume + Fire Flow Volume	437.40	cf	12.39	m3			
Calculate Containment Wall Height (including 6" Freeboard)	1.10	ft	335.53	mm			
Dewatering Building							
Truck Lane Length	68.00	ft	20,726.40	mm	DWB-TLL		Typically 68 ft for full container truck or roll-off.
Truck Lane Width	20.00	ft	6,096.00	mm	DWB-TLW		Typically ≥ 16 ft for full container truck or roll-off.
First Floor Height	24.00	ft	7,315.20	mm	DWB-FFH		Typically ≥ 22 ft
Number of Truck Lanes	2.00	#					Typically 2.
Offset Between Centrifuges	5.00	ft	1,524.00	mm	CN-OS		Typically ≥ 4 ft for access.
Centrifuge Offset from Wall (width direction in relationship to the centrifuges)	5.00	ft	1,524.00	mm	CN-OEW		Typically ≥ 4 ft for access.
Centrifuge Offset from Wall (length direction in relationship to centrifuges)	17.00	ft	5,181.60	mm	CN-ONW		Typically = 17 ft for proper alignment over truck bays.
Input Stair Tread Width	3.50	ft	1,066.80	mm			Typically ≥ 3.5 ft.
Calculate Stairwell Width	8.00	ft	2438.40	mm	DWB-SW		
Calculate Stairwell Length	25.50	ft	7772.40	mm	DWB-SL		
Dewatering Building Width	71.25	ft	21717.00	mm	DWB-W		
Dewatering Building Length	72.83	ft	22199.60	mm	DWB-L		
Conveyor Equipment							
Centrifuge Conveyor Length	48.54	ft	14795.50	mm	CON-CNL		
Centrifuge Conveyor Width or Diameter	10.00	in	254.00	mm	CON-CNW		Verify with conveyor vendor
Conveyor Truck Lane Length	40.00	ft	12,192.00	mm	CON-TLL		Typically 40 ft
Calculate Conveyor Truck Lane Width	10.00	in	254.00	mm	CON-TLW		
% Dry Solids Capture by Centrifuge	95.00%						
Optional: Input % Dry Solids Capture by Centrifuge (overwrites above calculations)							Typically 90 to 98%.
% Dry Solids in Centrifuge Cake	18.00%						
Optional: Input % Dry Solids in Centrifuge Cake (overwrites above calculations)							Typically 15 to 25%.
Calculate the Centrifuge Dry Solids Production Rate (dry)	1,511.78	lb/hr	685.73	kg/hr			
Calculate the Cake Density	69.53	lb/cf	1113.75	kg/m3			Assumes density of dried solids of 145 lb/cf.
Calculate the Centrifuge Cake Solids Production Rate	8,398.77	lb/hr	3809.62	kg/hr			
Calculate Truck Loads	0.17	per hour					
Calculate the Centrifuge Cake Volume Production Rate	120.79	cf/hr	3.42	m3/hr			
Calculate Total Yearly Wet Mass of Sludge (per year)	8,758.72	tons	7945778.18	kg			
Calculate Total Design Yearly Wet Sludge Volume	9,331.22	cy	7134.23	m3			
Calculate Average Annual Wet Sludge Volume	3,628.30	cy	2774.03	m3			
Calculate Number of Gates per Truck Conveyor	6	#					Assumes 6 ft on center
Input Depth of Burial		ft	0.00	mm	DB		
Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		
Mechanical Sizing Requirements:							
Pipe Name	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**

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Centrifuge Feed Header	5.00	fps	1.52	m/s	4.00	in	100.00
Centrifuge Feed Lateral	5.00	fps	1.52	m/s	3.00	in	80.00
Centrifuge Drain Lateral/Header	5.00	fps	1.52	m/s	3.00	in	80.00
Centrifuge Decant Header	5.00	fps	1.52	m/s	4.00	in	100.00
Centrifuge Decant Lateral	5.00	fps	1.52	m/s	3.00	in	80.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Comments	Red Flags
Centrifuge Feed Header	CFH	Exposed	DI	Cement Mortar	Tape Coating		
Centrifuge Feed Lateral	CFL	Exposed	Steel	Cement Mortar	Paint		
Centrifuge Drain Lateral/Header	CD	Exposed	Steel	Cement Mortar	Paint		
Centrifuge Decant Header	CDH	Exposed	Steel	Cement Mortar	Paint		
Centrifuge Decant Lateral	CDL	Exposed	Steel	Cement Mortar	Paint		

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Centrifuges (Active)	2	50.00	No	6.00	0.00	0.00	
Centrifuges (Standby)	1	50.00	No	3.00	0.00	0.00	
Centrifuge Conveyor Belt	1	3.00	No	2.00	0.00	0.00	
Truck Conveyor Belt	2	3.00	No	4.00	0.00	0.00	
User Defined Item #1	0	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0	0.00	No	0.00	0.00	0.00	
TOTAL		159.0		15.00	0.00	0.00	15.00

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	1.67

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Typically 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	13.33
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	17.33

Electric Room Width (ft):

CD6	0.00	If there is no switchgear, this distance will be Zero.
Maximum Equipment Depth	1.67	
CD7	3.00	
Total Width	4.67	

Estimating Dimensions:	Value English	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Centrifuge Building							
Building Length	72.83	ft	22199.60	mm			
Building Width	71.25	ft	21717.00	mm			
Slab on Grade Length	76.83	ft	23418.80	mm			
Slab on Grade Width	75.25	ft	22936.20	mm			
Excavation Length	80.83	ft	24638.00	mm			
Excavation Width	79.25	ft	24155.40	mm			
Excavation Depth	3.50	ft	1066.80	mm			
Stair Height	24.00	ft	7315.20	mm			

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Slab on Grade Thickness	18.00	in	457.20	mm			Model based on 18"
Slab on Grade Thickness	1.50	ft	457.20	mm			
Wall Thickness	12.00	in	304.80	mm			Model based on 12"
Wall Thickness	1.00	ft	304.80	mm			
Elevated Slab Thickness	12.00	in	304.80	mm			Model based on 12"
Elevated Slab Thickness	1.00	ft	304.80	mm			
Chemical Containment Wall Thickness	8.00	in	203.20	mm			
Chemical Containment Wall Thickness	0.67	ft	203.20	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Excavation	1011.41	CY	773.28	m3	$6.72	$6,800	
Imported Structural Backfill	474.52	CY	362.80	m3	$50.94	$24,173	
Native Backfill	72.63	CY	55.53	m3	$8.27	$600	
Haul Excess	938.78	CY	717.75	m3	$8.27	$7,759	
Allowance for Misc Items	5%				$39,332.25	$1,967	
Subtotal						$41,299	
CONCRETE:							
Centrifuge Building Slab on Grade	321.21	CY	245.58	m3	$490.62	$157,589	
Elevated Slab	203.02	CY	155.22	m3	$1,333.77	$270,781	
Equipment Pads	6.71	CY	5.13	m3	$490.62	$3,290	
Allowance for Misc Items	5%				$431,660.66	$21,583	
Subtotal						$453,244	
MASONRY:	Moderate						
CMU Building	10378.75	SF	964.22	m2	$165.31	$1,715,667	
Subtotal						$1,715,667	
METALS:							
Stairway	72	Risers			$495.92	$35,706	
Guardrail	291.33	LF	88.80	m	$27.82	$8,104	
Allowance for Misc Items	10%				$43,810.27	$4,381	
Subtotal						$48,191	
EQUIPMENT:							Budgetary Quote: (CPES will automatically add Installation Factor)
Centrifuges	3	EA			$790,882.11	$2,372,646	
Liquid Polymer Feed System	2	EA			$8,727.54	$17,455	
Shaftless Screw Conveyer	128.54	ft	39.18	m	$2,884.42	$370,768	
Allowance for Misc Items	10%				$2,760,869.69	$276,087	
Subtotal						$3,036,957	Total Horsepower >>>>
							Percent On-Line Factor >>>>
I&C:							Effective On-Line Horsepower >>>>
Instruments							
Centrifuge Feed Header Magmeter (CFH, 4 inch)	1	EA			$5,118.41	$5,118	
Isolation Valve Actuators (Electric)	9	EA			$6,409.82	$57,688	
Slide Gate Actuators	14	EA			$2,781.77	$38,945	
Number of Analog I/O Counts	2	EA			$264.27	$529	
Number of Digital I/O Counts	138	EA			$62.59	$8,637	
Number of Local Panels	3	EA			$13,074.33	$39,223	
Number of PLC's	1	EA			$13,908.86	$13,909	
I&C Conduit Wire	2324.00	LF	708.36	m	$12.06	$28,025	
Allowance for Misc Items	5%				$192,074.47	$9,604	
Subtotal						$201,678	
							Percent On-Line Factor >>>>
CONVEYING SYSTEMS:							Effective On-Line Horsepower >>>>
Bridge Crane (8 Ton)	1	EA			$70,027.47	$70,027	
Bridge Crane Rail	145.67	LF	44.40	m	$36.37	$5,298	
Allowance for Misc Items	10%				$75,325.72	$7,533	
Subtotal						$82,858	
MECHANICAL:							
Pipe:							
Centrifuge Feed Header (CFH, DI, 4 inch, Exposed)	85.67	LF	26.11	m	$34.68	$2,971	
Centrifuge Feed Lateral (CFL, Steel, 3 inch, Exposed)	14.75	LF	4.50	m	$69.34	$1,023	
Centrifuge Drain Lateral/Header (CD, Steel, 3 inch, Exposed)	100.42	LF	30.61	m	$69.34	$6,963	
Centrifuge Decant Header (CDH, Steel, 4 inch, Exposed)	85.67	LF	26.11	m	$92.45	$7,920	
Centrifuge Decant Lateral (CDL, Steel, 3 inch, Exposed)	14.75	LF	4.50	m	$69.34	$1,023	
Elbows:							
Centrifuge Feed Header (CFH, DI, 4 inch)	3	EA			$727.88	$2,184	
Centrifuge Feed Lateral (CFL, Steel, 3 inch)	3	EA			$417.60	$1,253	
Centrifuge Drain Lateral/Header (CD, Steel, 3 inch)	3	EA			$417.60	$1,253	
Centrifuge Decant Header (CDH, Steel, 4 inch)	6	EA			$556.80	$3,341	
Centrifuge Decant Lateral (CDL, Steel, 3 inch)	3	EA			$417.60	$1,253	
End Caps:							
Centrifuge Feed Header (CFH, DI, 4 inch)	0	EA			$180.64	$0	
Centrifuge Feed Lateral (CFL, Steel, 3 inch)	0	EA			$135.48	$0	
Centrifuge Drain Lateral/Header (CD, Steel, 3 inch)	0	EA			$135.48	$0	
Centrifuge Decant Header (CDH, Steel, 4 inch)	0	EA			$180.64	$0	
Centrifuge Decant Lateral (CDL, Steel, 3 inch)	0	EA			$135.48	$0	
Tee:							
Centrifuge Feed Header (CFH, DI, 4 inch)	2	EA			$1,208.62	$2,417	
Centrifuge Feed Lateral (CFL, Steel, 3 inch)	0	EA			$951.45	$0	
Centrifuge Drain Lateral/Header (CD, Steel, 3 inch)	2	EA			$951.45	$1,903	
Centrifuge Decant Header (CDH, Steel, 4 inch)	2	EA			$1,268.60	$2,537	
Centrifuge Decant Lateral (CDL, Steel, 3 inch)	0	EA			$951.45	$0	
Valves:							
Centrifuge Feed Header (CFH, DI, 4 inch)	0	EA			$3,544.25	$0	
Centrifuge Feed Lateral (CFL, Steel, 3 inch)	3	EA			$3,054.22	$9,163	
Centrifuge Drain Lateral/Header (CD, Steel, 3 inch)	3	EA			$3,054.22	$9,163	
Centrifuge Decant Header (CDH, Steel, 4 inch)	0	EA			$4,072.29	$0	
Centrifuge Decant Lateral (CDL, Steel, 3 inch)	3	EA			$3,054.22	$9,163	

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Slide Gates:						
Centrifuge Conveyor Solids Gates (10 in)	2	EA			***$985.05***	$1,970
Truck Conveyor Solids Gates (10 in)	12	EA			***$985.05***	$11,821
Allowance for Misc Items	5%				$77,318.46	$3,866
Subtotal						$81,184
ELECTRICAL:						
# MCC Sections	8	EA			***$10,730.27***	$85,842
Switchgear	0	EA			***$49,359.23***	$0
Adjustable Frequency Drives						
Centrifuges (Active) (50 hp each)	0	EA			***$15,422.17***	$0
Centrifuges (Standby) (50 hp each)	0	EA			***$15,422.17***	$0
Centrifuge Conveyor Belt (3 hp each)	0	EA			***$9,258.95***	$0
Truck Conveyor Belt (3 hp each)	0	EA			***$9,258.95***	$0
Electrical Conduit & Wire	581.00	LF	177.09	m	**$12.06**	$7,006
Allowance for Misc Items	10%				$92,848.41	$9,285
Subtotal						$102,133
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**
Item 1 Description	0.00		0.00		0.00	$0
Item 2 Description	0.00		0.00		0.00	$0
Item 3 Description	0.00		0.00		0.00	$0
Item 4 Description	0.00		0.00		0.00	$0
Item 5 Description	0.00		0.00		0.00	$0
Item 6 Description	0.00		0.00		0.00	$0
Item 7 Description	0.00		0.00		0.00	$0
Item 8 Description	0.00		0.00		0.00	$0
Item 9 Description	0.00		0.00		0.00	$0
Item 10 Description	0.00		0.00		0.00	$0
Item 11 Description	0.00		0.00		0.00	$0
Item 12 Description	0.00		0.00		0.00	$0
Item 13 Description	0.00		0.00		0.00	$0
Item 14 Description	0.00		0.00		0.00	$0
Item 15 Description	0.00		0.00		0.00	$0
Subtotal						$0
Subtotal						$5,763,212
ALLOWANCES:		**User Override**				
Finishes Allowance	2.00%		$6,333,199	$126,664		
I&C Allowance	2.00%		$6,333,199	$126,664		
Mechanical Allowance	3.00%		$6,333,199	$189,996		
Electrical Allowance	2.00%		$6,333,199	$126,664		
					Facility Cost Name	
Facility Cost	**9,093**	**Dry Pounds per Day**	**$696.46**	**$6,333,199**	SCEFC01	
Facility Cost with Standard Additional Project Costs Added	**9,093**	**Dry Pounds per Day**	**$846.32**	**$7,695,914**	SCEFC02	
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**9,093**	**Dry Pounds per Day**	**$1,451.59**	**$13,199,869**	SCEFC03	
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**9,093**	**Dry Pounds per Day**	**$1,194.55**	**$10,862,570**	SCEFC05	
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**9,093**	**Dry Pounds per Day**	**$1,451.59**	**$13,199,869**	SCEFC06	

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Wet Pit Submersible Pump Station

Is This Facility Included in My Project? No

Notes to Designer:

This Model is designed around the ITT Flygt Large Submersible Pump Design Recommendations with a maximum pump cycling of 5 starts per hour

For applications with a discharge pressure over 250 feet, use the Vertical Turbine PS Model. Submersible pumps are used in applications with smaller heads

If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Comment	Red Flags
Is this Facility Included in a Seawater Treatment Train?	No	Y/N					
Input Design Pump Station Inflow	2.04	mgd	10.56	ML/d			
Conversion of Design P.S. Flow from MGD to CFS	3.16	cfs	0.09	m3/s			
Input Average Pump Station Flow	1.92	mgd	6.85	ML/d			
Conversion of Average P.S. Flow from MGD to CFS	2.97	cfs	0.08	m3/s			
Input Maximum Water Temperature	50.00	degrees F	10.00	degrees C			
Calculate Maximum Vapor Pressure	0.40	ft	122.73	mm			
Input Pump Station Site Elevation	750.00	ft	228.60	m			
Calculate Atmospheric Pressure	33.02						
Mechanical Design Inputs:							
Pipe Name	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Standard Pipe Size**
Discharge Lateral Pipe	5.00	fps	1.52	m/s	8.00	in	200.00
Discharge Header Pipe	5.00	fps	1.52	m/s	12.00	in	300.00
Pipe Name	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Diameter**	**Pipe Length**
Discharge Lateral Pipe	DIS	Exposed	Steel	Cement Mortar	Paint	8.00	64.00
Discharge Header Pipe	DIS	Exposed/Buried	Steel	Cement Mortar	Paint	12.00	22.42
Select Type of Pump Isolation Valve	Butterfly Valve	Type					
Select Type of Pump Control Valve	Check Valve	Type					
Calculate Pump Discharge Lateral Pipe Length	16.00	ft	4876.80	mm	DLPL		
Calculate Pump Discharge Lateral Pipe Headloss	0.91	ft	276.36	mm	DLPH	Assumes minor loss K value for Tee, Valve, Control Valve, Elbow, and Reducer	
Is Pump Station Discharge Pressure Known?	Yes	Y/N					
Input Actual Design Discharge Pressure	50.00	ft	15,240.00	mm			
Input Design Discharge WSEL		ft		mm	MaxDL		
Input Length of Pump Station Discharge Header and Pipeline		ft		mm	LPSDP	Confirm with Hydraulic Analysis	
Input Total Friction Coefficient, K for Discharge Header Minor Losses		ft		mm	MPSDF	Friction K values should be obtained from D.S. Miller Internal Flow System.	
Input Hazen Williams Friction Coefficient	130.00	C			HWFC	Consult Conveyance GTL, for appropriate C value	
Calculate Design Discharge Header & Pipeline Dynamic Headloss	0.02	ft	7.43	mm	maxDPDH		
Calculate Total Dynamic Head at Design Flow	50.00	ft	15240.00	mm	maxTDH		
Pump Selection Design Inputs:							
Input Number of Active Pumps	3	#			NAP	Should be 1,2,3,5, or 7 if there is a standby pump	
Include a Standby Pump?	Yes	Y/N					
Pump Efficiency	75.00%					Fixed	
Motor Efficiency	95.00%					Fixed	
AFD Efficiency	95.00%					Fixed	
Safety Margin Allocated in Pump Design Brake Horsepower	1.15					Fixed	
Input Pump Information	**Capacity (MGD)**	**AFD? (Yes or No)**	**Actual Individual Pump Sizing Flow (GPM)**	**Calculated Individual Pump BHP**	**Actual Individual Pump BHP**	**Pump?? ("1"= Yes, "0" = No)**	**Weir Pump Model Number**
Active Pump # 1	0.68	Yes	500	9.628026436	10	1.00	F500_HP10_C3152.181_MT
Active Pump # 2	0.68	Yes	500	9.628026436	10	1.00	F500_HP10_C3152.181_MT
Active Pump # 3	0.68	Yes	500	9.628026436	10	1.00	F500_HP10_C3152.181_MT
Active Pump # 4	0.00	No	0	0	-	0.00	#N/A
Active Pump # 5	0.00	No	0	0	-	0.00	#N/A
Active Pump # 6	0.00	No	0	0	-	0.00	#N/A
Active Pump # 7	0.00	No	0	0	-	0.00	#N/A
Calculate Standby Pump Capacity = Max Pump	0.68	Yes	500	9.628026436	10	1.00	F500_HP10_C3152.181_MT
Calculate Total Active Pump Capacity	2.04	4.00	1500	28.88407931	30	User Override Pump Criteria (Pump 1)	
Calculate Total P.S. Capacity	2.72	mgd	2000	38.51210574	40	User Override Pump Criteria (Pump 2)	
Calculate Total Number of Pumps (Active & Standby)	4.00	#			TNP	should be 2,3,4,6, or 8	
Recommended NPSHR Margin	1.50	#				Fixed - Verify Margin with Pump Manufacturer	
Calculate Minimum Submergence based on NPSHR Margin or HI Standards	0.99	ft	301.73	mm	mSUB	Calculated - Verify with Pump Manufacturer	
Calculate Pump Elevation based on Minimum Submergence Requirements	742.22	ft	226227.52	mm		Calculated	
Wet Well Design Calculations:							
Calculate Number of Wet Wells	1.00	#			NW		
Calculate Number of Pumps per Wet Well	4.00	#			PPW		

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Calculate Conceptual Minimum Wet Well Volume	8,503.98	gal	32.19	m3	MWWV	Vreq=T*2*Q/4; T=12	
Calculate Distance From Wall to Baffles	41.70	in	1059.19	mm	WTB		
Calculate Conceptual Distance From Wall to Pump Center	65.70	in	1668.79	mm	PWFW	Greater than or equal to this value	
Calculate Distance Between Pump Shells	26.67	in	677.52	mm	DBPS		
Calculate Length From Wall to Pump Center	12.85	in	326.42	mm	PLFW	Less than or equal to this value	
Calculate Operational Wet Well Width	9.33	ft	2843.54	mm			
Calculate Operational Wet Well Length	13.87	ft	4228.45	mm	WWL		
Calculate Operational Wet Well Surface Area	129.42	sf	12.02	m2			
Calculate Minimum Operational Wet Well Depth	8.78	ft	2677.28	mm	OWWD		
Input Additional Storage Volume Requirements	**0.00**	gal		m3			
Input Wet Well Freeboard	**2.00**	ft		mm	WWFB	Typically 2 to 3 feet	
Calculate Required Wet Well Width	9.33	ft	2843.54	mm	WWW		
Calculate Total Required Wet Well Depth	14.78	ft	4506.08	mm	WWD		
Calculate Total Wet Well Volume	1,913.35	cf					
Calculate Total Wet Well Volume	14,312.88	gal			WWV		
Calculate Minimum Wet Well Low Operating Level Required	746.22	ft	227446.72	mm			
Calculate Maximum Wet Well High Operating Level Required	755.00	ft	230124.00	mm			
Does Wet Well Have a Liner?	No	Y/N					
Calculate Wet Well Liner Surface Area	0.00	sf	0.00	m2			

Pump Station Design User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Input Lateral Pipe Distance from Wall to Valve	**1.00**	ft	**100.00**	mm	PDWV	Typically 1 foot	
Input Lateral Distance from Valve to Header	**4.00**	ft		mm	VTHD	Minimum 2 feet	
Input Clear Distance Width From Discharge Header to Wall	**6.00**	ft		mm	HTW	Minimum 6 feet	
Input Discharge Pipe Distance from Wet Well Ceiling	**4.00**	ft		mm	PDTC	Typically 4 feet	
Input Discharge Pipe Height From Operating Room Floor	**1.00**	ft		mm	HHTF	Typically 1-2 feet	
Input Clear Distance Length Discharge Header to Wall	**3.00**	ft		mm	CDHW	Typically 3-4 feet	
Calculate Vertical Lateral Pipe Length	8.45	ft			VLPL		
Is the Surge Protection Area Covered?	**No**	Y/N					
Input Cutback Slope	**1.50**	:1				Cutback slope should be 1:1 for depth of burial≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.	
Input Over Excavation Depth	**1.00**	ft	**609.60**	mm			
Electrical User Inputs and Sizing Requirements:							
Is this a "Critical" Facility (requiring standby power)?	**No**	Y/N					
Is there SWGR?	No						

							MCC
Item	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
Active Pump # 1	1.00	10.53	Yes	0.00	4.00	2.00	
Active Pump # 2	1.00	10.53	Yes	0.00	4.00	2.00	
Active Pump # 3	1.00	10.53	Yes	0.00	4.00	2.00	
Active Pump # 4	0.00	0.00	No	0.00	0.00	0.00	
Active Pump # 5	0.00	0.00	No	0.00	0.00	0.00	
Active Pump # 6	0.00	0.00	No	0.00	0.00	0.00	
Active Pump # 7	0.00	0.00	No	0.00	0.00	0.00	
Standby	1.00	10.53	Yes	0.00	4.00	2.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**42.11**		**0.00**	**16.00**	**8.00**	**24.00**

Electrical Equipment Lengths:

Equipment	**Depth (ft)**
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	**Width**	**Length**	**Comment**	
CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet
CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	**3.00**		Clear Distance in front of Equipment	Typcally 3 feet
Contingency Length		**0.00**	Contingency length	Typically Zero

Electric Room Width (ft):

CD1	3.00
MCC	10.00
CD2	1.00

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Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Width	**14.00**				ERL		
Electric Room Length (ft):							
CD6	0.00					If there is no switchgear, this distance will be Zero.	
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Length	**4.67**				ERW		
Stair Dimensions:							
Operating Room Floor Elevation	751.00	ft			OREL		
Hatch Access Elevation	758.00	ft			HAEL		
Total Stair Height	84.00	in			TSH		
Individual Step Height	**7.00**	in		Between 6 and 8 inches	ISTH		
Number of Steps	12.00				NS		
Last Step Height	7.00	in			LSH		
Step Width	**12.00**	in		Typically 12 inches	SW		
Step Length	4.00	ft		Fixed	SL		
Handrail Length	12.00	ft			HRL		
Handrail Height	4.00	ft		Fixed	HRH		
Hatch Access Dimensions:							
Is Hatch Access Area Covered?	**Yes**	Y/N					
Double Door Width	**5.00**	ft		Typically at least 5 feet	DDW		
Clear Distance From Doors to Steps	**2.00**	ft		Between 2 and 4 feet	DTSW		
Landing Platform Width	**6.00**	ft		At least 6 feet	LPW		
Landing Platform Length	**4.00**	ft		Typically 4 feet	LPL		
Total Area Required	261.03	sf					
Hatch Access Area Without Wet Well Ceiling	53.00	ft					
Hatch Length	2.69	ft			HL		
Hatch Width	3.85	ft			HW		
Access Hatch Length	2.00	ft		Fixed	AHL		
Access Hatch Width	1.50	ft		Fixed	AHW		
Influent Pipe and Baffle Dimensions:							
Inlet Pipe Diameter	**24.00**	in			IPD		
Influent Pipe Height From Floor	4.00	ft		measured from top of pipe	IPHF		
Influent Pipe Offset Distance	8.25	in			IPOD		
Baffle Clearance Height	24.55	in			BCH		
Baffle Length	2.00	ft		Fixed	BL		
Baffle Height	4.00	ft		Same as IPHF	BH		
Baffle Thickness	6.00	in		Fixed	BT		
Inlet Slope Width	49.50	in			ISW		
Inlet Slope Height	8.25	in			ISH		
Estimating Dimensions:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Mechanical Fitting Dimensions:							
Discharge Lateral Increaser Length	0.67	ft	203.20	mm	DLIL		
Pump Control Valve Length	2.04	ft	622.30	mm	PCVL		
Discharge Lateral Butterfly Valve Length	0.50	ft	152.40	mm	BFVL		
Discharge Lateral to Header Increaser Length	1.33	ft	406.40	mm	LHIL		
Magmeter Length	1.67	ft	508.00	mm	MML		
Operating Room Area:							
Slab On Grade							
Operating Room Floor Width	15.54	ft	4737.10	mm	ORFW		
Operating Room Floor Length	31.49	ft	9597.99	mm	ORFL		
Concrete Thickness	**12.00**	in	**457.20**	mm		Model based on 24"	
Concrete Thickness	1.00	ft	304.80	mm	ORFST		
Surge Protection Area:							
Slab on Grade							
Overall Surge Area Width	15.54	ft	4737.10	mm	SSOGW		
Overall Surge Area Length	7.87	ft	2399.50	mm	SSOGL		
Concrete Thickness	**12.00**	in	**609.60**	mm		Model based on 24"	
Concrete Thickness	1.00	ft	304.80	mm	SSOGT		
Electrical Room Area:							
Slab on Grade							
Electrical Room Width	16.00	ft	4876.80	mm	ESOGW		
Electrical Room Length	6.67	ft	2032.00	mm	ESOGL		
Concrete Thickness	**12.00**	in	**609.60**	mm		Model based on 24"	
Concrete Thickness	1.00	ft	304.80	mm	ESOGT		
Pump Station Wet Well:							
Floor Slab							
Wet Well Floor Slab Area	208.03	sf	19.33	m2			
Wet Well Floor Slab Thickness	**24.00**	in	**609.60**	mm		Model based on 24"	
Wet Well Floor Slab Thickness	2.00	ft	609.60	mm	WWFST		
Wet Well Walls							
Wet Well Width	9.33	ft	2843.54	mm	WWW		
Wet Well Length	13.87	ft	4228.45	mm	WWL		
Wet Well Depth	14.78	ft	4506.08	mm	WWD		
Wall Thickness	**18.00**	in	**304.80**	mm		Model based on 12"	
Wall Thickness	1.50	ft	457.20	mm	WWWT		
Elevated Ceiling Slab							
Wet Well Ceiling Area	208.03	sf	19.33	m2			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	

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Elevated Slab Thickness	1.00	ft	304.80	mm	WWCT		
Hatch Access Room Area:							
Elevated Floor Slab							
Overall Hatch Access Area	261.03	sf	24.25	m2			
Overall Hatch Access Area New Concrete Required	53.00	sf	4.92	m2			
Concrete Thickness	**12.00**	in	**457.20**	mm			
Concrete Thickness	1.00	ft	304.80	mm	SOGT		
Overall Facility Dimensions:							
Operating Room Slab Length	31.49	ft	9597.99	mm			
Operating Room Slab WIdth	15.54	ft	4737.10	mm			
Operating Room Excavation Length	35.49	ft	10817.19	mm			
Operating Room Excavation Width	19.54	ft	5956.30	mm			
Operating Room Excavation Depth	1.00	ft	304.80	mm			
Wet Well Area	208.03	sf	19.33	m2			
Wet Well Excavation Length	20.87	ft	6362.05	mm			
Wet Well Excavation Width	16.33	ft	4977.14	mm			
Wet Well Excavation Depth	17.78	ft	5420.48	mm			
Surge Protection SOG Area	122.35	sf	11.37	m2			
Surge Protection Excavation Area	232.01	sf	21.55	m2			
Surge Protection Excavation Depth	2.00	ft	609.60	mm			
Electrical Room SOG Area	106.67	sf	9.91	m2			
Electrical Room Excavation Area	213.33	sf	19.82	m2			
Electrical Room Excavation Depth	2.00	ft	609.60	mm			
Hatch Access SOG Area	53.00	sf	4.92	m2			
Hatch Access Excavation Area	58.00	sf	5.39	m2			
Hatch Access Excavation Depth	2.00	ft	609.60	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Operating Room:							
Excavation	32.19	CY	24.61	m3	***$6.72***	$216	
Imported Structural Backfill	51.37	CY	39.28	m3	***$50.94***	$2,617	
Native Backfill	3.06	CY	2.34	m3	***$8.27***	$25	
Haul Excess	29.14	CY	22.28	m3	***$8.27***	$241	
Wet Well:							
Excavation	778.14	CY	594.93	m3	***$6.72***	$5,231	
Imported Structural Backfill	25.25	CY	19.30	m3	***$50.94***	$1,286	
Native Backfill	470.27	CY	359.55	m3	***$8.27***	$3,887	
Haul Excess	307.87	CY	235.38	m3	***$8.27***	$2,545	
Surge Protection:							
Excavation	26.83	CY	20.51	m3	***$6.72***	$180	
Imported Structural Backfill	17.19	CY	13.14	m3	***$50.94***	$875	
Native Backfill	6.77	CY	5.18	m3	***$8.27***	$56	
Haul Excess	20.06	CY	15.34	m3	***$8.27***	$166	
Hatch Access Room:							
Excavation	7.66	CY	5.85	m3	***$6.72***	$51	
Imported Structural Backfill	4.30	CY	3.28	m3	***$50.94***	$219	
Native Backfill	2.54	CY	1.94	m3	***$8.27***	$21	
Haul Excess	5.12	CY	3.91	m3	***$8.27***	$42	
Electrical Room:							
Excavation	24.97	CY	19.09	m3	***$6.72***	$168	
Imported Structural Backfill	15.80	CY	12.08	m3	***$50.94***	$805	
Native Backfill	6.49	CY	4.96	m3	***$8.27***	$54	
Haul Excess	18.48	CY	14.13	m3	***$8.27***	$153	
Allowance for Misc Items	5%				$18,839.13	$942	
Subtotal						$19,781	
CONCRETE:							
Operating Room							
Foundation	22.31	CY	17.06	m3	***$541.11***	$12,071	
Pipe Supports	0.44	CY	0.34	m3	***$490.62***	$218	
Electrical Room							
Foundation	3.95	CY	3.02	m3	***$541.11***	$2,138	
Surge Protection							
Foundation	4.53	CY	3.46	m3	***$541.11***	$2,452	
Pump Station Wet Well							
Floor Slab	15.41	CY	11.78	m3	***$490.62***	$7,560	
Wet Well Walls	43.04	CY	32.91	m3	***$880.79***	$37,910	
Ceiling Slab	7.70	CY	5.89	m3	***$1,333.77***	$10,276	
Pump Baffling	5.32	CY	4.07	m3	***$880.79***	$4,689	
Inlet Slope	0.73	CY	0.56	m3	***$490.62***	$357	
Pipe Support Fitting	3.82	CY	2.92	m3	***$490.62***	$1,872	
Hatch Access Room							
Foundation	1.96	CY	1.50	m3	***$198.37***	$389	
Allowance for Misc Items	5%				$79,933.88	$3,997	
Subtotal						$83,931	
MASONRY:	**Moderate**						
Operating Room	618.58	SF	57.47	m2	***$165.31***	$102,255	
Hatch Access Room	261.03	SF	24.25	m2	***$165.31***	$43,150	
Surge Building	0.00	SF	0.00	m2	***$165.31***	$0	
Electrical Room	106.67	SF	9.91	m2	***$165.31***	$17,633	
Subtotal	986.28					$163,037	
METALS:							
Pump Removal Hatches	44.43	SF	4.13	m2	***$160.25***	$7,120	
Stairs	20.00	Risers			***$495.92***	$9,918	
Access Hatch Ladder	14.78	VLF	4.51	VLM	***$141.02***	$2,085	
Allowance for Misc Items	10%				$19,123.17	$1,912	
Subtotal						$21,035	

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THERMAL & MOISTURE PROTECTION:							
Wet Well Liner	0.00	SF	0.00	m2	**$16.00**	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Pumps							
Active Pump # 1	1.00	EA			***$18,401.07***	$18,401	
Active Pump # 2	1.00	EA			***$18,401.07***	$18,401	
Active Pump # 3	1.00	EA			***$18,401.07***	$18,401	
Active Pump # 4	0.00	EA			***$0.00***	$0	
Active Pump # 5	0.00	EA			***$0.00***	$0	
Active Pump # 6	0.00	EA			***$0.00***	$0	
Active Pump # 7	0.00	EA			***$0.00***	$0	
Standby Pump	1.00	EA			***$18,401.07***	$18,401	
Allowance for Misc Items	10%				$73,604.27	$7,360	
Subtotal						$80,965	
INSTRUMENTATION & CONTROLS:							
Instruments							
Isolation Valve Actuators	5.00	EA			***$6,409.82***	$32,049	
Control Valve Actuators	4.00	EA			***$6,409.82***	$25,639	
Level Indicator Transmitters	2.00	EA			***$10,700.91***	$21,402	
Level Swithces	0.00	EA			***$11,264.12***	$0	
Pressure Indicator Transmitters	1.00	EA			***$11,264.12***	$11,264	
Pressure Switches	4.00	EA			***$11,264.12***	$45,056	
Number of Analog I/O Counts	21.60	EA			***$264.27***	$5,708	
Number of Digital I/O Counts	58.80	EA			***$62.59***	$3,680	
Number of PLC's	1.00	EA			***$13,074.33***	$13,074	
I&C Conduit & Wire	503.83	LF	153.57	m	***$12.06***	$6,076	
Allowance for Misc Items	10%				$163,949	$16,395	
Subtotal						$180,344	
MECHANICAL:							
Pipe:							
Discharge Lateral Pipe (8-inch,DIS, Exposed, Steel, Cement Mortar, Paint)	64.00	LF	19.51	m	***$237.74***	$15,215	
Discharge Header Pipe (12-inch,DIS, Exposed/Buried, Steel, Cement Mortar, Paint)	22.42	LF	6.83	m	***$365.78***	$8,200	
Elbows:							
Pump Discharge (6-inch)	4.00	EA			***$460.10***	$1,840	
Discharge Lateral Pipe (8-inch)	4.00	EA			***$720.42***	$2,882	
Discharge Header Pipe (12-inch)	2.00	EA			***$1,241.06***	$2,482	
Tees:							
Discharge Header Pipe (12-inch)	4.00	EA			***$2,361.54***	$9,446	
Valves:							
Discharge Lateral Isolation Valve (8-inch - Butterfly Valve)	4.00	EA			***$636.35***	$2,545	
Pump Control Valve (8-inch, Check Valve)	4.00	EA			***$4,282.77***	$17,131	
Discharge Header Isolation Valve (12-inch, BFV)	1.00	EA			***$2,170.32***	$2,170	
Air Release Vacuum Valves	1.00	EA			***$1,922.95***	$1,923	
Increasers:							
Pump Discharge to Discharge Lateral (6-inch to 8-inch)	4.00	EA			***$720.42***	$2,882	
Discharge Lateral to Discharge Header (8-inch to 12-inch)	4.00	EA			***$1,241.06***	$4,964	
Allowance for Misc Items	10%				$71,681.55	$7,168	
Subtotal						$78,850	
ELECTRICAL:							
MCC's							
Sections	6.00	EA			***$10,730.27***	$64,382	
AFD's							
Active Pump # 1	10.00	hp	7.46	kW	***$1,017.69***	$10,177	
Active Pump # 2	10.00	hp	7.46	kW	***$1,017.69***	$10,177	
Active Pump # 3	10.00	hp	7.46	kW	***$1,017.69***	$10,177	
Active Pump # 4	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 5	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 6	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 7	0.00	hp	0.00	kW	***$0.00***	$0	
Standby Pump	10.00	hp	7.46	kW	***$1,017.69***	$10,177	
Switchgear							
Units	0.00	EA			***$49,359.23***	$0	
Electrical Conduit & Wire	125.96	LF	38.39	m	***$12.06***	$1,519	
Allowance for Misc Items	5%				$106,608	$5,330	
Subtotal						$111,938	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	

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Subtotal						$739,881	
ALLOWANCES:		**User Override**					
Finishes Allowance	5.00%		$948,566	$47,428			
I&C Allowance	2.00%		$948,566	$18,971			
Surge Allowance	5.00%		$948,566	$47,428			
Mechanical Allowance	5.00%		$948,566	$47,428			
Electrical Allowance	5.00%		$948,566	$47,428			
Facility Cost	**40**	**Total Pump HP**	**$23,714.15**	**$948,566**			
Facility Cost with Standard Additional Project Costs Added	**40**	**Total Pump HP**	**$28,816.72**	**$1,152,669**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**40**	**Total Pump HP**	**$49,425.84**	**$1,977,034**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Adde (excluding ALL Additional Project Costs)	**40**	**Total Pump HP**	**$40,674.01**	**$1,626,960**			
Facility Cost with Standard Additional Project Costs, Contractor Markups and Location Adjustment Factor Added	**40**	**Total Pump HP**	**$49,425.84**	**$1,977,034**			

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CH2M Parametric Engineering System (CPES)

FACILITIES LIFE CYCLE COST ANALYSIS MODULE

File Version: 9/21/2017

Linked to CPES Facilities File: C:\Users\lodell\Documents\CPES_Configurable\CPES Facilities PWB 160.xlsm

Project Name:	***PWB Filtration Decision***	***Life Cycle Analysis:***	
Project Number:	***699275***	***i =***	***5.00%***
Project Manager:	***Kelly Irving***	***n =***	***25 years***
Estimator:	***Enoch Nicholson/Lee Odell***	***Annual Inflation:***	***3.00%***
Project Description:	***PWB Granular Media Filtration***		
Project Location (City):	***Portland OR***		
Project Location (State):	***OREGON***		
Project Location (Country):	***USA***		
Cost Basis (Month/Year):	***April/2018***		

Item	***Include? (Yes or No)***	***SCOPE OF PROJECT***	***Construction Cost***	***Annual O&M Cost (Year 1)***	***Life Cycle Cost (NPV)***
	Yes	**Flocculation: RapMix**	**$2,488,000**	**$182,000**	**$5,949,000**
	Yes	**Flocculation: Floc**	**$12,038,000**	**$124,000**	**$14,387,000**
	Yes	**DAF: DAF**	**$85,220,000**	**$2,873,000**	**$140,033,000**
	No	**Ozone Serpentine: Ozone**	**$0**	**$0**	**$0**
	Yes	**Filters: Filt**	**$55,945,000**	**$558,000**	**$66,584,000**
	Yes	**Concrete Clearwell: Clearwell**	**$36,021,000**	**$16,000**	**$36,311,000**
	Yes	**Liquid Chemical: Alum**	**$2,181,000**	**$681,000**	**$15,175,000**
	Yes	**Liquid Chemical: FAP**	**$497,000**	**$89,000**	**$2,184,000**
	Yes	**Liquid Chemical: CAP**	**$1,153,000**	**$641,000**	**$13,372,000**
	No	**Liquid Chemical: Hypo**	**$0**	**$0**	**$0**
	Yes	**On-Site Sodium Hypo: OSHG**	**$8,718,000**	**$642,000**	**$20,967,000**
	Yes	**Liquid Chemical: Caustic**	**$1,727,000**	**$2,902,000**	**$57,112,000**
	Yes	**Surge Basin-Decanter: BWSurge**	**$6,640,000**	**$154,000**	**$9,572,000**
	Yes	**Gravity Thickener: BWClar**	**$13,737,000**	**$27,000**	**$14,245,000**
	Yes	**Gravity Thickener: GravThick**	**$2,267,000**	**$27,000**	**$2,765,000**
	Yes	**WTP Centrifuge: Centrifuge**	**$10,087,000**	**$763,000**	**$24,636,000**
	No	**WPSPS: RecPS**	**$0**	**$0**	**$0**
	Yes	**Filter BW PS: BWPS**	**$4,325,000**	**$78,000**	**$5,802,000**
		Additional Project Costs:			
		Biosolids Disposal	**$0**	**$0**	**$0**
		Standard Items	**$52,319,000**	**$1,787,000**	**$86,416,000**
		User Defined Items	**$0**	**$0**	**$0**
		Plant O&M Labor		**$972,000**	**$18,532,000**
TOTAL - Life Cycle Analysis *(Red Flag Items and Market Adjustment Factor are EXCLUDED)*			**$295,363,000**	**$12,516,000**	**$534,042,000**
Construction Cost per GPD (based on Maximum Daily Flow Rate)			**$2.57 / GPD**		
Annual O&M Cost per 1,000 Gallons (based on Average Annual Daily Flow Rate)				**$ 0.457 / Thousand Gallons**	

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C H2M P arametric E ngineering S ystem (CPES)

WTP LIFE CYCLE COST ANALYSIS
Summary of Annual O&M Costs (Year 1)

Project Name:	PWB Filtration Decision	Life Cycle Analysis:	
Project Number:	699275	i =	5.00%
Project Manager:	Kelly Irving	n =	25 years
Estimator:	Enoch Nicholson/Lee Odell	Annual Inflation:	3.00%
Project Description:	PWB Granular Media Filtration		
Project Location (City):	Portland OR		
Project Location (State):	OREGON		
Project Location (Country):	USA		
Cost Basis (Month/Year):	April/2018		

Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Labor	Equipment Power	Building Electrical	Chemicals	Sludge Disposal	Specialty Items	Repair & Maintenance	Replacement	Other	User Defined	Total
5	Yes	Flocculation	$0	$94,877	$173	$0	$0	$0	$51,660	$0	$29,342	$0	$176,052
5	Yes	Flocculation	$0	$11,431	$14,521	$0	$0	$0	$73,651	$0	$19,921	$0	$119,524
11	Yes	DAF	$0	$390,941	$0	$0	$0	$0	$1,932,702	$0	$464,728	$0	$2,788,371
16	No	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
12	Yes	Conventional/GAC Filter	$0	$0	$1,072	$0	$0	$0	$449,956	$0	$90,206	$0	$541,234
22	Yes	Concrete Tank 1	$0	$0	$0	$0	$0	$0	$12,280	$0	$2,456	$0	$14,736
24	Yes	Liquid Chemical	$0	$2,858	$3,763	$529,642	$0	$0	$14,599	$0	$110,172	$0	$661,034
24	Yes	Liquid Chemical	$0	$857	$960	$67,602	$0	$0	$2,084	$0	$14,301	$0	$85,805
24	Yes	Liquid Chemical	$0	$2,000	$2,386	$507,018	$0	$0	$6,582	$0	$103,597	$0	$621,584
24	No	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
20	Yes	On-Site Sodium Hypochlorite Generation	$0	$233,193	$3,676	$87,458	$0	$0	$194,917	$0	$103,849	$0	$623,092
24	Yes	Liquid Chemical	$0	$572	$3,058	$2,331,407	$0	$0	$12,858	$0	$469,579	$0	$2,817,474
27	Yes	Combination Wastewater Surge Basin & Floating Tube Decanter Clarification (Large System >= 5MGD)	$0	$21,433	$95	$0	$0	$0	$102,794	$0	$24,864	$0	$149,187
30	Yes	Gravity Thickener	$0	$2,858	$1,027	$0	$0	$0	$17,639	$0	$4,305	$0	$25,829
30	Yes	Gravity Thickener	$0	$857	$1,008	$0	$0	$0	$19,230	$0	$4,219	$0	$25,315
31	Yes	Centrifuge Solids Dewatering	$0	$8,859	$12,198	$46,039	$361,780	$0	$187,893	$0	$123,354	$0	$740,122
4	No	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
44	Yes	Granular Media Filter Backwash Supply Pump Station	$0	$14,860	$2,101	$0	$0	$0	$45,663	$0	$12,525	$0	$75,149
		Totals	$0	$785,596	$46,039	$3,569,166	$361,780	$0	$3,124,507	$0	$1,577,418	$0	$9,464,507
		Additional Project Costs:											
		Biosolids Disposal					$0					$0	$0
		Standard Items							$1,445,433	$0	$289,087	$0	$1,734,520
		User Defined Items		$0	$0	$0		$0	$0	$0	$0	$0	$0
		Plant O&M Labor	$942,720										$942,720
		TOTAL - O&M Cost	$942,720	$785,596	$46,039	$3,569,166	$361,780	$0	$4,569,940	$0	$1,866,504	$0	$12,141,747
		Percent of TOTAL Cost	7.8%	6.5%	0.4%	29.4%	3.0%	0.0%	37.6%	0.0%	15.4%	0.0%	100.0%

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Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Labor	Equipment Power	Building Electrical	Chemicals	Sludge Disposal	Specialty Items	Repair & Maintenance	Replacement	Other	User Defined	Total

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Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Labor	Equipment Power	Building Electrical	Chemicals	Sludge Disposal	Specialty Items	Repair & Maintenance	Replacement	Other	User Defined	Total

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Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)

Construction Cost:	**$2,487,894**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	332	65%	8,760	$ 0.06	$ 79,065	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	147	2.00	8,760	$ 0.06	$ 144	

Chemicals:	$ -

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		$ 43,050
Replacement Cost	-	$ -

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 122,258	20.0%	$ 24,452	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	$ -
Item 2	$ -
Item 3	$ -
Item 4	$ -
Item 5	$ -
Item 6	$ -
Item 7	$ -
Item 8	$ -
Item 9	$ -
Item 10	$ -
Item 11	$ -
Item 12	$ -
Item 13	$ -
Item 14	$ -
Item 15	$ -

Subtotal Annual O&M Cost		$ 146,710
Contingency	20%	$ 29,342
Total Annual O&M Cost		$ 176,052

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	**Default Cost**	**User Over-Ride**	**Cost Used in NPV Calculation**	**Adjusted Annual O&M Cost**
0	**$2,487,894**		**$2,487,894**	
1	**$181,333**		**$181,333**	
2	**$186,773**		**$186,773**	
3	**$192,377**		**$192,377**	
4	**$198,148**		**$198,148**	
5	**$204,092**		**$204,092**	
6	**$210,215**		**$210,215**	
7	**$216,522**		**$216,522**	

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8	$223,017		$223,017				
9	$229,708		$229,708				
10	$236,599		$236,599				
11	$243,697		$243,697				
12	$251,008		$251,008				
13	$258,538		$258,538				
14	$266,294		$266,294				
15	$274,283		$274,283				
16	$282,512		$282,512				
17	$290,987		$290,987				
18	$299,717		$299,717				
19	$308,708		$308,708				
20	$317,969		$317,969				
21	$327,508		$327,508				
22	$337,334		$337,334				
23	$347,454		$347,454				
24	$357,877		$357,877				
25	$368,613		$368,613				
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
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39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
NPV			$5,948,657	$181,333			

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Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)

Construction Cost:	**$12,037,127**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	40	65%	8,760	$ 0.06	**$ 9,526**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	12,356	2.00	8,760	$ 0.06	**$ 12,101**	

Chemicals:	
	$ -

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 61,376**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 83,002	20.0%	**$ 16,600**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 99,603**
Contingency	**20%**	**$ 19,921**
Total Annual O&M Cost		**$ 119,524**

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	**Default Cost**	**User Over-Ride**	**Cost Used in NPV Calculation**	**Adjusted Annual O&M Cost**
0	**$12,037,127**		**$12,037,127**	
1	**$123,109**		**$123,109**	
2	**$126,802**		**$126,802**	
3	**$130,607**		**$130,607**	
4	**$134,525**		**$134,525**	
5	**$138,561**		**$138,561**	
6	**$142,717**		**$142,717**	
7	**$146,999**		**$146,999**	

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8	$151,409		$151,409				
9	$155,951		$155,951				
10	$160,630		$160,630				
11	$165,448		$165,448				
12	$170,412		$170,412				
13	$175,524		$175,524				
14	$180,790		$180,790				
15	$186,214		$186,214				
16	$191,800		$191,800				
17	$197,554		$197,554				
18	$203,481		$203,481				
19	$209,585		$209,585				
20	$215,873		$215,873				
21	$222,349		$222,349				
22	$229,019		$229,019				
23	$235,890		$235,890				
24	$242,967		$242,967				
25	$250,256		$250,256				
26							
27							
28							
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NPV			$14,386,676	$123,109			

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DAF

Construction Cost:						$85,219,929	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		1,368	65%	8,760	$ 0.06	$ 325,784	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		-	2.00	8,760	$ 0.06	$ -	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 1,610,585	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 1,936,369	20.0%	$ 387,274	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 2,323,642	
Contingency					20%	$ 464,728	
Total Annual O&M Cost						$ 2,788,371	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$85,219,929		$85,219,929	
1	$2,872,022		$2,872,022	
2	$2,958,182		$2,958,182	
3	$3,046,928		$3,046,928	
4	$3,138,336		$3,138,336	
5	$3,232,486		$3,232,486	
6	$3,329,460		$3,329,460	
7	$3,429,344		$3,429,344	

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8	$3,532,225		$3,532,225				
9	$3,638,191		$3,638,191				
10	$3,747,337		$3,747,337				
11	$3,859,757		$3,859,757				
12	$3,975,550		$3,975,550				
13	$4,094,816		$4,094,816				
14	$4,217,661		$4,217,661				
15	$4,344,191		$4,344,191				
16	$4,474,516		$4,474,516				
17	$4,608,752		$4,608,752				
18	$4,747,014		$4,747,014				
19	$4,889,425		$4,889,425				
20	$5,036,108		$5,036,108				
21	$5,187,191		$5,187,191				
22	$5,342,806		$5,342,806				
23	$5,503,091		$5,503,091				
24	$5,668,183		$5,668,183				
25	$5,838,229		$5,838,229				
26							
27							
28							
29							
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NPV			$140,032,690	$2,872,022			

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Ozone - Serpentine

Construction Cost:						**$41,393,057**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		1,382	65%	8,760	$ 0.06	**$ 329,118**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		4,880	2.00	8,760	$ 0.06	**$ 4,779**	
Liquid Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**	
Liquid Oxygen		100%	65%	7,311	$ 126.22	**$ 601,798**	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 847,437**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 1,783,132	20.0%	**$ 356,626**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 2,139,758**	
Contingency					**20%**	**$ 427,952**	
Total Annual O&M Cost						**$ 2,567,710**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$41,393,057		$41,393,057	
1	$2,644,741		$2,644,741	

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2	$2,724,083		$2,724,083				
3	$2,805,806		$2,805,806				
4	$2,889,980		$2,889,980				
5	$2,976,679		$2,976,679				
6	$3,065,979		$3,065,979				
7	$3,157,959		$3,157,959				
8	$3,252,698		$3,252,698				
9	$3,350,279		$3,350,279				
10	$3,450,787		$3,450,787				
11	$3,554,311		$3,554,311				
12	$3,660,940		$3,660,940				
13	$3,770,768		$3,770,768				
14	$3,883,891		$3,883,891				
15	$4,000,408		$4,000,408				
16	$4,120,420		$4,120,420				
17	$4,244,033		$4,244,033				
18	$4,371,354		$4,371,354				
19	$4,502,494		$4,502,494				
20	$4,637,569		$4,637,569				
21	$4,776,696		$4,776,696				
22	$4,919,997		$4,919,997				
23	$5,067,597		$5,067,597				
24	$5,219,625		$5,219,625				
25	$5,376,214		$5,376,214				
26							
27							
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NPV			$91,868,144	$2,644,741			

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Filters

Construction Cost:						**$55,944,199**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		-	65%	8,760	$ 0.06	$ -	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		912	2.00	8,760	$ 0.06	$ 893	
Chemicals:			**Annual Usage (tons)**	**Annual Facility Usage (% of year)**	**$/ton**	**Chemical Cost**	
GAC			-	100%	$ 3,251.28	$ -	
Total Chemical Cost						$ -	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						$ 374,964	
Replacement Cost					-	$ -	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 375,857	20.0%	$ 75,171	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 451,028	
Contingency					20%	$ 90,206	
Total Annual O&M Cost						$ 541,234	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$55,944,199		$55,944,199	
1	$557,471		$557,471	
2	$574,195		$574,195	
3	$591,421		$591,421	
4	$609,164		$609,164	
5	$627,438		$627,438	
6	$646,262		$646,262	
7	$665,649		$665,649	

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8	$685,619		$685,619				
9	$706,187		$706,187				
10	$727,373		$727,373				
11	$749,194		$749,194				
12	$771,670		$771,670				
13	$794,820		$794,820				
14	$818,665		$818,665				
15	$843,225		$843,225				
16	$868,522		$868,522				
17	$894,577		$894,577				
18	$921,415		$921,415				
19	$949,057		$949,057				
20	$977,529		$977,529				
21	$1,006,855		$1,006,855				
22	$1,037,060		$1,037,060				
23	$1,068,172		$1,068,172				
24	$1,100,217		$1,100,217				
25	$1,133,224		$1,133,224				
26							
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NPV			$66,583,576	$557,471			

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Concrete Tank

Construction Cost:	**$36,020,856**

Annual O&M Cost:

Power:	Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power	-	65%	8,760	$ 0.06	$ -	

Other Electrical:	Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical	-	2.00	8,760	$ 0.06	$ -	

Chemicals:	$ -

Repair and Maintenance, and Replacement:	Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost
Maintenance & Repair Cost		$ 10,233
Replacement Cost	-	$ -

Other:	Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost	$ 10,233	20.0%	$ 2,047	

User Defined Annual O&M Items:	Annual Cost
Item 1	$ -
Item 2	$ -
Item 3	$ -
Item 4	$ -
Item 5	$ -
Item 6	$ -
Item 7	$ -
Item 8	$ -
Item 9	$ -
Item 10	$ -
Item 11	$ -
Item 12	$ -
Item 13	$ -
Item 14	$ -
Item 15	$ -

Subtotal Annual O&M Cost		$ 12,280
Contingency	20%	$ 2,456
Total Annual O&M Cost		$ 14,736

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$36,020,856		$36,020,856	
1	$15,178		$15,178	
2	$15,633		$15,633	
3	$16,102		$16,102	
4	$16,585		$16,585	
5	$17,083		$17,083	
6	$17,595		$17,595	
7	$18,123		$18,123	
8	$18,667		$18,667	
9	$19,227		$19,227	
10	$19,803		$19,803	
11	$20,397		$20,397	

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12	$21,009		$21,009				
13	$21,640		$21,640				
14	$22,289		$22,289				
15	$22,958		$22,958				
16	$23,646		$23,646				
17	$24,356		$24,356				
18	$25,086		$25,086				
19	$25,839		$25,839				
20	$26,614		$26,614				
21	$27,412		$27,412				
22	$28,235		$28,235				
23	$29,082		$29,082				
24	$29,954		$29,954				
25	$30,853		$30,853				
26							
27							
28							
29							
30							
31							
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NPV			$36,310,522	$15,178			

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Liquid Chemical Storage & Feed

Construction Cost:						**$2,180,047**
Annual O&M Cost:						
Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	10	65%	8,760	$ 0.06	**$ 2,381**	
Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	3,202	2.00	8,760	$ 0.06	**$ 3,136**	
Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**	
Aluminum Sulfate (Alum)	100%	65%	1,218	$ 555.44	$ 441,368	
Aqueous Ammonia	100%	65%	-	$ 1,208.65	$ -	
Citric Acid	100%	65%	-	$ 3,204.91	$ -	
Ferric Chloride	100%	65%	-	$ 1,003.69	$ -	
Hydrofluorosilicic Acid	100%	65%	-	$ 500.72	$ -	
Hyrogen Peroxide (35%)	100%	65%	-	$ 2,223.22	$ -	
Liquid Polymer	100%	65%	-	$ 3,544.77	$ -	
Sodium Bisulfite	100%	65%	-	$ 1,336.98	$ -	
Sodium Hydroxide (25%)	100%	65%	-	$ 1,043.24	$ -	
Sodium Hydroxide (50%)	100%	65%	-	$ 1,222.48	$ -	
Sodium Hypochlorite (12.5%)	100%	65%	-	$ 2,205.88	$ -	
Sulfuric Acid	100%	65%	-	$ 379.51	$ -	
Other Chemical	100%	65%	-	$ -	$ -	
Total Chemical Cost					**$ 441,368**	
Repair and Maintenance, and Replacement:				**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost					**$ 12,166**	
Replacement Cost				-	**$ -**	
Other:			**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost			$ 459,052	20.0%	**$ 91,810**	
User Defined Annual O&M Items:					**Annual Cost**	
Item 1					**$ -**	
Item 2					**$ -**	
Item 3					**$ -**	
Item 4					**$ -**	
Item 5					**$ -**	
Item 6					**$ -**	
Item 7					**$ -**	
Item 8					**$ -**	
Item 9					**$ -**	
Item 10					**$ -**	
Item 11					**$ -**	
Item 12					**$ -**	
Item 13					**$ -**	
Item 14					**$ -**	
Item 15					**$ -**	
Subtotal Annual O&M Cost					**$ 550,862**	
Contingency				**20%**	**$ 110,172**	
Total Annual O&M Cost					**$ 661,034**	
Net Present Value (NPV) Calculation:						
i =	5.00%					

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$2,180,047		$2,180,047				
1	$680,865		$680,865				
2	$701,291		$701,291				
3	$722,330		$722,330				
4	$744,000		$744,000				
5	$766,320		$766,320				
6	$789,310		$789,310				
7	$812,989		$812,989				
8	$837,379		$837,379				
9	$862,500		$862,500				
10	$888,375		$888,375				
11	$915,026		$915,026				
12	$942,477		$942,477				
13	$970,751		$970,751				
14	$999,874		$999,874				
15	$1,029,870		$1,029,870				
16	$1,060,766		$1,060,766				
17	$1,092,589		$1,092,589				
18	$1,125,367		$1,125,367				
19	$1,159,128		$1,159,128				
20	$1,193,902		$1,193,902				
21	$1,229,719		$1,229,719				
22	$1,266,610		$1,266,610				
23	$1,304,609		$1,304,609				
24	$1,343,747		$1,343,747				
25	$1,384,059		$1,384,059				
26							
27							
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NPV			$15,174,418	$680,865			

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Liquid Chemical Storage & Feed

Construction Cost:	**$496,403**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	3	65%	8,760	$ 0.06	**$ 714**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	817	2.00	8,760	$ 0.06	**$ 800**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	65%	-	$ 555.44	$ -
Aqueous Ammonia	100%	65%	-	$ 1,208.65	$ -
Citric Acid	100%	65%	-	$ 3,204.91	$ -
Ferric Chloride	100%	65%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	65%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	65%	-	$ 2,223.22	$ -
Liquid Polymer	100%	65%	24	$ 3,544.77	$ 56,335
Sodium Bisulfite	100%	65%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	65%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	65%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	65%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	65%	-	$ 379.51	$ -
Other Chemical	100%	65%	-	$ -	$ -
Total Chemical Cost					**$ 56,335**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 1,737**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 59,587	20.0%	**$ 11,917**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 71,504**
Contingency	**20%**	**$ 14,301**
Total Annual O&M Cost		**$ 85,805**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$496,403		$496,403				
1	$88,379		$88,379				
2	$91,030		$91,030				
3	$93,761		$93,761				
4	$96,574		$96,574				
5	$99,471		$99,471				
6	$102,456		$102,456				
7	$105,529		$105,529				
8	$108,695		$108,695				
9	$111,956		$111,956				
10	$115,315		$115,315				
11	$118,774		$118,774				
12	$122,337		$122,337				
13	$126,007		$126,007				
14	$129,788		$129,788				
15	$133,681		$133,681				
16	$137,692		$137,692				
17	$141,822		$141,822				
18	$146,077		$146,077				
19	$150,459		$150,459				
20	$154,973		$154,973				
21	$159,622		$159,622				
22	$164,411		$164,411				
23	$169,343		$169,343				
24	$174,424		$174,424				
25	$179,656		$179,656				
26							
27							
28							
29							
30							
31							
32							
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47							
48							
49							
50							
NPV			$2,183,125	$88,379			

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Liquid Chemical Storage & Feed

Construction Cost:	**$1,152,293**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	7	65%	8,760	$ 0.06	**$ 1,667**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	2,030	2.00	8,760	$ 0.06	**$ 1,988**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	65%	-	$ 555.44	$ -
Aqueous Ammonia	100%	65%	-	$ 1,208.65	$ -
Citric Acid	100%	65%	-	$ 3,204.91	$ -
Ferric Chloride	100%	65%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	65%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	65%	-	$ 2,223.22	$ -
Liquid Polymer	100%	65%	183	$ 3,544.77	$ 422,515
Sodium Bisulfite	100%	65%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	65%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	65%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	65%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	65%	-	$ 379.51	$ -
Other Chemical	100%	65%	-	$ -	$ -
Total Chemical Cost					**$ 422,515**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 5,485**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 431,656	20.0%	**$ 86,331**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 517,987**
Contingency	**20%**	**$ 103,597**
Total Annual O&M Cost		**$ 621,584**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$1,152,293		$1,152,293				
1	$640,232		$640,232				
2	$659,439		$659,439				
3	$679,222		$679,222				
4	$699,598		$699,598				
5	$720,586		$720,586				
6	$742,204		$742,204				
7	$764,470		$764,470				
8	$787,404		$787,404				
9	$811,026		$811,026				
10	$835,357		$835,357				
11	$860,418		$860,418				
12	$886,230		$886,230				
13	$912,817		$912,817				
14	$940,202		$940,202				
15	$968,408		$968,408				
16	$997,460		$997,460				
17	$1,027,384		$1,027,384				
18	$1,058,205		$1,058,205				
19	$1,089,952		$1,089,952				
20	$1,122,650		$1,122,650				
21	$1,156,330		$1,156,330				
22	$1,191,020		$1,191,020				
23	$1,226,750		$1,226,750				
24	$1,263,553		$1,263,553				
25	$1,301,459		$1,301,459				
26							
27							
28							
29							
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NPV			$13,371,166	$640,232			

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Liquid Chemical Storage & Feed

Construction Cost:	**$2,192,435**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	10	65%	8,760	$ 0.06	**$ 2,381**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	3,080	2.00	8,760	$ 0.06	**$ 3,016**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	65%	-	$ 555.44	$ -
Aqueous Ammonia	100%	65%	-	$ 1,208.65	$ -
Citric Acid	100%	65%	-	$ 3,204.91	$ -
Ferric Chloride	100%	65%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	65%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	65%	-	$ 2,223.22	$ -
Liquid Polymer	100%	65%	-	$ 3,544.77	$ -
Sodium Bisulfite	100%	65%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	65%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	65%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	65%	731	$ 2,205.88	$ 1,051,714
Sulfuric Acid	100%	65%	-	$ 379.51	$ -
Other Chemical	100%	65%	-	$ -	$ -
Total Chemical Cost					**$ 1,051,714**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 20,297**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 1,077,409	20.0%	**$ 215,482**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 1,292,890**
Contingency	**20%**	**$ 258,578**
Total Annual O&M Cost		**$ 1,551,469**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$2,192,435		$2,192,435				
1	$1,598,013		$1,598,013				
2	$1,645,953		$1,645,953				
3	$1,695,332		$1,695,332				
4	$1,746,191		$1,746,191				
5	$1,798,577		$1,798,577				
6	$1,852,535		$1,852,535				
7	$1,908,111		$1,908,111				
8	$1,965,354		$1,965,354				
9	$2,024,315		$2,024,315				
10	$2,085,044		$2,085,044				
11	$2,147,595		$2,147,595				
12	$2,212,023		$2,212,023				
13	$2,278,384		$2,278,384				
14	$2,346,735		$2,346,735				
15	$2,417,137		$2,417,137				
16	$2,489,652		$2,489,652				
17	$2,564,341		$2,564,341				
18	$2,641,271		$2,641,271				
19	$2,720,509		$2,720,509				
20	$2,802,125		$2,802,125				
21	$2,886,188		$2,886,188				
22	$2,972,774		$2,972,774				
23	$3,061,957		$3,061,957				
24	$3,153,816		$3,153,816				
25	$3,248,431		$3,248,431				
26							
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NPV			$32,690,631	$1,598,013			

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Sodium Hypochlorite

Construction Cost:						**$8,717,518**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		816	65%	8,760	$ 0.06	**$ 194,327**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		3,128	2.00	8,760	$ 0.06	**$ 3,063**	
Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (tons)**	**Cost ($/ton)**	**Chemical Cost**	
Salt		100%	65%	731	$ 152.86	$ 72,881	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 162,430**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 432,702	20.0%	**$ 86,540**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 519,243**	
Contingency					**20%**	**$ 103,849**	
Total Annual O&M Cost						**$ 623,092**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$8,717,518		$8,717,518	
1	$641,784		$641,784	
2	$661,038		$661,038	
3	$680,869		$680,869	
4	$701,295		$701,295	
5	$722,334		$722,334	
6	$744,004		$744,004	

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7	$766,324		$766,324				
8	$789,314		$789,314				
9	$812,993		$812,993				
10	$837,383		$837,383				
11	$862,504		$862,504				
12	$888,380		$888,380				
13	$915,031		$915,031				
14	$942,482		$942,482				
15	$970,756		$970,756				
16	$999,879		$999,879				
17	$1,029,875		$1,029,875				
18	$1,060,772		$1,060,772				
19	$1,092,595		$1,092,595				
20	$1,125,373		$1,125,373				
21	$1,159,134		$1,159,134				
22	$1,193,908		$1,193,908				
23	$1,229,725		$1,229,725				
24	$1,266,617		$1,266,617				
25	$1,304,615		$1,304,615				
26							
27							
28							
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NPV			$20,966,022	$641,784			

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Liquid Chemical Storage & Feed

Construction Cost:	**$1,726,982**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	2	65%	8,760	$ 0.06	**$ 476**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	2,602	2.00	8,760	$ 0.06	**$ 2,548**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	65%	-	$ 555.44	$ -
Aqueous Ammonia	100%	65%	-	$ 1,208.65	$ -
Citric Acid	100%	65%	-	$ 3,204.91	$ -
Ferric Chloride	100%	65%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	65%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	65%	-	$ 2,223.22	$ -
Liquid Polymer	100%	65%	-	$ 3,544.77	$ -
Sodium Bisulfite	100%	65%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	65%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	65%	2,437	$ 1,222.48	$ 1,942,839
Sodium Hypochlorite (12.5%)	100%	65%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	65%	-	$ 379.51	$ -
Other Chemical	100%	65%	-	$ -	$ -
Total Chemical Cost					**$ 1,942,839**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 10,715**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 1,956,579	20.0%	**$ 391,316**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 2,347,895**
Contingency	**20%**	**$ 469,579**
Total Annual O&M Cost		**$ 2,817,474**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$1,726,982		$1,726,982				
1	$2,901,998		$2,901,998				
2	$2,989,058		$2,989,058				
3	$3,078,730		$3,078,730				
4	$3,171,092		$3,171,092				
5	$3,266,225		$3,266,225				
6	$3,364,212		$3,364,212				
7	$3,465,138		$3,465,138				
8	$3,569,092		$3,569,092				
9	$3,676,165		$3,676,165				
10	$3,786,450		$3,786,450				
11	$3,900,043		$3,900,043				
12	$4,017,044		$4,017,044				
13	$4,137,556		$4,137,556				
14	$4,261,683		$4,261,683				
15	$4,389,533		$4,389,533				
16	$4,521,219		$4,521,219				
17	$4,656,856		$4,656,856				
18	$4,796,561		$4,796,561				
19	$4,940,458		$4,940,458				
20	$5,088,672		$5,088,672				
21	$5,241,332		$5,241,332				
22	$5,398,572		$5,398,572				
23	$5,560,529		$5,560,529				
24	$5,727,345		$5,727,345				
25	$5,899,165		$5,899,165				
26							
27							
28							
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NPV			$57,111,850	$2,901,998			

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Large System Combination Wastewater Surge Basin and Floating Tube Decanter Clarification (>= 5 MGD)

Construction Cost:						**$6,639,209**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		75	65%	8,760	$ 0.06	**$ 17,861**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		81	2.00	8,760	$ 0.06	**$ 79**	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 85,662**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 103,602	20.0%	**$ 20,720**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 124,322**	
Contingency					**20%**	**$ 24,864**	
Total Annual O&M Cost						**$ 149,187**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$6,639,209		$6,639,209	
1	$153,662		$153,662	
2	$158,272		$158,272	
3	$163,020		$163,020	
4	$167,911		$167,911	
5	$172,948		$172,948	
6	$178,137		$178,137	
7	$183,481		$183,481	
8	$188,985		$188,985	
9	$194,655		$194,655	
10	$200,495		$200,495	
11	$206,509		$206,509	
12	$212,705		$212,705	

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13	$219,086		$219,086				
14	$225,658		$225,658				
15	$232,428		$232,428				
16	$239,401		$239,401				
17	$246,583		$246,583				
18	$253,981		$253,981				
19	$261,600		$261,600				
20	$269,448		$269,448				
21	$277,531		$277,531				
22	$285,857		$285,857				
23	$294,433		$294,433				
24	$303,266		$303,266				
25	$312,364		$312,364				
26							
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50							
NPV			$9,571,869.05	$153,662			

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Gravity Thickener

Construction Cost:						$13,736,792	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		10	65%	8,760	$ 0.06	$ 2,381	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		874	2.00	8,760	$ 0.06	$ 856	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 14,699	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 17,937	20.0%	$ 3,587	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 21,524	
Contingency					20%	$ 4,305	
Total Annual O&M Cost						$ 25,829	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$13,736,792		$13,736,792	
1	$26,604		$26,604	
2	$27,402		$27,402	
3	$28,224		$28,224	
4	$29,071		$29,071	
5	$29,943		$29,943	
6	$30,841		$30,841	
7	$31,766		$31,766	

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8	$32,719		$32,719				
9	$33,701		$33,701				
10	$34,712		$34,712				
11	$35,753		$35,753				
12	$36,826		$36,826				
13	$37,931		$37,931				
14	$39,069		$39,069				
15	$40,241		$40,241				
16	$41,448		$41,448				
17	$42,691		$42,691				
18	$43,972		$43,972				
19	$45,291		$45,291				
20	$46,650		$46,650				
21	$48,049		$48,049				
22	$49,491		$49,491				
23	$50,976		$50,976				
24	$52,505		$52,505				
25	$54,080		$54,080				
26							
27							
28							
29							
30							
31							
32							
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NPV			$14,244,527	$26,604			

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Gravity Thickener

Construction Cost:						$2,266,389	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		3	65%	8,760	$ 0.06	$ 714	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		858	2.00	8,760	$ 0.06	$ 840	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 16,025	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 17,580	20.0%	$ 3,516	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 21,096	
Contingency					20%	$ 4,219	
Total Annual O&M Cost						$ 25,315	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$2,266,389		$2,266,389	
1	$26,075		$26,075	
2	$26,857		$26,857	
3	$27,663		$27,663	
4	$28,492		$28,492	
5	$29,347		$29,347	
6	$30,228		$30,228	
7	$31,134		$31,134	

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8	$32,069		$32,069				
9	$33,031		$33,031				
10	$34,021		$34,021				
11	$35,042		$35,042				
12	$36,093		$36,093				
13	$37,176		$37,176				
14	$38,291		$38,291				
15	$39,440		$39,440				
16	$40,623		$40,623				
17	$41,842		$41,842				
18	$43,097		$43,097				
19	$44,390		$44,390				
20	$45,722		$45,722				
21	$47,094		$47,094				
22	$48,506		$48,506				
23	$49,962		$49,962				
24	$51,461		$51,461				
25	$53,004		$53,004				
26							
27							
28							
29							
30							
31							
32							
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NPV			$2,764,025	$26,075			

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Centrifuge Solids Dewatering Facility

Does Your Project Include *Sludge Drying Beds* ?	**No**						
Construction Cost:						**$10,086,624**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		31	65%	8,760	$ 0.06	**$ 7,383**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		10,379	2.00	8,760	$ 0.06	**$ 10,165**	
Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Quantity (tons/year)**	**Unit Cost**	$ -	
Polymer		100%	65%	17	$ 3,544.77	**$ 38,365**	
Sludge Disposal:				**Average Annual Qty. (cy)**	**Unit Cost**	**Cost**	
Haul Sludge to Disposal Site				3,628	$ 8.09	$ 29,361	
Dumping Charge				3,628	$ 75.00	$ 272,122	
Total Disposal Cost						**$ 301,484**	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 156,577**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				513,974	20.0%	**$ 102,795**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	

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Subtotal Annual O&M Cost						$	616,768
Contingency					20%	$	123,354
Total Annual O&M Cost						$	740,122

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$10,086,624		$10,086,624	
1	$762,326		$762,326	
2	$785,195		$785,195	
3	$808,751		$808,751	
4	$833,014		$833,014	
5	$858,004		$858,004	
6	$883,744		$883,744	
7	$910,257		$910,257	
8	$937,564		$937,564	
9	$965,691		$965,691	
10	$994,662		$994,662	
11	$1,024,502		$1,024,502	
12	$1,055,237		$1,055,237	
13	$1,086,894		$1,086,894	
14	$1,119,501		$1,119,501	
15	$1,153,086		$1,153,086	
16	$1,187,679		$1,187,679	
17	$1,223,309		$1,223,309	
18	$1,260,008		$1,260,008	
19	$1,297,808		$1,297,808	
20	$1,336,743		$1,336,743	
21	$1,376,845		$1,376,845	
22	$1,418,150		$1,418,150	
23	$1,460,695		$1,460,695	
24	$1,504,516		$1,504,516	
25	$1,549,651		$1,549,651	
26				
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NPV			$24,635,670	$762,326

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Wet Pit Submersible Pump Station

Construction Cost:	**$1,510,742**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	30	65%	8,760	$ 0.06	**$ 7,144**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	986	2.00	8,760	$ 0.06	**$ 966**	

Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 4,174**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 12,284	20.0%	**$ 2,457**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 14,741**
Contingency	**20%**	**$ 2,948**
Total Annual O&M Cost		**$ 17,689**

Net Present Value (NPV) Calculation:

i =	**5.00%**
n =	**25**
Annual Inflation % =	**3.00%**

Year	**Default Cost**	**User Over-Ride**	**Cost Used in NPV Calculation**	**Adjusted Annual O&M Cost**
0	**$1,510,742**		**$1,510,742**	
1	**$18,220**		**$18,220**	
2	**$18,767**		**$18,767**	
3	**$19,330**		**$19,330**	
4	**$19,910**		**$19,910**	
5	**$20,507**		**$20,507**	
6	**$21,122**		**$21,122**	
7	**$21,756**		**$21,756**	
8	**$22,409**		**$22,409**	
9	**$23,081**		**$23,081**	
10	**$23,773**		**$23,773**	

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11	$24,486		$24,486				
12	$25,221		$25,221				
13	$25,978		$25,978				
14	$26,757		$26,757				
15	$27,560		$27,560				
16	$28,386		$28,386				
17	$29,238		$29,238				
18	$30,115		$30,115				
19	$31,019		$31,019				
20	$31,949		$31,949				
21	$32,908		$32,908				
22	$33,895		$33,895				
23	$34,912		$34,912				
24	$35,959		$35,959				
25	$37,038		$37,038				
26							
27							
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29							
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NPV			$1,858,475	$18,220			

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Granular Media Filter Backwash Supply Pump Station

Construction Cost:						**$4,324,537**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		52	65%	8,760	$ 0.06	**$ 12,384**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		1,788	2.00	8,760	$ 0.06	**$ 1,751**	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 38,052**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 52,187	20.0%	**$ 10,437**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 62,624**	
Contingency					**20%**	**$ 12,525**	
Total Annual O&M Cost						**$ 75,149**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$4,324,537		$4,324,537	
1	$77,404		$77,404	
2	$79,726		$79,726	
3	$82,117		$82,117	
4	$84,581		$84,581	
5	$87,118		$87,118	
6	$89,732		$89,732	
7	$92,424		$92,424	
8	$95,197		$95,197	
9	$98,052		$98,052	
10	$100,994		$100,994	
11	$104,024		$104,024	
12	$107,145		$107,145	
13	$110,359		$110,359	

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14	$113,670		$113,670				
15	$117,080		$117,080				
16	$120,592		$120,592				
17	$124,210		$124,210				
18	$127,936		$127,936				
19	$131,774		$131,774				
20	$135,728		$135,728				
21	$139,799		$139,799				
22	$143,993		$143,993				
23	$148,313		$148,313				
24	$152,763		$152,763				
25	$157,345		$157,345				
26							
27							
28							
29							
30							
31							
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NPV			$5,801,790	$77,404			

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	A	B	C	D	E	F	G	H	I
1	***Global Life Cycle Data***								
2									
3									
4									
5	**Net Present Value Calculation Inputs:**								
6	Annual Discount Rate (i) :		5.00%						
7	Number of Years (n):		25	Valid Range: 1 to 50 years					
8	Annual Inflation Rate (%):		3.00%						
9									
10	**Annual O&M Cost Inputs:**								
11	Maximum Daily Plant Flow (mgd)		115.00						
12	Average Annual Daily Flow (mgd)		75.00						
13	Average-to-Maximum Flow Factor		65%						
14	**Power:**								
15	If Project in U.S., Select State Location:		OREGON		User Over-Ride				
16	Power Cost ($/kWh): (Note: "All-in" including usage, demand, TOU, and transmission charges)		$ 0.0559			Source for U.S. Power Costs	(Note: U.S. National Average is $0.0768/kW		
17	Facility Electrical (Watts/SF):		2.00						
18	**Fuel:**								
19	Natural Gas:		$ 3.50	$/MMBTU			(Note: Units are $/1,000,000 BTU)		
20	**Annual Plant Operating Usage**		Days per Year Used	Hour per Day Used	Annual Usage (hours / year)	Annual Usage (% of year)			
21	Annual Plant Operating Usage		365	24	8,760.00	100%			
22	**Maintenance, Repair, and Replacement Costs:**								
23	*Maintenance* and *Repair* Costs		Automatically Included						
24	Include *Replacement* Costs?		No						
25	**Chemical Costs:** *(Please check with your local Chemical vendor to verify the default unit costs shown CPES)*								
26	Liquid Chemicals:	Default Costs ($/dry ton)	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
27	Alum (48.5%)	$ 555.44		$ 555.44					
28	Aqueous Ammonia (29%)	$ 1,208.65		$ 1,208.65					
29	Ferric Chloride (40%)	$ 1,003.69		$ 1,003.69					
30	Hydrochloric Acid	$ 500.72		$ 500.72					
31	Hydrofluorosilicic Acid (18%)	$ 5,419.53		$ 5,419.53					
32	Hydrogen Peroxide (35%)	$ 2,223.22		$ 2,223.22					
33	Liquid Polymer	$ 3,544.77		$ 3,544.77					
34	Sodium Bilsulfite (40%)	$ 1,336.98		$ 1,336.98					
35	Sodium Hydroxide (25%)	$ 1,043.24		$ 1,043.24					
36	Sodium Hydroxide (50%)	$ 1,222.48		$ 1,222.48					
37	Sodium Hypochlorite (12.5%)	$ 2,205.88		$ 2,205.88					
38	Sulfuric Acid (93%)	$ 379.51		$ 379.51					
39	Other 1			$ -					
40	Other 2			$ -					
41	Other 3			$ -					
42	Other 4			$ -					
43	Liquid Chlorine	$ 128.20		$ 128.20					
44	Purate	$ 923.01		$ 923.01	Purate cost ranges from $150/ton for bulk delivery to $720/ton for totes.				
45	CO2	$ 165.21		$ 165.21					
46									
47	Dry Chemicals:	Default Costs ($/dry ton)	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
48	Powdered Activated Carbon	$ 1,441.81		$ 1,441.81					
49	Calcium Hydroxide	$ 345.23		$ 345.23					
50	Sodium Bicarbonate	$ 777.73		$ 777.73					
51	Sodium Carbonate	$ 364.09		$ 364.09					
52	Polymer	$ 5,478.26		$ 5,478.26					
53	Potassium Permanganate	$ 5,419.17		$ 5,419.17					
54	Ammonium Sulfate	$ 2,574.66		$ 2,574.66					
55	Bayoxide (SORB33)	$ 287.40		$ 287.40					
56	Other 1			$ -					
57	Other 2			$ -					
58									
59	Specialty Chemicals:	Default Costs ($/dry ton)	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
60	Liquid Oxygen	$ 126.22		$ 126.22					
61	GAC	$ 3,251.28		$ 3,251.28					
62	Sand	$ 181.61		$ 181.61					
63	IX TEA	$ 5,451.98		$ 5,451.98					
64	IX TPA	$ 8,505.08		$ 8,505.08					
65	IX Bifunctional	$ 54,519.77		$ 54,519.77					
66	Citric Acid	$ 3,204.91		$ 3,204.91					
67	Trisodium Phosphate	$ 3,461.31		$ 3,461.31					
68	Scale Inhibitor	$ 5,640.65		$ 5,640.65					
69	Sodium Tripolyphosphate	$ 3,974.09		$ 3,974.09					
70	Sodium EDTA	$ 1,752.52		$ 1,752.52					
71	Salt	$ 152.86		$ 152.86					
72	Resin ($/Gal for MIEX model)	$ 60.39		$ 60.39					
73									
74	Specialty Chemicals:	Default Costs	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
75	GFH ($/ton)	$ 25,014.11		$ 25,014.11					

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	A	B	C	D
76	Sybron Chemicals Inc., IONAC A-554 Strongly Basin Anion Ion Exchange Resin ($/cf)	$ 302.25		$ 302.25
77	**Membranes:**	**Default Cost ($/ea)**	**User Over-Ride**	**Cost Used in Life Cycle Cost Analysis**
78	**Pressure:**			
79	Memcor CP - L10	$ 1,276.60		$ 1,276.60
80	Memcor CP - L20	$ 1,276.60		$ 1,276.60
81	Norit	$ 2,102.64		$ 2,102.64
82	Pall - 48 Module Rack	$ 1,538.36		$ 1,538.36
83	Pall - 80 Module Rack	$ 1,538.36		$ 1,538.36
84	**Submerged:**			
85	Memcor CS	$ 938.68		$ 938.68
86	Zenon 1000	$ 1,089.67		$ 1,089.67
87	Zenon 500	$ 1,353.20		$ 1,353.20
88	**SWRO & BWRO:**			
89	Process Cartridge Filter Replacements	$ 16.52		$ 16.52
90	CIP Filter Replacements	$ 16.52		$ 16.52
91				
92	**Solids:**			
93	**Biosolids:**			
94	Biosolids Reuse or Disposal Technology	End-Use Technology Code		
95	1 = Class A - Composting (static pile, invessel, air dry)	8		
96	2 = Class A - Alkaline Stabilization			
97	3 = Class A - ATAD, TPAAD Advanced Digestion			
98	4 = Class A - Thermal Drying			
99	5 = Class B - Land Application (digested)			
100	6 = Class B - Land Application (alkaline stabilized)			
101	7 = Class B - Land Reclamation (alkaline stabilized)			
102	8 = Disposal - Landfill or Monofill			
103	9 = Disposal - Incineration			
104	Biosolids Unit Cost ($/US Dry Ton)	$ 100.00		
105	Percent Solids	20%		
106	Biosolids *CALCULATED* Unit Cost ($/WT)	$ 20.00		
107	Biosolids *USER OVER-RIDE* Unit Cost ($/WT)			
108	Biosolids Unit Cost Used in CPES ($/WT)	$ 20.00	8 = Disposal - Landfill or Monofill	
109	Haul Distance from Plant (Miles, Round Trip)	20		
110	Haulage *USER OVER-RIDE* Unit Cost ($/WT/mile)			
111	Haulage Cost ($/WT)	$ 2.40	Default haulage cost is $0.12/US wet tonne/mile	
112	**Trash Disposal:**			
113	Haul Distance from Plant (Miles, Round Trip)		20	
114	Disposal Cost ($/cy)		$ 75.00	Typical Range: $50 - $175 / CY
115	Haul Cost ($/cy)		$ 8.09	
116	**Other Costs:**			
117	O&M Other Costs: Percent for Misc Annual Costs:		20.0%	Includes vehicles, lab tests, office equipment other required misc expenses, default of 20% from OM
118	**O&M Cost Contingency:**			
119	O&M Cost Contingency		20.0%	
120				
121	**Overall Plant Labor:**			
122	Labor Calculation Method	User Defined		
123				
124				
125				
126				
127				
128				
129				
130	Overall Plant Labor:			

131	Supervisory Staff	Work Shift Scheme	User Defined Number of Personnel	User Defined Hours / Week	User Defined Weeks/Year	Hours / Year	Hourly Rate (Including Fringe Benefits)	Yearly Cost
132	Superintendent	1 8 hr shift 5 days per week	0	40	52	2,080	$ 50.00	$ 104,000
133	Assistant Superintendent	User Defined	0	40	52	-	$ 40.00	$ -
134	Plant Operator 1	2 Operators onsite at all times	0	40	52	17,520	$ 30.00	$ 525,600
135	Plant Operator 2	User Defined	0	40	52	-	$ 30.00	$ -
136	Plant Operator 3	User Defined	0	40	52	-	$ 30.00	$ -
137	Plant Maintenance Worker 1	1 8 hr shift 5 days per week	0	40	52	2,080	$ 25.00	$ 52,000
138	Plant Maintenance Worker 2	User Defined	0	40	52	-	$ 25.00	$ -
139	Plant Maintenance Worker 3	User Defined	0	40	52	-	$ 25.00	$ -
140	Clerical Worker	1 8 hr shift 5 days per week	0	40	52	2,080	$ 25.00	$ 52,000
141	Lab Technician	1 8 hr shift 5 days per week	0	40	52	2,080	$ 25.00	$ 52,000
142	Other		0	40	52	-	$ 25.00	$ -
143	Other		0	40	52	-	$ 25.00	$ -
144	Staff	User Defined	0	40	52	-	$ 25.00	$ -
145	Subtotal - Annual Labor Cost					25,840		$ 785,600
146	Contingency						20%	$ 157,120
147	TOTAL - Annual Labor Cost					25,840	$ 36.48	$ 942,720
148								
149	**LABOR Net Present Value (NPV) Calculation:**							
150								
151	i =	5%						
152	n =	25						
153	**Annual Inflation % =**	3.00%						
154								

155	Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
156	0	$0		$0	
157	1	$971,002		$971,002	
158	2	$1,000,132		$1,000,132	
159	3	$1,030,136		$1,030,136	
160	4	$1,061,040		$1,061,040	
161	5	$1,092,871		$1,092,871	

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	A	B	C	D	E	F	G	H	I
162	6	$1,125,657		$1,125,657					
163	7	$1,159,427		$1,159,427					
164	8	$1,194,209		$1,194,209					
165	9	$1,230,036		$1,230,036					
166	10	$1,266,937		$1,266,937					
167	11	$1,304,945		$1,304,945					
168	12	$1,344,093		$1,344,093					
169	13	$1,384,416		$1,384,416					
170	14	$1,425,949		$1,425,949					
171	15	$1,468,727		$1,468,727					
172	16	$1,512,789		$1,512,789					
173	17	$1,558,173		$1,558,173					
174	18	$1,604,918		$1,604,918					
175	19	$1,653,065		$1,653,065					
176	20	$1,702,657		$1,702,657					
177	21	$1,753,737		$1,753,737					
178	22	$1,806,349		$1,806,349					
179	23	$1,860,539		$1,860,539					
180	24	$1,916,356		$1,916,356					
181	25	$1,973,846		$1,973,846					
182	26								
183	27								
184	28								
185	29								
186	30								
187	31								
188	32								
189	33								
190	34								
191	35								
192	36								
193	37								
194	38								
195	39								
196	40								
197	41								
198	42								
199	43								
200	44								
201	45								
202	46								
203	47								
204	48								
205	49								
206	50								
207	NPV			$18,531,642	$971,002				

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ENVIRONMENTAL IMPACT CALCULATOR

Does your project span multiple U.S. states?	No	
	eGrid Region	Select state applicable to your project State
Select eGrid Region or State Where Electricity is Purchased	NWPP	OREGON
Region Name	WECC Northwest	Override
CO2 Emissions (lbs/MWh)[1]	842.58	
N2O Emissions (lbs/MWh)[1]	0.02	
CH4 Emissions (lbs/MWh)[1]	0.01	

Power Summary

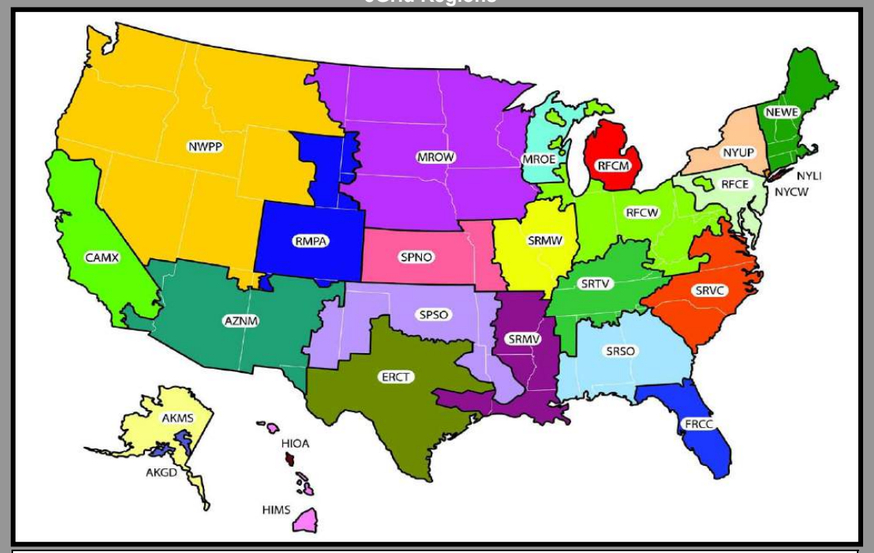
		Override
Total Horsepower (hp)	2,750.05	
Total Area of All Buildings (sf)	39,174.29	
Average to Maximum Flow Factor (%)	0.65	
Annual Plant Operating Hours (hr)	8,760.00	
Calculate Total Electricity Consumption (MWh/yr)	12,599.19	
Calculate Annual Emissions from Electricity Consumption (tons CO2/yr)	5,307.91	
Calculate Annual Emissions from Electricity Consumption (tons N20/yr)	0.10	
Convert N2O Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	30.13	
Calculate Annual Emissions from Electricity Consumption (tons CH4/yr)	0.08	
Convert CH4 Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	2.80	
Calculate Annual Emissions From Electrical Usage (tons CO2e/yr)	5,340.84	

1. U.S. Environmental Protection Agency. eGrid Ninth ed. 2010 data. Released 2/24/2014.Available: http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

Energy Price Summary

		Override
State Where Electricity is Purchased	OREGON	Override Options
Average Electrical Price (USD/kWh)[2]	$ 0.0559	0
Estimated Electrical Cost per Day (USD $)	$ 1,928	

eGrid Regions



2. U.S Energy Information Administration, Average Retail Price of Electricity to Ultimate Customers By End-Use, State, and Provider 2012. Released 11/8/2013. Available: http://www.eia.gov/electricity/data.cfm#sales

File Version: ***9/21/2017***

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Chemical Summary

If using either of these chemicals, input additional information in cells bx10 and by10

	Sodium Hypochlorite	Alum	Ferric Chloride	Sulfuric Acid	Hydrofluorosilicic Acid	Sodium Hydroxide	Aqueous Ammonia	Liquid Polymer	Hydrogen Peroxide	Sodium Bisulfite	Powdered Activated Carbon	Calcium Hydroxide	Sodium Bicarbonate	Sodium Carbonate	Potassium Permanganate	Ammonium Sulfate	Other 1	Other 2	Liquid Oxygen	GAC	Sand	Citric Acid	Trisodium Phosphate	Sodium Tripolyphosphate	Sodium EDTA	Salt	Purala	GFH / Resin Replacements (cf/yr)	CO2	Scale Inhibitor	Hydrochloric Acid	Other Liquid CIP Chem1	Other Liquid CIP Chem2	Other Dry Chem CIP 1	Other Pretreat Chem 1	Other Pretreat Chem 2
Total Chemical Usage (dry tons/yr)	0.00	1,218.43	0.00	0.00	0.00	2,436.86	0.00	223.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	731.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calculate Annual Emissions from Chemical Production (tons CO2)		336.29				3,353.11		465.80																		16.16										
Chemical Delivery Vehicle Type	Tanker	Tanker				Tanker		Tanker																		Tanker										
Size of Chemical Delivery (lbs/load)	40,000.00	40,000.00				40,000.00		40,000.00																		40,000.00										
If Using Totes, Drums, or Supersacks, Input Number Per Delivery								4.0																												
Calculate Number of Deliveries per year	0.00	126.00				244.00		11.00																		37.00										
Transportation Distance for Delivery (Miles/Delivery)	50.0	50.0				50.0		50.0																		50.0										
Calculate Total Miles Traveled by Delivery Vehicles	0.00	12,600.00				24,400.00		1,100.00																		3,700.00										
Delivery Vehicle Fuel Economy (mpg)	8.90	8.90				8.90		8.90																		8.90										
Emissions for Transportation (tons CO2/gal)	0.01	0.01				0.01		0.01																		0.01										
Calculate Annual Emissions for Transportation (tons CO2/yr)	0.00	15.54				30.10		1.36																		4.56										
Emissions for Transportation (tons N2O/mile)	0.00	0.00				0.00		0.00																		0.00										
Emissions for Transportation (tons CH4/mile)	0.00	0.00				0.00		0.00																		0.00										
Convert N2O Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	0.00	0.26				0.50		0.02																		0.08										
Convert CH4 Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	0.00	0.01				0.03		0.00																		0.00										
Calculate Annual Emissions from Chemical Transportation (tons CO2)	0.00	15.54				30.10		1.36																		4.56										
Calculate Total Annual Emissions from Chemical Usage (tons CO2)		351.83				3,383.21		467.16																		20.72										

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	Sodium Hypochlorite	Alum	Ferric Chloride	Sulfuric Acid	Hydrofluorosilicic Acid	Sodium Hydroxide	Aqueous Ammonia	Liquid Polymer	Hydrogen Peroxide	Sodium Bisulfite	Powdered Activated Carbon	Calcium Hydroxide	Sodium Bicarbonate	Sodium Carbonate	Potassium Permanganate	Ammonium Sulfate	Other 1	Other 2	Liquid Oxygen	GAC	Sand	Citric Acid	Trisodium Phosphate	Sodium Tripolyphosphate	Sodium EDTA	Number of Membrane Elements	Cartridge Replacements	Sludge (cy/year)	Liquid Chlorine Cylinders	Salt	Purate	Lamps	Ballasts	Sleeves	Intensity Sensors	SFPT Resin Replacements	CO2	Membrane Type	Scale Inhibitor	CIP Cartridge	Hydrochloric Acid	Other Liquid CIP Chem1	Other Liquid CIP Chem2	Other Dry Chem CIP 1	Other Pretreat Chem 1	Other Pretreat Chem 2
Wet Density (lbs/gal)	10.0914	11.1756	11.9262	15.2622	10.0914	12.8436	7.7562	9.174	9.4242	10.842												13.8444									11.43						6.43		9.17		3.67					
% Active Chemical	0.125	0.485	0.4	0.93	0.18	0.5	0.19	1	0.35	0.4									1												1						1		1		0.37					
Dry Density (lbs/cf)											35	30	60	65	100	60				28	99		60	60	54					80																

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Construction Summary

	Concrete (cy)	Excavation (cy)	Structural Backfill (cy)	Native Backfill (cy)	Haul Excess (cy)	Steel Process Piping (lbs)	Iron Process Piping (lbs)
Total Quantity Used	58,556.36	529,699.42	19,730.56	331,653.53	198,045.88	88,063.26	574,315.32
Input Load Factor		Low	Low	Low			
Calculate Gallons of Diesel Consumed based on Quantity Used (gal)		11,477.78	427.53	7,186.43			
Calculate CO2 Emissions based on Consumption (tons CO2)		127.12	4.73	79.59			
Calculate CH4 Emissions based on Consumption (tons CH4)		0.02	0.00	0.01			
Calculate N2O Emissions based on Consumption (tons N2O)		0.00	0.00	0.00			
Convert CH4 Into CO2 Equivalents for Emissions (tons CO2e)		0.37	0.01	0.23			
Convert N2O Into CO2 Equivalents for Emissions (tons CO2e)		0.39	0.01	0.25			
Calculate Emissions from Construction Quantities (tons CO2e)	2,195.86	127.88	4.76	80.07		228.08	554.21
Select Vehicle Capacity (cy)	7.85	10.00	10.00	10.00	10.00	40,000.00	40,000.00
Calculate Number of Vehicle Trips per year	7,462.00	52,970.00	1,974.00	33,166.00	19,805.00	3.00	15.00
Input Transportation Distance for Delivery (Miles/Delivery)	50.00	20.00	20.00	20.00	20.00	20.00	20.00
Calculate Total Miles Traveled by Construction Vehicles	373,100.00	1,059,400.00	39,480.00	663,320.00	396,100.00	60.00	300.00
Vehicle Fuel Economy (mpg)	8.90	8.90	8.90	8.90	8.90	8.90	8.90
Emissions for Transportation (tons CO2/ gal)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Calculate Emissions for Transportation (tons CO2)	460.25	1,306.87	48.70	818.27	488.63	0.07	0.37
Emissions for Transportation (tons N2O/ mile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions for Transportation (tons CH4/ mile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Convert N2O Into CO2 Equivalents for Emissions (tons CO2e)	7.65	21.71	0.81	13.59	8.12	0.00	0.01
Convert CH4 Into CO2 Equivalents for Emissions (tons CO2e)	0.43	1.23	0.05	0.77	0.46	0.00	0.00
Calculate Total Emissions from Transportation (tons CO2e)	468.33	1,329.81	49.56	832.63	497.20	0.08	0.38
Calculate Total Emissions from Construction Quantities (tons CO2e)	2,664.19	1,457.69	54.32	912.70	497.20	228.16	554.59

Load factor guide for excavation and backfill:

High - Most pipeline applications in hard rocky material. Digging 90-95% of the daily work schedule

Medium - Most residential sewer applications in natural bed clay. Digging 60-85% of the daily work schedule. Most log loading applications.

Low - Most utility, urban applications in sandy loam. Digging less than 50% of daily work schedule. Scrap handling applications.

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WTP Solids Summary

Solids Handling Emissions from WTP sludge

	Sludge (cy/year)	
Are the Solids Produced in a WTP or WWTP?	WTP	
Quantity of Sludge Produced Annually (cy/yr)	3,628.30	
Input % Dry Solids in Dewatered Sludge	20.00%	*Typically 15 to 25%.*
Weight of Sludge (lbs/cy)	1,901.43	***Assumption:*** Density of dried solids of 145 lb/cf.
Vehicle Hauling Capacity (cy)	10.00	
Calculate Number of Hauls per year	362.83	
Transportation Distance for Hauling (Miles/Delivery)	20.00	
Calculate Total Miles Traveled by Hauling Vehicles	14,513.19	
Hauling Vehicle Fuel Economy (mpg)	8.90	
Emissions for Transportation (tons CO_2/ gal)	0.01	
Calculate Annual Emissions for Transportation (tons CO_2/yr)	17.90	
Emissions for Transportation (tons N_2O/ mile)	0.00	
Emissions for Transportation (tons CH_4/ mile)	0.00	
Convert N_2O Into CO_2 Equivalents for Annual Emissions (tons CO_2e/yr)	0.30	
Convert CH_4 Into CO_2 Equivalents for Annual Emissions (tons CO_2e/yr)	0.02	
Calculate Annual Emissions from Solids Transportation (tons CO_2)	18.22	

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Membrane Filtration Cost Estimate

CH2M Parametric Engineering System (CPES)

FACILITIES DESIGN & CONSTRUCTION COST MODULE

File Version: 1/26/2018

Project Capacity: >>>	150.00	Project Unit: >>>	MGD	(For example: MGD, HP, GPM...)

Project Name:	PWB Filtration Decision	
Project Number:	699275	
Project Manager:	Kelly Irving	
Estimator:	Enoch Nicholson/Lee Odell	
Project Description:	PWB Membrane Filtration	Roundup to the nearest:
Project Location (City):	Portland OR	$10,000
Project Location (State):	OREGON	
Project Location (Country):	USA	
Cost Basis (Month/Year):	April/2018	

Item	Include? (Yes or No)	SCOPE OF PROJECT	Cost
	Yes	Flocculation: RapMix	$1,910,000
	Yes	Flocculation: Floc	$8,890,000
	No	DAF: DAF	$0
	No	Ozone Serpentine: Ozone	$0
	No	Filters: Filt	$0
	Yes	Concrete Clearwell: Clearwell	$31,540,000
	Yes	Liquid Chemical: Alum	$1,250,000
	Yes	Liquid Chemical: FAP	$320,000
	Yes	Liquid Chemical: CAP	$620,000
	Yes	Liquid Chemical: Hypo	$1,130,000
	Yes	On-Site Sodium Hypo: OSHG	$5,490,000
	Yes	Liquid Chemical: Caustic	$430,000
	Yes	Surge Basin-Decanter: BWSurge	$2,620,000
	Yes	Gravity Thickener: BWClar	$6,150,000
	Yes	Gravity Thickener: GravThick	$2,370,000
	Yes	WTP Centrifuge: Centrifuge	$7,710,000
	Yes	WPSPS: RecPS	$1,250,000
	Yes	Pall - Large: Membrane	$124,490,000
SUBTOTAL - PROJECT COST			$196,170,000
ADDITIONAL PROJECT COSTS:			
Demolition:		0.00%	$0
Overall Sitework:		5.00%	$9,810,000
Plant Computer System:		5.00%	$9,810,000
Yard Electrical:		4.00%	$7,850,000
Yard Piping:		7.50%	$14,720,000
UD #1 Default Description		0.00%	$0

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	A	B	C	D	E
47	UD #2 Default Description		0.00%		$0
48	UD #3 Default Description		0.00%		$0
49	SUBTOTAL with Additional Project Costs				$238,360,000
50					
51	RED FLAGS:				
52	1	Rock Excavation			
53	2	Pile Foundations			
54	3	Seismic Foundations			
55	4	Dewatering Conditions			
56	5	Wetlands Mitigation			
57	6	Weather Impacts			
58	7	Depth of Structures			
59	8	Local Building Code Restrictions			
60	9	Coatings or Finishes			
61	10	Building or Architectural Considerations			
62	11	Client Material Preferences			
63	12	Client Equipment Preferences			
64	13	Piping Galleries, Piping Trenches, Piping Racks			
65	14	Yard Piping Complexity			
66	15	Existing Site Utilities (New, Retrofit, and Complexity)			
67	16	I & C Automation (New or Retrofit)			
68	17	Electrical Feed (New or Retrofit)			
69	18	Electrical Distribution			
70	19	Shoring			
71	20	Contamination			
72	21	User Defined Red Flag 1			
73	22	User Defined Red Flag 2			
74	23	User Defined Red Flag 3			
75	24	User Defined Red Flag 4			
76	25	User Defined Red Flag 5			
77	26	User Defined Red Flag 6			
78	27	User Defined Red Flag 7			
79	TOTAL - RED FLAGS				$0
80					
81	SUBTOTAL - PROJECT COST with Additional Project Costs and Red Flag Costs				$238,360,000
82					
83	TAX:		0.00%	$0	$0
84	SUBTOTAL with Tax				$238,360,000
85					
86	CONTRACTOR MARKUPS:				
87	Overhead (includes General Conditions and General Administrative Costs)		14.00%	$238,360,000	$33,380,000
88	Subtotal				$271,740,000
89	Profit		5.00%	$271,740,000	$13,590,000
90	Subtotal				$285,330,000
91	Mob/Bonds/Insurance		3.50%	$285,330,000	$9,990,000
92	Subtotal				$295,320,000
93	Contingency		40.00%	$295,320,000	$118,130,000
94	SUBTOTAL with Markups				$413,450,000

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	A	B	C	D	E
95					
96	***LOCATION ADJUSTMENT FACTOR***		**100**	**$413,450,000**	**$413,450,000**
97	***SUBTOTAL - with Local Adjustment Factor***				**$413,450,000**
98					
99	***MARKET ADJUSTMENT FACTOR***		**0.00%**	**$413,450,000**	**$0**
100	***SUBTOTAL - CONSTRUCTION COST with Market Adjustment Factor***				**$413,450,000**
101	***Your CPES Estimate MUST be reviewed by a Process person AND an Estimator:***				
102	***Name of Process Reviewer***			**Odell, Lee**	
103	***Name of Estimator Reviewer***				
104	***MAXIMUM CONSTRUCTION COST***				**$413,450,000**
105					
106	***NON-CONSTRUCTION COSTS:***				
107	***Permitting:***		**0.00%**	**$413,450,000**	**$0**
108	***Engineering:***		**0.00%**	**$413,450,000**	**$0**
109	***Services During Construction:***		**0.00%**	**$413,450,000**	**$0**
110	***Commissioning & Startup:***		**0.00%**	**$413,450,000**	**$0**
111	***Land / ROW:***		**$0.00**		**$0**
112	***Legal / Admin:***		**$0.00**		**$0**
113	***Other Default Description***		**$0.00**		**$0**
114	***SUBTOTAL - Non-Construction Costs***				**$0**
115					
116	***TOTAL - CAPITAL COST***				**$413,450,000**
117					
118	***Currency Conversion of TOTAL CAPITAL COST:***				
119		***Currency***	***Unit of Measure***	***Conversion Rate***	***Converted Amount***
120		**None**	**U.S. Dollar**	**1**	**413,450,000**

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	B	C	D	E	F	G	H	I
1	***Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)***							
2								
3	**Is This Facility Included in My Project? Yes**							
4	Assumptions:							
5								
6	Based on Denver Water Reuse Project							
7	2 Basins @ 15 MGD each							
8	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
9	***NOTE TO USER: The Lamella Plate Clarifier should be sized before working on the Flocculation model.***							
10								
11	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
12	Is this a Seawater Desalination Application?	**No**	Y/N					
13	Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N					
14	Input Total Flocculation Flow Rate	**160.00**	mgd	**567.81**	ML/d			
15	Conversion of Total Flocculation Flow Rate	111,111.11	gpm	7,010.02	L/s			
16	Conversion of Total Flocculation Flow Rate	247.56	cfs	7.01	m3/s			
17	Input Number of Active Flocculation Trains	**3**	#					
18	Input Number of Standby Flocculation Trains	**1**	#					Typically 0.
19	Calculate Total Number of Flocculation Trains	4	#			NT		
20	Input Flocculation Detention Time	**0.50**	min					
21	Input Number of Flocculation Basin Stages per Train	**1**	#			NFS		Valid Range: 1 - 6.
22	Calculate Flocculation Basin Water Volume per Train	2,475.57	cf	70.10	m3			
23	Calculate Flocculation Stage Water Volume	2,475.57	cf	70.10	m3			
24	Select Flocculation Baffle Type	**O/U**	Type					
25	Input Flocculation Basin Influent Weir Head, If Serpentine Baffling Selected	**1.00**	ft	**304.80**	mm			
26	Calculate Flocculation Basin Influent Weir Length	0.00	ft	0.00	mm	WL		
27	Input Internal Flocculation Basin / Stage Width per Train = Lamella Plate Clarifier Train Width (W)	**15.00**	ft	**4,572.00**	mm	IBW		The Flocculation Basin / Stage Width should equal the Clarifier Stage Width. For information, the DAF Clarifier Stage Width can be found in the DAF model cell C25. Lamella Clarifier Width can be found in cell C46 of the Lamella Clarifier model.
28	Calculate Stage Length	12.85	ft	3,915.67	mm	SL		
29	Calculate Side Water Depth	12.85	ft	3,915.67	mm	SWD		Equal to Stage Length.
30	Input Flocculator Equipment Type	**VT**	Type					For VP and VT, the flocculation stage length must be less than 20-feet.
31	Calculate Horizontal Paddle Wheel Flocc Pedestal Height	0.00	ft	0.00	mm	FPH		
32	Number of Baffle Walls per Train	0	#					
33	Include Influent Channel?	**Yes**	Y/N					
34	Input Influent Channel Width	**5.00**	ft	**1,524.00**	mm	ICW		Valid Range: ≥ 3 ft.
35	Calculate Internal Flocculation Basin Length per Train	12.85	ft	3,915.67	mm	IBL		
36	Input Basin Freeboard	**3.00**	ft	**609.60**	mm	FB		Valid Range: 1-3 ft.
37	Calculate Basin Depth	15.85	ft	4,830.07	mm			Flocculation Basin BD should be less than or equal to lamella clarifier BD. If not, add more trains and / or more stages
38	Input Perimeter Operator Deck Walkway Width	**6.00**	ft	**1,524.00**	mm	WWW		Typically 4 to 8 ft.
39	Input Central Operator Deck Walkway Width	**10.00**	ft	**1,828.80**	mm	WWWC		Typically 8 to 12 ft.
40	Include Building over Basin?	**No**	Y/N					
41	Input Structure Depth of Burial	**6.00**	ft	**0.00**	mm			
42	Input Cutback Slope	**1.50**	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
43	Input Over Excavation Depth	**1.00**	ft	**0.00**	mm			
44	For Horizontal Paddle Wheel, Input Number of Reels per Stage	**6**	#			NRS		
45	Calculate Number of Flocculation Basin Pedestal Supports	0						
46	Distance between Reel and Pedestal	0.00	in	0.00	mm			
47	Conversion from Inches to Feet	0.00	ft	0.00	mm	RPW		
48	Width of Pedestal	0.00	in	0.00	mm			
49	Conversion from Inches to Feet	0.00	ft	0.00	mm	PW		
50	Calculate Reel Length	0.00	ft	0.00	mm	RL		Valid Range: 6 to 20 ft.
51	Calculate Reel Diameter	0.00	ft	0.00	mm	RD		
52	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Stage	1	#					
53	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Train	1	#					
54	For Vertical Paddle Wheel or Vertical Turbine, Calculate Total Number of Mixers per All Trains	4	#					
55	For Vertical Paddle Wheel or Vertical Turbine, Calculate Mixer Diameter, Each	9.00	ft	2,743.20	mm	MD		
56	For Vertical Paddle Wheel or Vertical Turbine, Calculate Distance Between Mixers	3.00	ft	914.40	mm	DBM		
57	Input Stage 1 Velocity Gradient	**700.00**	sec-1					
58	Input Stage 2 Velocity Gradient	**40.00**	sec-1					
59	Input Stage 3 Velocity Gradient	**20.00**	sec-1					
60	Input Stage 4 Velocity Gradient	**0.00**	sec-1					
61	Input Stage 5 Velocity Gradient	**0.00**	sec-1					
62	Input Stage 6 Velocity Gradient	**0.00**	sec-1					
63	Input Wire to Water Flocculation Energy Input Efficiency	**75.00%**						
64	Input min water temperature	33.80	degrees F	**1.00**	degrees C			Valid Range: 0 - 40 deg C.

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	B	C	D	E	F	G	H	I
65	Dynamic (Absolute) Viscosity of Water	0.000037	lb•s/sf	0.001792	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
66	Calculate Stage 1 Power per Mixer	111.00	hp	82.77	kW			
67	Calculate Stage 2 Power per Mixer	0.00	hp	0.00	kW			
68	Calculate Stage 3 Power per Mixer	0.00	hp	0.00	kW			
69	Calculate Stage 4 Power per Mixer	0.00	hp	0.00	kW			
70	Calculate Stage 5 Power per Mixer	0.00	hp	0.00	kW			
71	Calculate Stage 6 Power per Mixer	0.00	hp	0.00	kW			
72								
73	Electrical User Inputs and Sizing Requirements:							
74	Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N					
75	Is there SWGR?	No						
76								MCC
77	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
78	Flocculation Mixers Stage 1 (total facility)	4.00	111.00	Yes	0.00	0.00	12.00	
79	Flocculation Mixers Stage 2 (total facility)	0.00	0.00	Yes	0.00	0.00	0.00	
80	Flocculation Mixers Stage 3 (total facility)	0.00	0.00	Yes	0.00	0.00	0.00	
81	Flocculation Mixers Stage 4 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
82	Flocculation Mixers Stage 5 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
83	Flocculation Mixers Stage 6 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
84	User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
85	User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
86	User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
87	**TOTAL**		**444.00**		**0.00**	**0.00**	**12.00**	**12.00**
88								
89	Electrical Equipment Widths:							
90	**Equipment**	**Depth (ft)**						
91	MCC	1.67						
92	Small AFD's	2.08						
93	Large AFD's	0.00						
94	Switchgear	0.00						
95	**Maximum Depth**	**2.08**						
96								
97	Clear Distances:							
98	**Clear Distance**	**Width**	**Length**	**Comment**				
99	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
100	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
101	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
102	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
103	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
104	CD6	**4.00**		Clear Distance behind Switchgear (If				
105	CD7	**3.00**		Clear Distance in front of Equipment	Typically 3 feet			
106	Contingency Length		**0.00**	Contingency length	Typically Zero			
107								
108	Electric Room Length (ft):							
109	CD1	3.00						
110	MCC	11.67						
111	CD2	1.00						
112	Small AFD's	13.32						
113	CD3	0.00						
114	Large AFD's	0.00						
115	CD4	0.00						
116	Swithgear	0.00						
117	CD5	0.00						
118	Contingency	0.00						
119	**Total Length**	**28.99**						
120								
121	Electric Room Width (ft):							
122	CD6	0.00	If there is no switchgear, this distance will be Zero.					
123	Maximum Equipment Depth	2.08						
124	CD7	3.00						
125	**Total Width**	**5.08**						
126								
127	**Estimating Dimensions (per trian):**	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
128								
129	Influent Channel:							
130	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
131	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
132	Concrete Thickness	2.00	ft	609.60	mm	TICS0G		
133	SOG Length	8.50	ft	2,590.80	mm			
134	SOG Width	71.50	ft	21,793.20	mm			
135	Channel Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
136	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
137	Concrete Thickness	1.50	ft	457.20	mm	TWIC		
138	Wall Length	135.00	ft	41,148.00	mm			
139	Wall Height	15.85	ft	4,830.07	mm			
140	Elevated Slab:							
141	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
142	Concrete Thickness	1.00	ft	304.80	mm			

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	B	C	D	E	F	G	H	I
143	Elevated Slab Length	8.00	ft	2,438.40	mm			
144	Elevated Slab Width	67.50	ft	20,574.00	mm			
145								
146	Flocculation Basin:							
147	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
148	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
149	Concrete Thickness	2.00	ft	609.60	mm	TFBSOG		
150	SOG Length	14.35	ft	4,372.87	mm			
151	SOG Width	71.50	ft	21,793.20	mm			
152	Basin Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
153	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
154	Concrete Thickness	1.50	ft	457.20	mm	TWFB		
155	Wall Length	89.23	ft	27,198.37	mm			If flocc basin shares a common wall with downstream facility, then common wall is counted with downstream facility.
156	Wall Height	15.85	ft	4,830.07	mm			
157	Baffle Walls:							
158	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
159	Concrete Thickness	1.00	ft	304.80	mm	BWTF		
160	Wall Width per Train	15.00	ft	4,572.00	mm	BWL		
161	Quantity of Over Baffle Walls per Train	0	#					
162	Quantity of Under Baffle Walls per Train	0	#					
163	Quantity of Under Baffle Walls per Train	0	#					
164	Over Baffle Wall Length per Facility	0.00	ft	0.00	mm			
165	Under Baffle Wall Length per Facility	0.00	ft	0.00	mm			
166	Serpentine Baffle Wall Length per Facility	0.00	ft	0.00	mm			
167	Over Baffle Wall Height	10.85	ft	3,306.07	mm			Assumes top of wall 2 ft below WSE.
168	Under Baffle Wall Height	14.85	ft	4,525.27	mm			Assumes bottom of wall 1 ft above basin floor.
169	Serpentine Baffle Wall Height	0.00	ft	0.00	mm			
170	Elevated Slab:							
171	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
172	Concrete Thickness	1.00	ft	304.80	mm	TESLC		
173	Center Walkway:							
174	Elevated Slab Width	10.00	ft	3,048.00	mm			
175	Elevated Slab Length per 2 Trains	6.85	ft	2,086.87	mm			
176	Elevated Slab Length per Facility	20.54	ft	6,260.62	mm			
177	Perimeter and Baffle Wall Walkway:							
178	Elevated Slab Width at Perimeter	7.50	ft	2,286.00	mm			Includes basin wall thickness.
179	Elevated Slab Length at Perimeter per Facility	81.19	ft	24,747.75	mm			
180	Elevated Slab Width at Baffle Wall	6.00	ft	1,828.80	mm			For VP and VT flocc basin mixing only.
181	Elevated Slab Length at Baffle Wall per Facility	0.00	ft	0.00	mm			For VP and VT flocc basin mixing only.
182								
183	Electrical Room Slab on Grade:							
184	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
185	Concrete Thickness	1.00	ft	304.80	mm			
186								
187	Overall Dimensions:							
188	Total Basin/Building Length	20.85	ft	6,354.07	mm	TBL		
189	Total Basin/Building Width	67.50	ft	20,574.00	mm	TBW		
190	SOG Length	22.85	ft	6,963.67	mm			
191	SOG Width	71.50	ft	21,793.20	mm			
192	Electrical Room Length	28.99	ft	8,835.14	mm			
193	Electrical Room Width	5.08	ft	1,549.40	mm			
194	Excavation Length	26.85	ft	8,182.87	mm			
195	Excavation Width	75.50	ft	23,012.40	mm			
196	Excavation Depth	9.00	ft	2,743.20	mm			
197								
198								
199	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
200								
201	SITEWORK:							
202	Excavation	1,273	CY	972.93	m3	***$6.72***	$8,555	
203	Imported Structural Backfill	150	CY	114.79	m3	***$50.94***	$7,649	
204	Native Backfill	461	CY	352.12	m3	***$8.27***	$3,807	
205	Haul Excess	812	CY	620.81	m3	***$8.27***	$6,711	
206	Allowance for Misc Items	5%				$26,721.89	$1,336	
207	Subtotal						$28,058	
208								
209	CONCRETE:							
210	Influent Channel:							
211	Foundation	45	CY	34.42	m3	***$541.11***	$24,360	
212	Walls	119	CY	90.87	m3	***$880.79***	$104,682	
213	Elevated Slab	20	CY	15.29	m3	***$1,333.77***	$26,675	
214	Flocc Basin							
215	Foundation	76	CY	58.09	m3	***$541.11***	$41,116	
216	Basin Walls	79	CY	60.06	m3	***$880.79***	$69,194	
217	Over Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
218	Under Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
219	Serpentine Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
220	Elevated Slab	25	CY	19.18	m3	***$1,333.77***	$33,464	
221	Flocc Bearing Supports	0	EA			$0.00	$0	
222	Electrical Room							

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	B	C	D	E	F	G	H	I
223	Slab on Grade	5	CY	4.17	m3	***$490.62***	$2,677	
224	Allowance for Misc Items	5%				$302,168.22	$15,108	
225	Subtotal						$317,277	
226								
227	MASONRY:	**High**						
228	CMU Building	0	SF	0.00	m2	***$198.37***	$0	
229	Electrical Room	147	SF	13.69	m2	***$198.37***	$29,229	
230	Subtotal	147					$29,229	
231								
232	METALS:							
233	Aluminum Handrail	276	LF	84.27	m	***$90.92***	$25,136	
234	Stairs (1 set per basin)	65	RISERS			***$495.92***	$32,274	
235	Allowance for Misc Items	10%				$57,410.27	$5,741	
236	Subtotal						$63,151	
237								
238	WOODS & PLASTICS:							
239	FRP Weir	60	LF	18.29	m	$41.64	$2,498	
240	FRP Ladder	8	EA			$1,715.48	$13,724	
241	Allowance for Misc Items	5%				$16,222.01	$811	
242	Subtotal						$17,033	
243								
244	THERMAL & MOISTURE PROTECTION:							
245	Concrete Liner	0	SF	0.00	m2	**$16.00**	$0	
246	Allowance for Misc Items	10%				$0.00	$0	
247	Subtotal						$0	
248								
249	DOORS & WINDOWS:							
250	Stainless Steel Door (2' x 2') for O/U Baffling	0	EA			$1,332.36	$0	
251	Stainless Steel Door (7' x 2.5') for O/U Baffling	0	EA			$5,829.09	$0	
252	Stainless Steel Door (2' x 2') for Serpentine Baffling	0	EA			$1,332.36	$0	
253	Allowance for Misc Items	5%				$0.00	$0	
254	Subtotal						$0	
255								
256	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
257	Horizontal Paddle Wheel Flocculation Mechanism (Paddles & Drives)	0	LF	0.00	m	***$0.00***	$0	
258	Vertical Paddle Wheel Flocculation Mechanism (Paddles & Drives)	4	EA			***$0.00***	$0	
259	Vertical Turbine Flocculation Mechanism (Turbines & Drives)	444	hp	331.09	kW	***$1,534.78***	$681,443	
260	Vertical Turbine Flocculator VFD's	444	hp	331.09	kW	***$558.32***	$247,894	
261	Fabricated Slide Gate	4	EA			***$9,614.74***	$38,459	
262	Allowance for Misc Items	10%				$967,795.48	$96,780	
263	Subtotal						$1,064,575	
264								
265	ELECTRICAL:							
266	*MCC's*							
267	Sections	7	EA			***$10,730.27***	$75,112	
268	*AFD's*							
269	Flocculation Mixers Stage 1 (total facility) (111 hp each)	4	EA			***$23,421.23***	$93,685	
270	Flocculation Mixers Stage 2 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
271	Flocculation Mixers Stage 3 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
272	Flocculation Mixers Stage 4 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
273	Flocculation Mixers Stage 5 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
274	Flocculation Mixers Stage 6 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
275	*Switchgear*							
276	Units	0	EA			***$49,359.23***	$0	
277	Electrical Conduit & Wire	572	LF	174.35	m	***$12.06***	$6,898	
278	Allowance for Misc Items	10%				$175,694.53	$17,569	
279	Subtotal						$193,264	
280								
281	INSTRUMENTS & CONTROLS:							
282	Instruments							
283	Level Switch	4	EA			***$695.44***	$2,782	
284	Number of Analog I/O Counts	10	EA			***$264.27***	$2,537	
285	Number of Digital I/O Counts	24	EA			***$62.59***	$1,502	
286	Number of PLC's	1	EA			***$13,074.33***	$13,074	
287	I&C Conduit & Wire	1,080	LF	329.18	m	***$12.06***	$13,024	
288	Allowance for Misc Items	10%				$32,918.93	$3,292	
289	Subtotal						$36,211	
290								
291	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
292	Item 1 Description	0.00		0.00		0.00	$0	
293	Item 2 Description	0.00		0.00		0.00	$0	
294	Item 3 Description	0.00		0.00		0.00	$0	
295	Item 4 Description	0.00		0.00		0.00	$0	
296	Item 5 Description	0.00		0.00		0.00	$0	
297	Item 6 Description	0.00		0.00		0.00	$0	
298	Item 7 Description	0.00		0.00		0.00	$0	
299	Item 8 Description	0.00		0.00		0.00	$0	
300	Item 9 Description	0.00		0.00		0.00	$0	
301	Item 10 Description	0.00		0.00		0.00	$0	
302	Item 11 Description	0.00		0.00		0.00	$0	
303	Item 12 Description	0.00		0.00		0.00	$0	
304	Item 13 Description	0.00		0.00		0.00	$0	
305	Item 14 Description	0.00		0.00		0.00	$0	
306	Item 15 Description	0.00		0.00		0.00	$0	
307	Subtotal						$0	
308								
309	Subtotal						$1,748,798	
310								
311	ALLOWANCES:		**User Override**					
312	Finishes Allowance	2.00%		$1,900,867	$38,017			
313	I&C Allowance	2.00%		$1,900,867	$38,017			
314	Mechanical Allowance	2.00%		$1,900,867	$38,017			
315	Electrical Allowance	2.00%		$1,900,867	$38,017			
316						Facility Cost Name		
317	Facility Cost	**160,000,000**	**GPD**	**$0.01**	**$1,900,867**	FCPFC01		
318	Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.01**	**$2,309,684**	FCPFC02		

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	B	C	D	E	F	G	H	I
319	Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$0.03**	**$4,006,289**	FCPFC03		
320	Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$0.02**	**$3,297,171**	FCPFC05		
321	Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$0.03**	**$4,006,289**	FCPFC06		

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	B	C	D	E	F	G	H	I
1	***Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)***							
2								
3	**Is This Facility Included in My Project? Yes**							
4	Assumptions:							
5								
6	Based on Denver Water Reuse Project							
7	2 Basins @ 15 MGD each							
8	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
9	***NOTE TO USER: The Lamella Plate Clarifier should be sized before working on the Flocculation model.***							
10								
11	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
12	Is this a Seawater Desalination Application?	**No**	Y/N					
13	Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N					
14	Input Total Flocculation Flow Rate	**160.00**	mgd	**567.81**	ML/d			
15	Conversion of Total Flocculation Flow Rate	111,111.11	gpm	7,010.02	L/s			
16	Conversion of Total Flocculation Flow Rate	247.56	cfs	7.01	m3/s			
17	Input Number of Active Flocculation Trains	**4**	#					
18	Input Number of Standby Flocculation Trains	**0**	#					Typically 0.
19	Calculate Total Number of Flocculation Trains	4	#			NT		
20	Input Flocculation Detention Time	**30.00**	min					
21	Input Number of Flocculation Basin Stages per Train	**3**	#			NFS		Valid Range: 1 - 6.
22	Calculate Flocculation Basin Water Volume per Train	111,400.47	cf	3,154.51	m3			
23	Calculate Flocculation Stage Water Volume	37,133.49	cf	1,051.50	m3			
24	Select Flocculation Baffle Type	**O/U**	Type					
25	Input Flocculation Basin Influent Weir Head, If Serpentine Baffling Selected	**1.00**	ft	**304.80**	mm			
26	Calculate Flocculation Basin Influent Weir Length	0.00	ft	0.00	mm	WL		
27	Input Internal Flocculation Basin / Stage Width per Train = Lamella Plate Clarifier Train Width (W)	**40.00**	ft	**7,620.00**	mm	IBW		The Flocculation Basin / Stage Width should equal the Clarifier Stage Width. For information, the DAF Clarifier Stage Width can be found in the DAF model cell C25. Lamella Clarifier Width can be found in cell C46 of the Lamella Clarifier model.
28	Calculate Stage Length	30.47	ft	9,286.84	mm	SL		
29	Calculate Side Water Depth	30.47	ft	9,286.84	mm	SWD		Equal to Stage Length.
30	Input Flocculator Equipment Type	**HP**	Type					For VP and VT, the flocculation stage length must be less than 20-feet.
31	Calculate Horizontal Paddle Wheel Flocc Pedestal Height	15.23	ft	4,643.42	mm	FPH		
32	Number of Baffle Walls per Train	2	#					
33	Include Influent Channel?	**Yes**	Y/N					
34	Input Influent Channel Width	**5.00**	ft	**1,524.00**	mm	ICW		Valid Range: ≥ 3 ft.
35	Calculate Internal Flocculation Basin Length per Train	93.41	ft	28,470.11	mm	IBL		
36	Input Basin Freeboard	**3.00**	ft	**609.60**	mm	FB		Valid Range: 1-3 ft.
37	Calculate Basin Depth	33.47	ft	10,201.24	mm			Flocculation Basin BD should be less than or equal to lamella clarifier BD. If not, add more trains and / or more stages
38	Input Perimeter Operator Deck Walkway Width	**6.00**	ft	**1,524.00**	mm	WWW		Typically 4 to 8 ft.
39	Input Central Operator Deck Walkway Width	**10.00**	ft	**1,828.80**	mm	WWWC		Typically 8 to 12 ft.
40	Include Building over Basin?	**Yes**	Y/N					
41	Input Structure Depth of Burial	**6.00**	ft	**0.00**	mm			
42	Input Cutback Slope	**1.50**	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
43	Input Over Excavation Depth	**1.00**	ft	**0.00**	mm			
44	For Horizontal Paddle Wheel, Input Number of Reels per Stage	**6**	#			NRS		
45	Calculate Number of Flocculation Basin Pedestal Supports	7						
46	Distance between Reel and Pedestal	3.00	in	76.20	mm			
47	Conversion from Inches to Feet	0.25	ft	76.20	mm	RPW		
48	Width of Pedestal	12.00	in	304.80	mm			
49	Conversion from Inches to Feet	1.00	ft	304.80	mm	PW		
50	Calculate Reel Length	5.00	ft	1,524.00	mm	RL	**Warning! Reel length outside valid range.**	Valid Range: 6 to 20 ft.
51	Calculate Reel Diameter	28.47	ft	8,677.24	mm	RD		
52	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Stage	0	#					
53	For Vertical Paddle Wheel or Vertical Turbine, Calculate Number of Mixers per Train	0	#					
54	For Vertical Paddle Wheel or Vertical Turbine, Calculate Total Number of Mixers per All Trains	0	#					
55	For Vertical Paddle Wheel or Vertical Turbine, Calculate Mixer Diameter, Each	0.00	ft	0.00	mm	MD		
56	For Vertical Paddle Wheel or Vertical Turbine, Calculate Distance Between Mixers	0.00	ft	0.00	mm	DBM		
57	Input Stage 1 Velocity Gradient	**60.00**	sec-1					
58	Input Stage 2 Velocity Gradient	**40.00**	sec-1					
59	Input Stage 3 Velocity Gradient	**20.00**	sec-1					
60	Input Stage 4 Velocity Gradient	**0.00**	sec-1					
61	Input Stage 5 Velocity Gradient	**0.00**	sec-1					
62	Input Stage 6 Velocity Gradient	**0.00**	sec-1					
63	Input Wire to Water Flocculation Energy Input Efficiency	**75.00%**						

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	B	C	D	E	F	G	H	I
64	Input min water temperature	32.00	degrees F	**0.00**	degrees C			Valid Range: 0 - 40 deg C.
65	Dynamic (Absolute) Viscosity of Water	0.000037	lb•s/sf	0.001792	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
66	Calculate Stage 1 Power per Mixer	13.00	hp	9.69	kW			
67	Calculate Stage 2 Power per Mixer	6.00	hp	4.47	kW			
68	Calculate Stage 3 Power per Mixer	2.00	hp	1.49	kW			
69	Calculate Stage 4 Power per Mixer	0.00	hp	0.00	kW			
70	Calculate Stage 5 Power per Mixer	0.00	hp	0.00	kW			
71	Calculate Stage 6 Power per Mixer	0.00	hp	0.00	kW			
72								
73	Electrical User Inputs and Sizing Requirements:							
74	Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N					
75	Is there SWGR?	No						
76								**MCC**
77	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
78	Flocculation Mixers Stage 1 (total facility)	4.00	13.00	Yes	0.00	16.00	8.00	
79	Flocculation Mixers Stage 2 (total facility)	4.00	6.00	Yes	0.00	16.00	8.00	
80	Flocculation Mixers Stage 3 (total facility)	4.00	2.00	Yes	0.00	12.00	8.00	
81	Flocculation Mixers Stage 4 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
82	Flocculation Mixers Stage 5 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
83	Flocculation Mixers Stage 6 (total facility)	0.00	0.00	No	0.00	0.00	0.00	
84	User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
85	User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
86	User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
87	**TOTAL**		**84.00**		**0.00**	**44.00**	**24.00**	**68.00**
88								
89	Electrical Equipment Widths:							
90	**Equipment**	**Depth (ft)**						
91	MCC	1.67						
92	Small AFD's	0.00						
93	Large AFD's	0.00						
94	Switchgear	0.00						
95	**Maximum Depth**	**1.67**						
96								
97	Clear Distances:							
98	**Clear Distance**	**Width**	**Length**	**Comment**				
99	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
100	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
101	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
102	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
103	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
104	CD6	**4.00**		Clear Distance behind Switchgear (If				
105	CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet			
106	Contingency Length		**0.00**	Contingency length	Typically Zero			
107								
108	Electric Room Length (ft):							
109	CD1	3.00						
110	MCC	20.00						
111	CD2	1.00						
112	Small AFD's	0.00						
113	CD3	0.00						
114	Large AFD's	0.00						
115	CD4	0.00						
116	Swithgear	0.00						
117	CD5	0.00						
118	Contingency	0.00						
119	**Total Length**	**24.00**						
120								
121	Electric Room Width (ft):							
122	CD6	0.00	If there is no switchgear, this distance will be Zero.					
123	Maximum Equipment Depth	1.67						
124	CD7	3.00						
125	**Total Width**	**4.67**						
126								
127	**Estimating Dimensions (per trian):**	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
128								
129	Influent Channel:							
130	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
131	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
132	Concrete Thickness	2.00	ft	609.60	mm	TICS0G		
133	SOG Length	8.50	ft	2,590.80	mm			
134	SOG Width	171.50	ft	52,273.20	mm			
135	Channel Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
136	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
137	Concrete Thickness	1.50	ft	457.20	mm	TWIC		
138	Wall Length	335.00	ft	102,108.00	mm			
139	Wall Height	33.47	ft	10,201.24	mm			
140	Elevated Slab:							
141	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"

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	B	C	D	E	F	G	H	I
142	Concrete Thickness	1.00	ft	304.80	mm			
143	Elevated Slab Length	8.00	ft	2,438.40	mm			
144	Elevated Slab Width	167.50	ft	51,054.00	mm			
145								
146	Flocculation Basin:							
147	Slab on Grade:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
148	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 24"
149	Concrete Thickness	2.00	ft	609.60	mm	TFBSOG		
150	SOG Length	94.91	ft	28,927.31	mm			
151	SOG Width	171.50	ft	52,273.20	mm			
152	Basin Walls:							Use Wall Thickness Spreadsheet to Adjust Based on Overall Wall Height and Depth of Burial
153	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
154	Concrete Thickness	1.50	ft	457.20	mm	TWFB		
155	Wall Length	492.03	ft	149,970.56	mm			If flocc basin shares a common wall with downstream facility, then common wall is counted with downstream facility.
156	Wall Height	33.47	ft	10,201.24	mm			
157	Baffle Walls:							
158	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
159	Concrete Thickness	1.00	ft	304.80	mm	BWTF		
160	Wall Width per Train	40.00	ft	12,192.00	mm	BWL		
161	Quantity of Over Baffle Walls per Train	1	#					
162	Quantity of Under Baffle Walls per Train	1	#					
163	Quantity of Under Baffle Walls per Train	0	#					
164	Over Baffle Wall Length per Facility	160.00	ft	48,768.00	mm			
165	Under Baffle Wall Length per Facility	160.00	ft	48,768.00	mm			
166	Serpentine Baffle Wall Length per Facility	0.00	ft	0.00	mm			
167	Over Baffle Wall Height	28.47	ft	8,677.24	mm			Assumes top of wall 2 ft below WSE.
168	Under Baffle Wall Height	32.47	ft	9,896.44	mm			Assumes bottom of wall 1 ft above basin floor.
169	Serpentine Baffle Wall Height	0.00	ft	0.00	mm			
170	Elevated Slab:							
171	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
172	Concrete Thickness	1.00	ft	304.80	mm	TESLC		
173	Center Walkway:							
174	Elevated Slab Width	10.00	ft	3,048.00	mm			
175	Elevated Slab Length per 2 Trains	87.41	ft	26,641.31	mm			
176	Elevated Slab Length per Facility	262.22	ft	79,923.94	mm			
177	Perimeter and Baffle Wall Walkway:							
178	Elevated Slab Width at Perimeter	7.50	ft	2,286.00	mm			Includes basin wall thickness.
179	Elevated Slab Length at Perimeter per Facility	342.31	ft	104,336.63	mm			
180	Elevated Slab Width at Baffle Wall	0.00	ft	0.00	mm			For VP and VT flocc basin mixing only.
181	Elevated Slab Length at Baffle Wall per Facility	0.00	ft	0.00	mm			For VP and VT flocc basin mixing only.
182								
183	Electrical Room Slab on Grade:							
184	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
185	Concrete Thickness	1.00	ft	304.80	mm			
186								
187	Overall Dimensions:							
188	Total Basin/Building Length	101.41	ft	30,908.51	mm	TBL		
189	Total Basin/Building Width	167.50	ft	51,054.00	mm	TBW		
190	SOG Length	103.41	ft	31,518.11	mm			
191	SOG Width	171.50	ft	52,273.20	mm			
192	Electrical Room Length	24.00	ft	7,315.20	mm			
193	Electrical Room Width	4.67	ft	1,422.40	mm			
194	Excavation Length	107.41	ft	32,737.31	mm			
195	Excavation Width	175.50	ft	53,492.40	mm			
196	Excavation Depth	9.00	ft	2,743.20	mm			
197								
198								
199	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
200								
201	SITEWORK:							
202	Excavation	8,463	CY	6,470.49	m3	***$6.72***	$56,898	
203	Imported Structural Backfill	1,396	CY	1,067.53	m3	***$50.94***	$71,129	
204	Native Backfill	1,273	CY	973.34	m3	***$8.27***	$10,522	
205	Haul Excess	7,190	CY	5,497.15	m3	***$8.27***	$59,427	
206	Allowance for Misc Items	5%				$197,976.24	$9,899	
207	Subtotal						$207,875	
208								
209	CONCRETE:							
210	Influent Channel:							
211	Foundation	108	CY	82.56	m3	***$541.11***	$58,429	
212	Walls	623	CY	476.23	m3	***$880.79***	$548,636	
213	Elevated Slab	50	CY	37.94	m3	***$1,333.77***	$66,194	
214	Flocc Basin							
215	Foundation	1,206	CY	921.79	m3	***$541.11***	$652,388	
216	Basin Walls	915	CY	699.46	m3	***$880.79***	$805,806	
217	Over Baffle Wall	169	CY	128.98	m3	***$880.79***	$148,592	
218	Under Baffle Wall	192	CY	147.11	m3	***$880.79***	$169,470	
219	Serpentine Baffle Wall	0	CY	0.00	m3	***$880.79***	$0	
220	Elevated Slab	127	CY	97.45	m3	***$1,333.77***	$170,001	
221	Flocc Bearing Supports	84	EA			$1,879.41	$157,871	

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	B	C	D	E	F	G	H	I
222	Electrical Room							
223	Slab on Grade	4	CY	3.17	m3	***$490.62***	$2,035	
224	Allowance for Misc Items	5%				$2,779,422.33	$138,971	
225	Subtotal						$2,918,393	
226								
227	MASONRY:	**High**						
228	CMU Building	16,985	SF	1,578.00	m2	***$198.37***	$3,369,358	
229	Electrical Room	112	SF	10.41	m2	***$198.37***	$22,217	
230	Subtotal	17,097					$3,391,575	
231								
232	METALS:							
233	Aluminum Handrail	944	LF	287.81	m	***$90.92***	$85,849	
234	Stairs (1 set per basin)	171	RISERS			***$495.92***	$84,708	
235	Allowance for Misc Items	10%				$170,557.69	$17,056	
236	Subtotal						$187,613	
237								
238	WOODS & PLASTICS:							
239	FRP Weir	160	LF	48.77	m	$41.64	$6,662	
240	FRP Ladder	8	EA			$3,623.13	$28,985	
241	Allowance for Misc Items	5%				$35,646.88	$1,782	
242	Subtotal						$37,429	
243								
244	THERMAL & MOISTURE PROTECTION:							
245	Concrete Liner	0	SF	0.00	m2	**$16.00**	$0	
246	Allowance for Misc Items	10%				$0.00	$0	
247	Subtotal						$0	
248								
249	DOORS & WINDOWS:							
250	Stainless Steel Door (2' x 2') for O/U Baffling	8	EA			$1,332.36	$10,659	
251	Stainless Steel Door (7' x 2.5') for O/U Baffling	8	EA			$5,829.09	$46,633	
252	Stainless Steel Door (2' x 2') for Serpentine Baffling	0	EA			$1,332.36	$0	
253	Allowance for Misc Items	5%				$57,291.66	$2,865	
254	Subtotal						$60,156	
255								
256	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
257	Horizontal Paddle Wheel Flocculation Mechanism (Paddles & Drives)	480	LF	146.30	m	***$1,716.25***	$823,801	
258	Vertical Paddle Wheel Flocculation Mechanism (Paddles & Drives)	0	EA			***$0.00***	$0	
259	Vertical Turbine Flocculation Mechanism (Turbines & Drives)	0	hp	0.00	kW	***$0.00***	$0	
260	Vertical Turbine Flocculator VFD's	0	hp	0.00	kW	***$0.00***	$0	
261	Fabricated Slide Gate	4	EA			***$9,614.74***	$38,459	
262	Allowance for Misc Items	10%				$862,259.99	$86,226	
263	Subtotal						$948,486	
264								
265	ELECTRICAL:							
266	*MCC's*							
267	Sections	12	EA			***$10,730.27***	$128,763	
268	*AFD's*							
269	Flocculation Mixers Stage 1 (total facility) (13 hp each)	4	EA			***$10,570.28***	$42,281	
270	Flocculation Mixers Stage 2 (total facility) (6 hp each)	4	EA			***$9,652.35***	$38,609	
271	Flocculation Mixers Stage 3 (total facility) (2 hp each)	4	EA			***$9,127.82***	$36,511	
272	Flocculation Mixers Stage 4 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
273	Flocculation Mixers Stage 5 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
274	Flocculation Mixers Stage 6 (total facility) (0 hp each)	0	EA			***$8,865.56***	$0	
275	*Switchgear*							
276	Units	0	EA			***$49,359.23***	$0	
277	Electrical Conduit & Wire	4,116	LF	1,254.56	m	***$12.06***	$49,635	
278	Allowance for Misc Items	10%				$295,799.75	$29,580	
279	Subtotal						$325,380	
280								
281	INSTRUMENTS & CONTROLS:							
282	Instruments							
283	Level Switch	4	EA			***$695.44***	$2,782	
284	Number of Analog I/O Counts	29	EA			***$264.27***	$7,611	
285	Number of Digital I/O Counts	72	EA			***$62.59***	$4,506	
286	Number of PLC's	1	EA			***$13,074.33***	$13,074	
287	I&C Conduit & Wire	5,360	LF	1,633.73	m	***$12.06***	$64,636	
288	Allowance for Misc Items	10%				$92,609.62	$9,261	
289	Subtotal						$101,871	
290								
291	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
292	Item 1 Description	0.00		0.00		0.00	$0	
293	Item 2 Description	0.00		0.00		0.00	$0	
294	Item 3 Description	0.00		0.00		0.00	$0	
295	Item 4 Description	0.00		0.00		0.00	$0	
296	Item 5 Description	0.00		0.00		0.00	$0	
297	Item 6 Description	0.00		0.00		0.00	$0	
298	Item 7 Description	0.00		0.00		0.00	$0	
299	Item 8 Description	0.00		0.00		0.00	$0	
300	Item 9 Description	0.00		0.00		0.00	$0	
301	Item 10 Description	0.00		0.00		0.00	$0	
302	Item 11 Description	0.00		0.00		0.00	$0	
303	Item 12 Description	0.00		0.00		0.00	$0	
304	Item 13 Description	0.00		0.00		0.00	$0	
305	Item 14 Description	0.00		0.00		0.00	$0	
306	Item 15 Description	0.00		0.00		0.00	$0	
307	Subtotal						$0	
308								
309	Subtotal						$8,178,779	
310								
311	ALLOWANCES:		**User Override**					
312	Finishes Allowance	2.00%		$8,889,977	$177,800			
313	I&C Allowance	2.00%		$8,889,977	$177,800			
314	Mechanical Allowance	2.00%		$8,889,977	$177,800			
315	Electrical Allowance	2.00%		$8,889,977	$177,800			
316						Facility Cost Name		
317	Facility Cost	**160,000,000**	**GPD**	**$0.06**	**$8,889,977**	FCPFC01		
318	Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.07**	**$10,801,931**	FCPFC02		

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	B	C	D	E	F	G	H	I
319	Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$0.12**	**$18,736,610**	FCPFC03		
320	Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$0.10**	**$15,420,208**	FCPFC05		
321	Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$0.12**	**$18,736,610**	FCPFC06		

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	B	C	D	E	F	G	H	I
1	***Dissolved Air Flotation***							
2								
3	**Is This Facility Included in My Project? No**							
4	***Assumptions:***							
5								
6	***1.) High-rate DAF based on Infilco Degremont AquaDAF.***							
7	***2.) Conventional DAF based on Parkson DAF.***							
8	***3.) Precede DAF with Flocculation with equal basin width to DAF.***							
9	***4.) Default System includes Mechanical Float Skimming.***							
10	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
11	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
12	DAF SYSTEM SIZING							
13	1.) Is this a Seawater Desalination Application?	**No**	Y/N					
14	2.) Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N					Fixed
15	3.) Input Total Plant Flow	**160.00**	mgd	**567.81**	ML/d	Q		
16	Conversion of Total Plant Flow from MGD to GPM	111,111.11	gpm	25,236.08	m3/hr	QM		
17	4.) Input DAF Type	**Conventional**	Type			DTYP		Conventional OR High Rate
18	5.) Input Flotation Zone Surface Loading Rate	**10.00**	gpm/sf	**24.45**	m/h	FSLR		Typically, 4 to 6 gpm/sf for Conventional & 10 to 12 gpm/sf for High Rate
19	6.) Input Flotation Zone Side Water Depth	**15.00**	ft	**4,572.00**	mm	SWD		Typically 10 to 15 feet
20	Calculate Total Surface Area of Flotation Zone per Train = QM/FSLR	11,111.11	sf	1,032.26	m2	FZA		
21	7.) For Conventional DAF, Select Single Train Flotation Area from Standard Sizes	**1,395.00**	sf	129.60	m2	SCTS		
22	8.) For High Rate DAF, Select Single Train Flotation Area from Standard Sizes	**717.00**	sf	66.61	m2	SHTS		
23	Calculate Number of Trains	8	#			NT		
24	Calculate Length of Flotation Zone	46.50	ft	14,173.20	mm	FZL		
25	Calculate Width of Flotation Zone	30.00	ft	9,144.00	mm	FZW		
26	Calculate Capacity of Each Train	13,888.89	gpm	3,154.51	m3/hr	QTM		
27	9.) Input Influent Channel, Contact Zone, and Effluent Channel Velocity	**0.50**	fps	**0.15**	m/s	VEL		Typically < 0.5 fps
28	Calculate Influent Channel, Contact Zone, and Effluent Channel Length = QTM/7.48/60/VEL/FZW OR 3	3.00	ft	914.40	mm	ICL, CZLB, SBL, ECL		
29	Calculate Contact Zone Under Baffle Entry Opening Height = QTM/7.48/60/VEL/FZW OR 3	3.00	ft	914.40	mm	CZEH		
30	Calculate Contact Zone Top Length = sin(15)/cos(15)*(CZBH - CZEH) + CZLB	5.55	ft	1,690.27	mm	CZLT		
31	Effluent Collection System Plenum Height for High Rate DAF	0.00	ft	0.00	mm	PH		
32	10.) Input Effluent Collection Lateral Velocity for Conventional DAF	**2.50**	fps	**0.76**	m/s	ECVEL		Typically 2.5 fps or less
33	Number of Effluent Collection Laterals for Conventional DAF	8.00	#			NCL		
34	Calculate Effluent Collection Lateral Pipe Diameter for Conventional DAF Train	17.00	in	431.80	mm	CLD		2.5 feet lower than effluent weir
35	Calculate Effluent Collection Lateral Spacing for Conventional DAF Train	3.34	ft	1,018.03	mm	CLSP		2.5 feet lower than effluent weir
36	Calculate Contact Zone 75-Degree Exit Baffle Height =	12.50	ft	3,810.00	mm	CZBH		2.5 feet lower than effluent weir
37	Calculate Float Weir Height = SWD+PH+0.5	15.50	ft	4,724.40	mm	FWH		0.5 feet higher than effluent weir
38	Sludge Float Trough Width	1.50	ft	457.20	mm	FTW		
39	Calculate Sludge Float Trough Depth	7.00	ft	2,133.60	mm	FTD		Based on hydraulic float removal at 3 fps
40	Calculate Recycle Pumping & Compressor Gallery Length	17.58	ft	5,359.40	mm	GL		
41	11.) Input Freeboard	**3.00**	ft	**1,219.20**	mm	FB		Typically 2 to 4 feet
42	Calculate Basin Depth BD = SWD+PH+FB	18.00	ft	5,486.40	mm	BD		
43	12.) Input Structure Depth of Burial	**0.00**	ft	**1,828.80**	mm	DB		
44	13.) Is the Basin Covered?	**No**	Y/N					
45	SATURATED AIR RECYCLE SYSTEM SIZING							
46	14.) Input Grams of Air per Cubic Meter Water Treated	**10.00**	g/m3			ALR		Typically 8 to 10 g/m3
47	15.) Input Air Saturation Recycle Stream Pressure	**85.00**	psig	**586.05**	kPa	RSP		Typically 60 to 90 psig
48	Conversion of Air Saturation Recycle Stream Pressure from PSIG to kPA	586.06	kPa			RSPM		
49	16.) Input Maximum Water Temperature	68.00	degrees F	**20.00**	degrees C	WT		Valid Range: 0 - 40 deg C. Warmer water requires greater recycle ratio for a given air loading rate and recycle stream pressure.
50	Dynamic (Absolute) Viscosity of Water	0.000021	lb•s/sf	0.001002	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
51	Calculate Air Dissolution at Recycle Stream Pressure & Water Temperature	117.21	mg/L			AD		See Data from air dissolution graphs worksheet
52	Calculate Air Saturation Recycle Stream Ratio = ALR/AD	0.09				ARR		
53	Calculate Number of Packed Saturators	8.00	#			#S		Equals Number of Trains
54	17.) Input Saturator Surface Loading Rate	**34.00**	gpm/sf	**83.12**	m/h			Typically 34 gpm/sf
55	18.) Input Saturator Packing Depth	**4.00**	ft	**1,219.20**	mm			Typically 4 feet or 0 feet, if No Packing
56	19.) Input Saturator Bottom Pool Depth	**3.00**	ft	**914.40**	mm			Typically 3 feet
57	20.) Input Saturator Freeboard Above Packing	**3.00**	ft	**914.40**	mm			Typically 3 feet
58	21.) Input Saturator Clear Height Above Deck	**3.00**	ft	**914.40**	mm			Typically 3 feet
59	22.) Input Saturator Inlet Velocity	**5.00**	fps	**1.52**	m/s			Typically 5 fps
60	23.) Input Saturator Outlet Velocity	**2.50**	fps	**0.76**	m/s			Typically 2.5 fps
61	Calculate Saturator Diameter	6.66	ft	2,030.39	mm	SD		
62	Calculate Saturator Height	13.00	ft	3,962.40	mm	SH		
63	Calculate Saturator Inlet Header Diameter	9.84	in	249.91	mm	SIHD		
64	Calculate Saturator Inlet Lateral Diameter	6.96	in	176.72	mm	SILD		
65	Calculate Saturator Outlet Header Diameter	13.91	in	353.43	mm	SOHD		
66	Calculate Saturator Outlet Half-Lateral Diameter	9.84	in	249.91	mm	SOHLD		
67	Calculate Number of Saturator Sub-Laterals	5.00	#			NSL		
68	Calculate Saturator Sub Lateral Diameter	6.22	in	158.06	mm	SOSLD		
69	Calculate Saturator Outlet Nozzle Header Diameter	4.92	in	124.96	mm	SODH		
70	Calculate Number of Recycle Pumps	8.00	#			#RP		Equals Number of Trains

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	B	C	D	E	F	G	H	I
71	Calculate Recycle Pump Capacity, each = QTM*ARR	1,184.94	gpm	269.13	m3/hr	RPC		
72	Calculate Recycle Pump Power, each = RPC*RSP/1714/0.75	79.00	hp	58.91	kW	RPP		
73	24.) Select Standard Recycle Pump Horsepower	**55.00**	hp	41.01	kW			Based on ITT Goulds Model 3196 Horizontal End Suction Centifugal Pump
74	Calculate Recycle Pump Suction Diameter	8.00	in	203.20	mm	RPS		
75	Calculate Recycle Pump Discharge Diameter	6.00	in	152.40	mm	RPD		
76	Calculate Recycle Pump Length	5.58	ft	1,701.80	mm	RPL		
77	Calculate Recycle Pump Width	2.00	ft	609.60	mm	RPW		
78	Calculate Recycle Pump Height	3.25	ft	990.60	mm	RPH		
79	Calculate Number of Compressors	2.00	#			#C		1 Duty and 1 Standby
80	25.) Input Compressor Inlet Air Density	**0.08**	lb/cf	**1.28**	kg/m3	IAD		0.075 for Dry Air @ Sea Level and 70 deg F
81	Calculate Compressor Capacity, each = AD*Q*ARR*8.3454/1440/IAD	115.91	icfm	3.28	m3/min	CC		
82	26.) Select Standard Rotary Screw Compressor Capacity	**116.00**	scfm	3.28	m3/min			Based on Gardner Denver Rotary Screw Compressor
83	Calculate Compressor Power	30.00	hp	22.37	kW	CHP		
84	Calculate Compressor Length	3.96	ft	1,206.50	mm	CL		
85	Calculate Compressor Width	2.46	ft	749.30	mm	CW		
86	Calculate Compressor Height	5.42	ft	1,651.00	mm	CH		
87	27.) Input Minimum Number of DAF Trains On-Line to Size Compressor Receiver Storage Volume	**1.00**	#			MDT		
88	28.) Input Maximum Number of Compressor Motor Starts per Hour	**3.00**	#			MMS		Typically 3 to 4
89	Calculate Minimum Compressed Air Use	14.49	icfm	0.41	m3/min	MCA		
90	29.) Input Compressed Air Density	**0.63**	lb/cf	**10.09**	kg/m3	CAD		0.626 for Dry Air @ 120 psig and 120 deg F
91	Calculate Minimum Receiver Storage Volume for 125 psig/120 deg F Air	1,926.79	gal	7.29	m3	TRSV		Calculated
92	Calculate Number of Receivers	2.00	#			#R		1 Duty and 1 Standby
93	30.) Select Standard Receiver Volume	**2,180.00**	gal	**8.25**	m3	SRSV		
94	Calculate Receiver Storage Diameter, each	5.00	ft	1,524.00	mm	RSD		
95	Calculate Receiver Storage Height w/1-Foot Stand, each	6.00	ft	1,828.80	mm	RSH		
96	Calculate Receiver Storage Length, each	16.00	ft	4,876.80	mm	RSL		
97	**(1) PARKSON CONVENTIONAL DAF SINGLE TRAIN STANDARD FLOTATION AREA (SF)**	**(2) Flotation Basin Width (ft)**	**(3) Flotation Basin Length (ft)**	**(4) Budget Quote**	**(5) Number of Saturator Outlet Quarter Laterals**	**(6) Number of 14-inch Perforated Effluent Collection Laterals on 4-foot Centers**	**(1) IDI High Rate AQUADAF Single Train Standard Flotation Area (SF)**	**(2) Flotation Basin Width (ft)**
98	720	24	30	$ 376,505.00	3.0	8.0	65	8.0
99	920	27	34	$ 455,513.00	4.0	8.0	110	12.0
100	1040	29	36	$ 502,918.00	4.0	8.0	162	16.0
101	1150	30	38.5	$ 546,372.00	4.0	8.0	222	20.0
102	1395	30	46.5	$ 643,157.00	4.0	8.0	292	24.0
103							369	28.0
104							463	32.0
105							581	36.0
106							717	40.0
107	**Process User Inputs**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
108	Estimating Dimensions (per Train):							
109	DAF Basin							
110	Slab on Grade:							
111	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on18"
112	Concrete Thickness	2.00	ft	609.60	mm	TLCS0G		
113	SOG Width (2 + PWLC + FZW + PWLC + 2)	38.00	ft	11,582.40	mm	WLCSOG		Assumes no common wall
114	SOG Length (IWLC + CL + IWLC + CL + CZBH/2*SIN15 + FZL + IWLC + STW + IWLC + CL + IWLC + CL + PWLC + 2)	74.31	ft	22,651.00	mm	LLCSOG		
115	Perimeter Walls:							
116	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 16"
117	Concrete Thickness	2.00	ft	609.60	mm	PWLC		
118	Wall Length = (L + L + W)	178.63	ft	54,446.00	mm			
119	Wall Height = BD	18.00	ft	5,486.40	mm			
120	Internal Walls:							
121	Concrete Thickness	**15.00**	in	**381.00**	mm			Model based on 12"
122	Concrete Thickness	1.25	ft	381.00	mm	IWLC		
123	Wall Length = (5 * FZW)	150.00	ft	45,720.00	mm			
124	Wall Height = BD - FB	15.00	ft	4,572.00	mm			
125	Elevated Slab:							
126	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 12"
127	Concrete Thickness	1.50	ft	457.20	mm	TESLC		
128	Elevated Slab Length = (L + L + W + W)	212.63	ft	64,809.20	mm			Assumes Perimeter Walkway on all 4 sides
129	Elevated Slab Width	6.00	ft	1,828.80	mm	TESIC		Fixed
130								
131	Gallery							
132	Slab on Grade:							
133	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 18"
134	Concrete Thickness	2.00	ft	609.60	mm	TECS0G		
135	SOG Width (Match DAF Basin)	38.00	ft	11,582.40	mm	WECSOG		
136	SOG Length (2 + TWEC + GL + TWEC + 2)	25.58	ft	7,797.80	mm	LECSOG		
137	Walls:							
138	Concrete Thickness	**24.00**	in	**609.60**	mm			Model based on 16"
139	Concrete Thickness	2.00	ft	609.60	mm	TWEC		
140	Wall Length = (GL + W + GL)	65.17	ft	19,862.80	mm			
141	Wall Height = BD	18.00	ft	5,486.40	mm			
142	Elevated Slab:							
143	Concrete Thickness	**15.00**	in	**381.00**	mm			Model based on 12"
144	Concrete Thickness	1.25	ft	381.00	mm	TESEC		
145	Elevated Slab Width (Match DAF Basin)	34.00	ft	10,363.20	mm			

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	B	C	D	E	F	G	H	I
146	Elevated Slab Length (TWEC + GL + TWEC)	21.58	ft	6,578.60	mm	TESIC		
147								
148	Overall Dimensions:							
149	SOG Width	38.00	ft	11,582.40	mm	SOGW		
150	SOG Length	99.90	ft	30,448.80	mm	SOGL		
151	Building Width (SOGW - 4)	34.00	ft	10,363.20	mm			
152	Building Length (SOGL - 4)	95.90	ft	29,229.60	mm			
153	Excavation Width	42.00	ft	12,801.60	mm			
154	Excavation Length	103.90	ft	31,668.00	mm			
155	Excavation Depth (DB + TLCSOG + 1)	3.00	ft	914.40	mm			
156								
157								
158	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
159	SITEWORK:							
160	Excavation	4,780.05	CY	3,654.61	m3	***$6.72***	$32,137	
161	Imported Structural Backfill	1,292.95	CY	988.53	m3	***$50.94***	$65,865	
162	Native Backfill	389.06	CY	297.46	m3	***$8.27***	$3,216	
163	Haul Excess	4,390.99	CY	3,357.16	m3	***$8.27***	$36,293	
164	Allowance for Misc Items	5%				$137,510.04	$6,876	
165	Subtotal						$144,386	
166								
167	CONCRETE:							
168	*DAF Basin:*							
169	Foundation	1,673.45	CY	1,279.44	m3	***$541.11***	$905,512	
170	Perimeter Walls	1,905.37	CY	1,456.76	m3	***$880.79***	$1,678,238	
171	Internal Walls	833.33	CY	637.13	m3	***$1,333.77***	$1,111,472	
172	Elevated Slab	567.01	CY	433.51	m3	***$490.62***	$278,184	
173	*Gallery:*							
174	Foundation	576.10	CY	440.46	m3	***$541.11***	$311,730	
175	Walls	695.11	CY	531.45	m3	***$880.79***	$612,249	
176	Elevated Slab	271.79	CY	207.80	m3	***$1,333.77***	$362,505	
177	Allowance for Misc Items	5%				$5,259,890.81	$262,995	
178	Subtotal						$5,522,885	
179								
180	MASONRY:	**High**						
181	CMU Building	0.00	SF	0.00	m2	***$198.37***	$0	
182	Subtotal						$0	
183								
184	METALS:							
185	Aluminum Handrail	1,023.18	LF	311.87	m	***$90.92***	$93,026	
186	Additional Handrail with NO Building	735.80	LF	224.27	m	***$90.92***	$66,897	
187	Aluminum Grating	360.00	SF	33.45	m2	***$90.92***	$32,731	
188	Stairs (1 per basin)	216.00	RISERS			***$495.92***	$107,118	
189	Allowance for Misc Items	10%				$299,771.53	$29,977	
190	Subtotal						$329,749	
191								
192	WOODS & PLASTICS:							
193	FRP Ladder	16.00	EA			***$1,757.20***	$28,115	
194	Allowance for Misc Items	5%				$28,115.24	$1,406	
195	Subtotal						$29,521	
196								
197	THERMAL & MOISTURE PROTECTION:							
198	Concrete Liner	0.00	SF	0.00	m2	**$16.00**	$0	
199	Allowance for Misc Items	10%				$0.00	$0	
200	Subtotal						$0	
201								
202	EQUIPMENT:							
203								**Budgetary Quote: (CPES will automatically add Installation Factor)**
204	Conventional DAF Equipment Scope of Supply per DAF Unit	8.00	EA			***$1,236,757.07***	$9,894,057	
205	Single Train Flotation Area (sf):	1,395.00						
206	Surface Skimmer, 304 SS reciprocating type mechanisms and							
207	Sludge Beach, 304SS with mounting hardware.							
208	Air Dispersion System, SCH 10 304SS vertical riser with isolation valves and lateral header with nozzles, for 10% recycle @ design flow.							
209	Recycle Pumps, base mounted Goulds Model 3196, suction and discharge wafer style isolation valves, check valves and magnetic flow meter with transmitter, One installed spare.							
210	Underflow Collection Pipes, SCH 80 PVC with 304 SS support brackets.							
211	Effluent Level Control Weir, FRP or SS with mounting hardware							
212	Sludge hopper spray system with spray nozzles and auto valve.							
213	Packed Tower Saturator with level control valve, outlet with isolation valve, air pressure controls and air filters with isolation valving.							
214	Duplex Screw Compressor and air receiver, each @ 100% of air required.							
215	Control Panel with PLC for process control and HOA operations.							
216	Lot of Isolation Valves, Anchors and Fasteners for supplied equipment.							
217	Submittals, Startup Services and IOM Manual							
218								
219	High Rate DAF Equipment Scope of Supply per DAF Unit	8.00	EA			***$0.00***	$0	
220	Single Train Flotation Area (sf):	717.00						
221	Mechanical sludge scraper system.							
222	Sludge Beach, 304SS with mounting hardware.							
223	Air Dispersion System, SCH 10 304SS vertical riser with isolation valves and lateral header with nozzles, for 10% recycle @ design flow.							
224	Recycle Pump, vertical turbine pumps per unit with VFD, butterfly isolation and check valves.							
225	Aluminum false flooring and support columns.							

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	B	C	D	E	F	G	H	I
226	Effluent Level Control Weir, FRP or SS with mounting hardware							
227	Sludge hopper spray system with spray nozzles and auto valve.							
228	Unpacked Saturator with level control valve, outlet with isolation valve, air pressure controls and air filters with isolation valving.							
229	Rotary Screw Compressor and air receiver system.							
230	Control Panel with PLC for process control and HOA operations.							
231	Lot of Isolation Valves, Anchors and Fasteners for supplied equipment.							
232	Submittals, Startup Services and IOM Manual							
233	Allowance for Misc Items	10%				$9,894,056.60	$989,406	
234	Subtotal						$10,883,462	
235								
236	INSTRUMENTS & CONTROLS:							
237	Turbidimeters	8.00	EA			***$11,714.68***	$93,717	
238	Allowance for Misc Items	5%				$93,717.45	$4,686	
239	Subtotal						$98,403	
240								
241	MECHANICAL:							
242	Mud Valves	24.00	EA			***$2,252.82***	$54,068	
243	Allowance for Misc Items	10%				$54,067.76	$5,407	
244	Subtotal						$59,475	
245								
246	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
247	Item 1 Description	0.00		0.00		0.00	$0	
248	Item 2 Description	0.00		0.00		0.00	$0	
249	Item 3 Description	0.00		0.00		0.00	$0	
250	Item 4 Description	0.00		0.00		0.00	$0	
251	Item 5 Description	0.00		0.00		0.00	$0	
252	Item 6 Description	0.00		0.00		0.00	$0	
253	Item 7 Description	0.00		0.00		0.00	$0	
254	Item 8 Description	0.00		0.00		0.00	$0	
255	Item 9 Description	0.00		0.00		0.00	$0	
256	Item 10 Description	0.00		0.00		0.00	$0	
257	Item 11 Description	0.00		0.00		0.00	$0	
258	Item 12 Description	0.00		0.00		0.00	$0	
259	Item 13 Description	0.00		0.00		0.00	$0	
260	Item 14 Description	0.00		0.00		0.00	$0	
261	Item 15 Description	0.00		0.00		0.00	$0	
262	Subtotal						$0	
263								
264	Subtotal						$17,067,881	
265								
266	ALLOWANCES:		**User Override**					
267	Finishes Allowance	2.00%		$20,318,906	$406,378			
268	I&C Allowance	4.00%		$20,318,906	$812,756			
269	Mechanical Allowance	6.00%		$20,318,906	$1,219,134	Includes Drain, USL, SA (Sample) piping		
270	Electrical Allowance	4.00%		$20,318,906	$812,756			
271						Facility Cost Name		
272	**Facility Cost**	**160,000,000**	**GPD**	**$0.13**	**$20,318,906**	CDFFC01		
273	**Facility Cost with Standard Additional Project Costs Added**	**160,000,000**	**GPD**	**$0.15**	**$24,688,863**	CDFFC02		
274	**Facility Cost with Standard Additional Project Costs and Contractor Markups Added**	**160,000,000**	**GPD**	**$0.27**	**$42,824,344**	CDFFC03		
275	**Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)**	**160,000,000**	**GPD**	**$0.22**	**$35,244,385**	CDFFC05		
276	**Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added**	**160,000,000**	**GPD**	**$0.27**	**$42,824,344**	CDFFC06		

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Mel

Pall Microfiltraion - Large Systems Greater Than 5 mgd

Is This Facility Included in My Project? Yes

Assumptions:

Applicable for Pall 8-inch Rack Systems, Pall 12-inch Rack Systems, Pall 48 Module Racks and Pall 80 Module Racks

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Comment	Red Flags	User Comments
Input Pressurized Membrane Type	Pall - 12 inch Rack Train	Type				Select "48 Module Rack" or "80 Module Rack" only for applications with < 5 mgd. Select "8-inch Rack" or "12-inch Rack" for applications > 5 mgd.		
Input Design Water Temperature	37.40	degrees F	3.00	degrees C				
Input Permeate Capacity (at Design Water Temperature)	160.00	mgd	567.81	ML/d				
Input Instantaneous Flux Rate (at Design Water Temperature)	53.00	gfd	89.98	Lmh		Should be endorsed by Senior Technical Consultant		
Input % of Feedflow Recirculation	3.00%					Should be endorsed by Senior Technical Consultant. Typically 0%. Pall is the only mfr to practice recirculation. Applicable range: 10% - 25%	OKAY	
Input Feedwater Recovery at Design Flow	97.00%					Typically 15 to 40 minutes		
Calculate Numer of Equal Capacity Subsystems	6.00	#				Maximum capacity per subsystem is 30 mgd		
Capacity of Each Subsystem	26.67	mgd	100.94	ML/d				
Treatment Trains per Subsystem:							Sizing Calculations per Subsystem	
Input Active Membrane Trains	9.00	#						
Input Number of Arrays per Skid	1.00	#				Pall - Multiple Rack Train: 1-3, Other Pall Selections: 1	OKAY	
Calculate Suggested Number of Standby Membrane Treatment Trains	1.00	#						
Input Number of Standby Membrane Treatment Trains	1.00	#						
Calculate Total Number of Membrane Treatment Trains	10.00	#						
Membrane Module Area	538.00	sf	49.98	m2		look up table		
Calculate Total Number of Membrane Modules	1,053.00	#						
Calculate Total Number of Membrane Modules per TreatmentTrain	117.00	#				Valid Ranges: 48 Module Rack 28 to 48, 80 Module Rack 48 to 80, 8-inch Rack 20 to 104, 12-inch Rack 20 to 132	OKAY	
Calculate Potential Number of Open Spaces for Future Membrane Modules per Cassette/Rack	15.00	#						
Calculate Percent Available Capacity Expansion on Existing Cassettes/Racks	12.82%							
Input Number of Spaces Reserved for Future Membrane Train	1.00	#				Suggest minimum 10% excess space for future expansion by either adding modules to existing trains, or space for a new train		
Calculate Total Number of Membrane Modules	1,170.00	#						
Calculate Total Installed Membrane Area	629,460.00	sf	58478.75	m2				
System Productivity Information:								
Calculate Minutes per Day Available for Filtration/Backwash Cycles	1,393.00	min						
Calculate Number of Filter/Backwash Cycles per Rack per Day	45.98	#						
Calculate Filtration Duration	28.63	min						
Calculate System On-line Factor	91.41%							
Calculate Gross Filtrate Production	27.31	mgd	103.40	ML/d				
Calculate Filtrate Flow Rate per Membrane Module	19.80	gpm	0.00	Lmh				
Backwash Information:								
Input Air Only Duration	0.00	min				Typical Range: 0.25 to 0.5		
Input Simultaneous Air + Reverse Filtration Duration	1.00	min				Typical Range: 0.5 to 1.5		
Input Feed Flush Duration	0.50	min				Typical Range: 0.25 to 0.75		
Pnuematic Valve Open and Close Time	10.00	sec				Fixed		
Air Flow per Membrane Module	3.00	scfm	0.08	m3/min		Look up table		This should be a user input witrh a default value of 3
RF Flow per Membrane Module	8.00	gpm	30.28	L/min		Fixed		This should be a user input with a default value of 8
FF Flow per Membrane Module	18.00	gpm	68.14	L/min		Fixed		This should be a user input with a default value of 18.
Calculate Feed to Waste per Module per Backwash Event	8.00	gal	30.28	L				
Calculate Filtrate to Waste per Module per Backwash Event	9.00	gal	34.07	L				
Calculate Total Water per Module per Backwash Event	17.00	gal	64.35	L				
Total Backwash Duration	1.67	min						
Chemically Enhanced Backwash (CEB) or Enhanced Flux Maintenance (EFM) Information:								
Input CEB/EFM Frequency	2.00	days				Typically 7 days, can be as often as 0.5 days		
Input CEB/EFM Duration	30.00	min				Typically 15 - 30 min		
Input Drain and Rinse Time	0.00	min				Typically 15 - 30 min		
Input Filtrate Used per Membrane Module	20.00	gal	75.71	L		Obtain from membrane manufacturer. Default is 20		
Pnuematic Valve Open and Close Time	10.00	sec				Fixed		
Is CEB/EFM Heated?	Yes	Y/N				Only Pall provides heated CEB/EFM	OKAY	
Is Sodium Hypochlorite CEB/EFM Conducted?	Yes	Y/N				Used for Organic Foulants		
Input Concentration of Sodium Hypochlorite for CEB/EFM	500.00	mg/L				Typically 50 - 500 mg/L		
Input Total Time of Backpulsing per Sodium Hypochlorite CEB/EFM	2.00	min				Typically 2 min		Doesn't apply for Pall systems
Is Citric Acid CEB/EFM Conducted?	No	Y/N				Used for Inorganic Foulants		
Input Concentration of Citric Acid for CEB/EFM	5,000.00	mg/L				Typically 5,000 - 20,000 mg/L		
Input Total Time of Backpulsing per Citric Acid CEB/EFM	2.00	min				Typically 2 min		Doesn't apply for Pall systems
Calculate Number of CEB/EFM Tanks Required	1.00	#			NCEBT			
Clean-In-Place (CIP) Information:								
Input CIP Frequency (both NaOCl/NaOH and Acid)	30.00	days				Should be endorsed by Senior Technical Consultant		
Input Sodium Hypochlorite/Sodium Hydroxide Duration	180.00	min				Typically 3 hours		
Input NaOCl/NaOH Filtrate Used per Membrane Module	20.00	gal	75.71	L		Typically 3 gpm/module		
Input Citric Acid Duration	180.00	min				Typically 2 hours		
Input Citric Acid Filtrate Used per Membrane Module	20.00	gal	75.71	L		Typically 3 gpm/module		
Integrity Testing Cycle Information:								

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Input Integrity Test Frequency	1.00	days				Typical Range: 0.33 to 6	
Input Integrity Test Duration	20.00	min				Typical Range: 15 to 30 minutes	
Pnuematic Valve Open and Close Time	10.00	sec				Fixed	
Average Daily Operating Mode Times:							
Calculate Permeating Time per Day	1,316.36	min					
Calculate Air Only Time Total per Day (min)	0.00	min					
Calculate Simulatenous Air and Reverse Filtration Total Time Per Day	45.98	min					
Calculate Feed Flush Total Time per Day	22.99	min					
Calculate AS Valve Open/Close Time per Day	15.33	min					
Calculate CEB/EFM Time Total per Day	15.00	min					
Calculate CEB/EFM Valve Open/Close Time per Day	15.00	min					
Calculate Total Cleain-In-Place Time per Day	12.00	min					
Calculate Integrity Testing Time per Day	20.00	min					
Calculate Integrity Testing Valve Open/Close Time per Day	0.33	min					
Calculate Daily Flows per Membrane Module:							
Calculate Total Gross Membrane Filtrate	26,065.85	gpd	98669.99	L/d			
Calculate Total Membrane Filtrate to Waste	617.85	gpd	2338.81	L/d			
Calculate Total Net Membrane Filtrate	25,448.01	gpd	96331.18	L/d			
Calculate Total Membrane Feed to Waste	413.83	gpd	1566.51	L/d			
Calculate Total Membrane Waste	1,031.68	gpd	3905.33	L/d			
Calculate Total Membrane Feed	26,479.68	gpd	100236.51	L/d			
Calculate Total Daily Feed Volume	27.88	mgd	105.55	ML/d			
Input Minimum Design Water Temperature	37.40	degrees F	3.00	degrees C			
Calculate Finished Water Capacity at Minimum Water Temperature	160.00	mgd	605.67	ML/d		Verify this is sufficient to meet cold water demands, if not increase design finished water capacity	
Calculate AS Time Total per Day	45.98	min	45.98				
Input Feed Forward/ Inst. Permeate Flow Ratio	1.00					Typical Range: 0.5 to 1.5	
Reverse Filtration (RF) Cycle Information:							
Input RF Frequency	0.50	hours				Typical Range: 0.25 to 0.75	
Input RF Duration	0.25	min				Typical Range: 0.25 to 0.5	
Pnuematic Valve Open or Closure Time	10.00	sec				Fixed	
RF Rate/Inst. Permeate Flow Rate	0.91					Look up table	
Membrane Train Dimensions:							
Train Length	33.21	ft	10121.90	mm	MTL	Look up table	
Train Width	5.92	ft	1803.40	mm	MTW	Look up table	
Train Height	11.50	ft	3505.20	mm	MTH	Look up table	
Membrane Train Concrete Pad Length	34.21	ft	10426.70	mm			
Membrane Train Concrete Pad Width	6.92	ft	2108.20	mm			
Clear Distance from Wall to End of Membrane Train	3.00	ft	914.40	mm	MTCD1	Look up table	
Clear Distance Between Membrane Trains Side by Side	3.00	ft	914.40	mm	MTCD2	Look up table	
Clear Distance above Top of Train	1.00	ft	304.80	mm	MTCH	Look up table	
Calculate Total Liquid Volume per Train	2,461.00	gal	9.32	m3		Look up table	
Membrane Train Pipe Trench Area Requirements							
Calculate Membrane Influent Header Diameter	42.00	in	1066.80	mm	FWIH		
Calculate Reverse Filtration Header Diameter	10.00	in	254.00	mm			
Calculate CIP Header Diameter	14.00	in	355.60	mm			
Calculate Backpulse Air Header Diameter	6.00	in	152.40	mm			
Calculate Common Permeate Header Diameter	42.00	in	1066.80	mm	MIH		
Calculate Backwash Waste Pipe Diameter	14.00	in	355.60	mm	SBWW		
Input Clear Distance Between Pipe Headers and Pipe Trench Walls	1.00	ft	304.80	mm		Typically 1 foot	
Input Clear Distance Between Stacked CIP and Backpulse Air Headers and Adjacent Pipe	3.00	ft	914.40	mm		Typically 2*max pipe diameter	OKAY
Input Clear Distance Between Pipe Headers and Pipe Trench Bottom	0.50	ft	152.40	mm		Typically 0.5 foot	
Input Clear Distance Between Pipe Headers and Top of Pipe Trench	1.00	ft	304.80	mm		Typically 1 foot	
Calculate Membrane Train Effluent Pipe Trench Width	0.00	ft	0.00	mm	PTW1	Not used for Pall Systems	
Calculate Membrane Train Effluent Pipe Trench Depth	0.00	ft	0.00	mm	PTD1	Not used for Pall Systems	
Calculate Membrane Train Influent Pipe Trench Width	18.17	ft	5537.20	mm	PTW2		
Calculate Membrane Train Influent Pipe Trench Depth	18.67	ft	5689.60	mm	PTD2		
Strainers:							**Sizing Calculations per Subsystem**
Are Strainers Included with this Facility?	Yes	Y/N					
Input Number of Equal Capacity Active Strainers	4.00	#				Per subsystem	OKAY
Input Number of Standby Strainers	1.00	#				Per subsystem	OKAY
Calculate Maximum Capacity per Strainer	5,082.86	gpm	320.68	L/s			
Input Strainer Inlet Size	24.00	in	609.60	mm			
Calculate Maximum Strainer Inlet Velocity	3.60	fps	1.10	m/s		Target velocity between 6 and 10 fps	**ERROR! - Reselect Number of Strainers and/or Strainer Size to Meet Velocity Criteria Between 6 and 10 fps**
Calculate Minimum Flow per Strainer	8,460.27	gpm	533.76	L/s		Based on 6 fps minimum for effective strainer performance	
Calculate Stainer Height	11.08	ft	3378.19	mm	STH	Look up table	
Calculate Strainer Length	4.50	ft	1371.60	mm	STL	look up table	
Calculate Strainer Width	4.17	ft	1270.01	mm	STW	look up table	
Input Clear Distance Between Strainers	4.00	ft	1,219.20	mm	STCD	Typically ≥ 4 ft	
Input Clear Distance Between Pipe Trench and Feed Pumps or Pipe Trench and Strainers	6.00	ft	1,828.80	mm	D1	Typically ≥ 6 ft	
Feed Pumps:							**Sizing Calculations per Subsystem**
Are Feed Pumps Included with this Facility?	Yes	Y/N					
Feed Pump Type	Horizontal Centrifugal	Type				Fixed	
If No Strainers, Input Number of Active Feed Pumps		#				Per subsystem	
If No Strainers, Input Number of Standby Feed Pumps		#				Per subsystem	
Number of Active Feed Pumps	4.00	#					
Number of Standby Feed Pumps	1.00	#					
Calculate Membrane Feed Pump Flow Rate (each)	4,990.53	gpm	314.85	L/s		Calculated based on required feed flow rate, including recirculation flow	

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Average Headloss through Membrane Treatment	16.00	psi	110.32	kPa		Look up table		
Maximum Headloss through Membrane Treatment	40.00	psi	275.79	kPa		Look up table		
Input Feed Pump Efficiency	80.00%							
Input Motor Efficiency of Feed Pump	95.00%							
Is Adjustable Frequency Drive (AFD) Used?	Yes	Y/N						
Input AFD Efficiency	98.00%							
Input Safety Margin Allocated in Pump Design Brake Horsepower	1.15							
Calculate Wire to Water Efficiency for Feed Pumps	74.48%							
Input Feed Pump TDH	102.30	ft	31.18	m		TDH is the sum of the permeate discharge pressure leaving the facility plus pipe losses (3.87 ft) plus losses across the membrane (92.43 ft) and the strainer (9.25 ft) minus the influent pressure to the facility		Pasco feed pumps are at intake, not in the membrane building. They have a design TDH of 205 ft with a static head of 80 ft.
Calculate Feed Pump Brake Horsepower (each)	190.00	hp	141.68	kW				
Calculate Average Motor Power Consumption for Feed Pump (each)	79.26	hp	59.11	kW				
Calculate Average Motor Power Consumption for Feed Pump (All ACTIVE)	317.06	hp	236.43	kW		Based on active pumps		
Calculate Feed Pump Pad Length	10.95	ft	3338.66	mm	FPL			
Calculate Feed Pump Pad Width	5.66	ft	1725.17	mm	FPW			
Calculate Feed Pump Height	5.09	ft	1551.90	mm	FPH			
Input Clear Distance Between Feed Pumps or Between Feed Pump and Strainer	6.00	ft	1,828.80	mm	FPCD	Typically ≥ 4 ft		
Strainer/Feed Pump Pipe Trench Area Requirements								
Calculate Strainer Influent Header Diameter	42.00	in	1066.80	mm	FWIH			
Calculate Strainer Effluent Header Diameter	42.00	in	1066.80	mm	MIH			
Calculate Reverse Filtration Header Diameter	10.00	in	254.00	mm				
Calculate Strainer Backwash Waste Pipe Diameter	4.00	in	101.60	mm	SBWW			
Input Clear Distance Between Pipe Headers and Pipe Trench Walls	1.00	ft	304.80	mm		Typically 1 foot		
Input Clear Distance Between Pipe Headers and Pipe Trench Bottom	0.50	ft	152.40	mm		Typically 0.5 foot		
Input Clear Distance Between Pipe Headers and Top of Pipe Trench	1.00	ft	304.80	mm		Typically 1 foot		
Input Clear Distance Between Feed Water Pipe Trench and Wall	8.00	ft	2,438.40	mm	D2	Typically greater than 8 ft for access		
Calculate Minimum Strainer Effluent Pipe Trench Width	8.17	ft	2489.20	mm	PTW3			
Calculate Minimum Strainer Effluent Pipe Trench Depth	5.00	ft	1524.00	mm	PTD3			
Calculate Minimum Strainer Influent Pipe Trench Width	5.50	ft	1676.40	mm	PTW4			
Calculate Minimum Strainer Influent Pipe Trench Depth	5.00	ft	1524.00	mm	PTD4			
Calculate Minimum Gallery Pipe Trench Width	6.83	ft	2082.80	mm	PTW5			
Calculate Minimum Gallery Pipe Trench Depth	5.00	ft	1524.00	mm	PTD5			
Blowers:							**Sizing Calculations per Subsystem**	
Calculate Instantaneous Air Flow per Treatment Train	351.00	scfm	9.94	m3/min				
Number of Air Scour Blowers	2.00	#			NASB	1 duty and 1 standby		
Approximate Blower Outlet Gage Pressure at Standard Conditions	13.00	psig	89.63	kPa	BOP	Fixed		
Determine PD Blower Model Number (Sutorbuilt, Legend Series, LP)	7HP					Look up table		
Determine Blower Horsepower at Standard Conditions	33.10	hp	24.68	kW		Look up table		
Calculate Blower Height	2.63	ft	800.10	mm	BLH			
Calculate Blower Pad Length	6.51	ft	1984.38	mm	BLL			
Calculate Blower Pad Width	10.69	ft	3257.55	mm	BLW	includes space for inlet and outlet silencers		
Input Clear Distance Between Blowers	4.00	ft	1,219.20	mm	BCD	Typically ≥ 4 ft		
Reverse Filtration System:							**Sizing Calculations per Subsystem**	
Reverse Filtration Pumps								
Number of Active Reverse Filtration Pumps	1.00	#				Fixed		
Input Number of Standby Reverse Filtration Pumps	1.00	#				Typically 1		
Calculate Total Number of Reverse Filtration Pumps	2.00	#			NRFP			
Calculate RF Flowrate	936.00	gpm	59.05	L/s				
Input Reverse Filtration Pump Efficiency	75.00%							
Input Motor Efficiency of Reverse Filtration Pump	95.00%							
Is Adjustable Frequency Drive (AFD) Used?	Yes	Y/N						
Input AFD Efficiency	98.00%							
Input Safety Margin Allocated in Pump Design Brake Horsepower	1.15							
Calculate Wire to Water Efficiency for Reverse Filtration Pumps	69.83%							
Input Reverse Filtration Pump TDH	115.00	ft	35.05	m		TDH is the sum of the backwash waste discharge pressure leaving the facility plus pipe losses (24 ft) plus losses across the membrane (92.43 ft) minus the permeate pressure leaving the facility		
Calculate Reverse Filtration Pump Brake Horsepower (each)	50.00	hp	37.28	kW				
Calculate Average Motor Power Consumption for Reverse Filtration Pump (each)	51.44	hp	38.36	kW				
Calculate Reverse Filtration Pump Pad Length	7.96	ft	2427.26	mm	RFPL			
Calculate Reverse Filtration Pump Pad Width	3.67	ft	1118.62	mm	RFPW			
Calculate Reverse Filtration Pump Pad Height	3.61	ft	1099.24	mm	RFPH			
Input Clear Distance Between Reverse Filtration Pumps	4.00	ft	1,219.20	mm	RFPCD			
Reverse Filtration Supply Tank								
Is a Tank Included as Part of the Reverse Filtration System?	No	Y/N				Default is Yes	**OKAY**	
Calculate Volume of Reverse Filtration Tank	0.00	gal	0.00	m3		20% over the liquid volume of a membrane train		
Calculate Volume of Reverse Filtration Tank	0.00	cf	0.00	m3				
Number of Reverse Filtration Tanks of Equal Size	0.00	#				Fixed		
Input Reverse Filtration Tank Freeboard	3.00	ft	609.60	mm	FB	Typically 2 feet		
Input Tank Type ("Circular" or "Rectangular")	Circular	Type				Typically a circular tank		
Input Height to Width Ratio or Height to Diameter Ratio	1.20							
Input Length to Width Ratio	1.00							
For Circular Tank, Calculate Flushing Tank Diameter	0.00	ft	0.00	mm	FTL & FTW			
For Circular Tank, Calculate Flushing Tank Side Water Depth	0.00	ft	0.00	mm	SWD			
For Circular Tank, Calculate Flushing Tank Total Height	0.00	ft	0.00	mm	FTH			
For Rectangular Tank, Calculate Flushing Tank Length	0.00	ft	0.00	mm	FTL			
For Rectangular Tank, Calculate Flushing Tank Width	0.00	ft	0.00	mm	FTW			
For Rectangular Tank, Calculate Flushing Tank Side Water Depth	0.00	ft	0.00	mm	SWD			
For Rectangular Tank, Calculate Flushing Tank Total Height	0.00	ft	0.00	mm	FTH			
Pneumatic Actuator Compressors:								
Total Required Hourly Air Volume (@ 80 psi, 21.1 deg C)	100.55	cf/hr	2.85	m3/hr		Based on assumed valve usage		
Optional: Input Hourly Air Volume if Known (@ 80 psi, 21.1 deg C)		cf/hr	0.00	m3/hr		This overwrites previous calculated volume		
Calculate Total Design Hourly Air Volume (@ 80 psi, 21.1 deg C)	201.11	cf/hr	5.69	m3/hr		Volume multiplied by two to allow capacity for MIT		
Input Max Operational Temperature	100.40	degrees F	38.00	degrees C				
Input Min Operational Temperature	50.00	degrees F	10.00	degrees C				
Design Temperature for Valves	69.98	degrees F	21.10	degrees C		21.1 degrees C		
Max Operational Pressure	125.00	psi	861.84	kPa		Fixed		
Min Operational Pressure	85.00	psi	586.05	kPa		Fixed		
Select Compressor Model	D 5.0 hp	Type				"S" indicates Simplex Compressor, "D" indicates Duplex Compressor		
Volume of Receiver	120.00	gal	0.45	m3		Look up table		
Calculate Operational Volume at Max Temp, Max Press (@ 80 psi, 21.1 deg C)	23.70	cf	0.67	m3				
Calculate Operational Volume at Min Temp, Max Press (@ 80 psi, 21.1 deg C)	26.05	cf	0.74	m3				
Calculate Max Number of Starts Required, per hour	8.48					Should be less than 3 per hour	**Error: Choose Larger Compressor**	

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Calculate Max Air Flowrate	501.66	scfm	14.21	m3/min		Flowrate multiplied by two to allow capacity for MIT, for informational purposes only		
Compressor Model, Gardener Denver	H5MTOIID-12					Look up table		
Compressor Pressurization Rate (@ 100 psi)	31.20	scfm	0.88	m3/min		Look up table		
Maximum Duration of Compressor Operation to Pressurize Tank	0.83	min						
Compressor Horsepower	5.00	hp	3.73	kW		Look up table		
Calculate Effective Compressor Horsepower	0.07	hp	0.05	kW				
Calculate Compressor Pad Length	7.08	ft	2159.00	mm	CL	Look up table		
Calculate Compressor Pad Width	3.42	ft	1041.40	mm	CW	Look up table		
Calculate Compressor Height	4.63	ft	1409.70	mm	CH	Look up table		
Clean-In-Place System:								
Calculate Number of CIP Systems Required	6.00	#				Includes CIP/Neutralization Tanks and Pumps		
Calculate Number of Chemical Cleans per Year	13.00	#						
Sodium Hypochlorite								
Will Sodium Hypochlorite be Used for Membrane Cleaning?	**Yes**	Y/N				Used to Remove Inorganic Foulants		These inputs should be with the other cleaning inputs
Input Concentration of Sodium Hypochlorite for Membrane Cleaning	**0.10%**					Typically 2%		
Input Number of Cleaning Segments Same Sodium Hypochlorite Solution Used	**1.00**					If unknown, use 1		
Calculate Annual Weight of Sodium Hypochlorite Used for Membrane Cleaning (100%)	16,273.53	lb	7381.55	kg				
Calculate Volume of BP Solution for Sodium Hypochlorite CEB	140,400.00	gpd	531471.82	L/d				
Calculate Sodium Hypochlorite Required for CEB	464.13	gpd	1756.93	L/d				
Calculate Annual Weight of Sodium Hypochlorite Required for CEB (100%)	213,834.18	lb	96993.55	kg				
Calculate Number of CIP Tanks Required	1.00	#						
Citric Acid								
Will Citric Acid be Used for Membrane Cleaning?	**Yes**	Y/N				Used to Remove Inorganic Foulants		These inputs should be with the other cleaning inputs
Input Concentration of Citric Acid for Membrane Cleaning	**2.00%**					Typically 2%		
Input Number of Consecutive Trains Cleaned with Same Citric Acid Solution	**1.00**	#				If unknown, use 1		
Calculate Annual Weight of Citric Acid Used for Membrane Cleaning (100%)	325,470.60	lb	147630.98	kg				
Calculate Volume of BP Solution for Citric Acid CEB	0.00	gpd	0.00	L/d				
Calculate Citric Acid Required for CEB	0.00	gpd	0.00	L/d				
Calculate Annual Weight of Citric Acid Required for CEB (100%)	0.00	lb	0.00	kg				
Calculate Number of CIP Tanks Required	1.00	#						
Sodium Bisulfite						Used for Sodium Hypochlorite Neutralization		
Calculate Annual Weight of Sodium Bisulfite (100%)	22,747.97	lb	10318.31	kg				
Sodium Hydroxide						Used for Acid Neutralization. Pall and Norit may also use to increase the pH of the Sodium Hypochlorite CIP		
Calculate Annual Weight of Sodium Hydroxide (100%)	203,292.07	lb	92211.73	kg				
Other Chemical								
Input Other Chemical's Name	**Phosphoric Acid**	Type						
Will this Chemical be Used for Membrane Cleaning?	**No**	Y/N						
Input Equivalent Weight of Chemical	**64.04**	mg/mg				calculate by dividing the molar mass of the chemical by the number of charges in ionic form		
Which chemical does this replace of the above choices?	**Citric Acid**	Type						
Input Concentration of Chemical	**2.00%**							
Input Number of Consecutive Trains Cleaned with Same Citric Acid Solution	**1.00**	#				If unknown, use 1		
Calculate Annual Weight of Chemical Used for Membrane Cleaning (100%)	0.00	lb	0.00	kg				
CIP/Neutralization Tank Sizing:							**Sizing Calculations per Subsystem**	
Ratio of CIP/Neutralization Tank to Membrane Train Volume	1.00					Look up table		
Calculate CIP Tank Size	2,500.00	gal	9.46	m3		Typically 2,500 to 3,000 gal, each		2479.72
Calculate Number of CEB/EFM Tanks	1.00	#			NCEBT			
Calculate Number of CIP Tanks	3.00	#			NCIPT	Includes CEB/EFM and CIP tanks		
Input Diameter of CIP Tanks	**7.50**	ft	**2.29**	m	CIPTD	Typically 7.5 ft diameter		
Calculate CIP Tank Height	7.56	ft	2305.74	mm				
Use this Tank Height	8.00	ft	2438.40	mm	CIPTH			
Is Neutralization Tank Included?	**Yes**	Y/N						
Calculate Number of Neutralization Tanks	1.00	#						
Calculate Neutralization Tank Size	7,500.00	gal	28.39	m3		Typically 3 to 4 times the CIP tank		
Input Diameter of Neutralization Tanks	**10.00**	ft	**3.05**	m	NTD	Typically 10 ft diameter		
Calculate Neutralization Tank Height	12.77	ft	3890.94	mm				
Use this Tank Height	13.00	ft	3962.40	mm	NTH			
Input Minimum Clear Distance Around CEB/CIP/Neutralization Tanks	**5.00**	ft	**1,524.00**	mm	D3	Typically ≥ 5 ft		
Cleaning Chemicals Storage Area Calculations:								
Chemical	**Sodium Hypochlorite**	**Citric Acid**	**Sodium Bisulfite**	**Sodium Hydroxide**	**Phosphoric Acid**			
Is this Chemical Used for CEB?	Yes	No	NA	NA	NA			
Is this Chemical Used CIP?	Yes	Yes	Yes	Yes	No			
Equivalent Weight of Chemical	74.45	64.04	104.07	40.00	64.04			
Percent Active Chemical	13%	50%	38%	**50.00%**	**50.00%**			
Bulk Chemical Specific Gravity	1.21	1.24	1.30	1.54	1.24			
Active Chemical Concentration, lb/gallon	1.26	5.17	4.12	6.43	5.17			
Choose Chemical Delivery Method	Tank Truck	Tank Truck	Tote	Tank Truck	Tank Truck			
Bulk Delivery Volume (Tank Truck, Totes, Drums), gallons	4,456.36	4,348.54	300.00	3,501.42	4,348.54			
Input Number of Days of CEB Storage (days)	30.00	30.00	30.00	30.00	30.00			
Calculate Storage Volume for CEB @ Avg. Flow/Dose (gallons)	13,923.97	0.00	N/A	N/A	N/A			
Input Number Full Facility Chemical Cleans to Store On-site	1.00	1.00	1.00	1.00	1.00			
Calculate **Storage Volume for Chemical Cleaning** (gallons)	991.74	4,838.71	424.45	2,433.54	0.00			
Calculate Total Storage Required for CEB & CIP (gallons)	14,915.70	4,838.71	424.45	2,433.54	0.00			
Calculate Bulk Delivery Volume * 1.5 (gallons)	6,684.54	6,522.81	300.00	5,252.14	6,522.81			
Maximum of Above 2 Volumes (gallons)	14,915.70	6,522.81	424.45	5,252.14	6,522.81			
Maximum Volume in (cf)	1,993.94	871.97	56.74	702.11	871.97			
Calculate Number of Totes or Drums (each)	0.00	0.00	2.00	0.00	0.00			
BULK TANKS:								
Input Number of Tanks (each)	2.00	1.00		1.00	1.00			
Input Tank Diameter (ft)	10.00	10.00		10.00	10.00	BTD Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.		
Calculate Height of Tanks (ft)	12.69	11.10		8.94	11.10			
Use this Tank Height (Liquid Height * 1.1) (ft)	**14.00**	**13.00**		**10.00**	**13.00**			
Input Number of Rows of Tanks (each)	1.00	1.00		1.00	1.00			
Calculate Number of Tanks per Row	2.00	1.00		1.00	0.00			
Input Tank Material (FRP, PE-Polyethylene, PLS-Phenolic Lined Steel)	FRP	FRP		FRP	FRP			
Input Clear Distance Around BulkTanks, Totes, or Drums (CDT)	4.00	4.00	4.00	4.00	4.00			
TOTES & DRUMS:								
Input Number of Rows of Totes or Drums (each)			2.00					
Calculate Number of Totes or Drums per Row			1.00					
Length of Each Tote (ft, Fixed)			4.00			Fixed		
Width of Each Tote (ft, Fixed)			4.00			Fixed		
Diameter of Each Drum (ft, Fixed)			2.50			Fixed		
METERING PUMPS:								

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Calculate Number of Active CEB Metering Pumps (each)	1.00	0.00				Rule: One active metering pump per application point.		
Calculate Number of Standby CEB Metering Pumps (each)	1.00	0.00				Rule: One standby metering pump per application point		
Calculate Total Number of CEB Metering Pumps (each)	2.00	0.00						
Calculate CEB Metering Pump Design Capacity (gph)	0.32	0.79						
Calculate Number of Active CIP Metering Pumps (each)	1.00	1.00	1.00	1.00	0.00	Rule: One active metering pump per application point.		
Calculate Number of Standby CIP Metering Pumps (each)	1.00	1.00	1.00	1.00	0.00	Rule: One standby metering pump per application point		
Calculate Total Number of CIP Metering Pumps (each)	2.00	2.00	2.00	2.00	0.00			
Calculate CEB Metering Pump Design Capacity (gph)	247.93	1,209.68	106.11	608.39	0.00			
Input Clear Distance Around Metering Pumps	**3.00**	ft	**914.40**	mm	CHCD	Typically ≥ 3 ft		
Length of Metering Pumps	3.00	ft	914.40	mm	CHPL	Conservatively assumes Pulsafeeder metering pump type.		
Width of Metering Pumps	1.50	ft	457.20	mm	CHPW	Conservatively assumes Pulsafeeder metering pump type.		
Width of Stair Access	3.50	ft	1066.80	mm	WS			
Input Common Chemical Access Corridor Width	**8.00**	ft	**2,438.40**	mm		Typically ≥ 6 ft		
CONTAINMENT AREA:								
Calculate Containment Area Length (ft)	32.00	18.00	12.00	18.00	0.00	80		
Calculate Containment Area Width (ft)	41.50	27.50	24.50	27.50	0.00			
Calculate Fire Sprinkler Water Volume (gal) (0.2 gpm/sf for 20 min.)	5,312.00	1,980.00	1,176.00	1,980.00	0.00			
Calculate 120% of One Storage Tank Volume (gal)	9,870.31	9,165.29	360.00	7,050.22	9,165.29			
Calculate 30% of All Tank Volume (gal)	4,935.16	2,291.32	180.00	1,762.56	2,291.32			
Maximum of Above 2 Volumes (gal)	9,870.31	9,165.29	360.00	7,050.22	9,165.29			
Calculate Maximum Volume + Fire Flow Volume (gal)	15,182.31	11,145.29	1,536.00	9,030.22	9,165.29			
Calculate Maximum Volume + Fire Flow Volume (cf)	2,029.58	1,489.91	205.33	1,207.17	1,225.22			
Calculate Containment Wall Height (including 6" Freeboard) (ft)	2.03	3.51	1.20	2.94	0.00	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.		
Cleaning Solution Recirculation Pumps Sizing:								
Number of Active Cleaning Solution Recirculation Pumps per Chemical	1.00	#				Fixed		Pasco has 2 pumps, 1 for recirculation, one for CIP drain. Circulation pump is sized for 434 gpm @ 70 ft (15 hp). Drain is sized for 310 gpm @ 70 ft (7.5 hp).
Input Number of Standby Cleaning Solution Recirculation Pumps per Chemical	**0.00**	#				Typically 1		
Calculate Total Number of Cleaning Solution Recirculation Pumps	2.00	#			NCIPP			
Ratio of Cleaning Solution Flux to Instantaneous Flux	3.00					Look up table		
Calculate CIP Flowrate	2,340.00	gpm	147.63	L/s				
Input Cleaning Solution Recirculation Pump Efficiency	**75.00%**							
Input Motor Efficiency of Cleaning Solution Recirculation Pump	**95.00%**							
Is Adjustable Frequency Drive (AFD) Used?	**No**	Y/N						
Input AFD Efficiency	**98.00%**							
Input Safety Margin Allocated in Pump Design Brake Horsepower	**1.15**							
Calculate Wire to Water Efficiency for Cleaning Solution Recirculation Pumps	71.25%							
Input Cleaning Solution Recirculation Pump TDH	**24.00**	ft	**7.32**	m		TDH is greater than or equal to pipe losses (5.06 ft)		
Calculate Cleaning Solution Recirculation Pump Horsepower (each)	22.00	hp	16.41	kW				
Calculate Average Motor Power Consumption for Cleaning Solution Recirculation Pump (each)	19.90	hp	14.84	kW				
Calculate Cleaning Solution Recirculation Pump Pad Length	7.38	ft	2248.52	mm	CPL			
Calculate Cleaning Solution Recirculation Pump Pad Width	3.67	ft	1118.62	mm	CPW			
Calculate Cleaning Solution Recirculation Pump Pad Height	3.32	ft	1010.86	mm	CPH			
Input Clear Distance Between CIP/Neutralization Pumps	**4.00**	ft	**1,219.20**	mm	CPCD			
Neutralized Chemical Transfer Pump Sizing:								
Number of Active Neutralized Chemical Transfer Pumps	1.00	#				Fixed		
Input Number of Standby Neutralized Chemical Transfer Pumps per Chemical	**0.00**	#				Typically 0		
Calculate Total Number of Neutralized Chemical Transfer Pumps	1.00	#			NCEBP			
Input Neutralized Chemical Transfer Pump Flowrate	**310.00**	gpm	**19.56**	L/s		Based on how fast the tank (2644 gal) should be drained. Typically 30 to 120 minutes		
Input Neutralized Chemical Transfer Pump TDH	**70.00**	ft	**21.34**	m		TDH is the sum of the backwash waste discharge pressure leaving the facility plus pipe losses (2.07 ft)		
Input Neutralized Chemical Transfer Pump Efficiency	**70.00%**							
Input Motor Efficiency of Neutralized Chemical Transfer Pump	**95.00%**							
Is Adjustable Frequency Drive (AFD) Used?	**No**	Y/N						
Input AFD Efficiency	**100.00%**							
Input Safety Margin Allocated in Pump Design Brake Horsepower	**1.15**							
Calculate Wire to Water Efficiency for Neutralized Chemical Transfer Pumps	66.50%							
Calculate Neutralized Chemical Transfer Pump Horsepower (each)	10.00	hp	7.46	kW				
Calculate Average Motor Power Consumption for Neutralized Chemical Transfer Pump (each)	8.24	hp	6.14	kW				
Calculate Neutralized Chemical Transfer Pump Pad Length	6.81	ft	2076.86	mm	CBPL			
Calculate Neutralized Chemical Transfer Pump Pad Width	3.67	ft	1118.62	mm	CBPW			
Calculate Neutralized Chemical Transfer Pump Pad Height	3.04	ft	925.97	mm	CBPH			
CIP Heater Sizing:								
Will a Heater be Used to Increase Temperature of CIP Cleaning Solution?	**Yes**	Y/N				Norit does not use heater, Suggest adding heater when design water temperature is below 20 deg C		
Input Minimum Initial Cleaning Solution Temperature	64.40	degrees F	**18.00**	degrees C		Based on Makeup Water Temperature		
Input Maximum Target Cleaning Solution Temperature	98.60	degrees F	**37.00**	degrees C		Check with MFR		
Total Number of Hours Required to Heat Cleaning Solution	4.00	hr				look up table		
Calculate CIP Heater Size (each)	65.35	kW				Includes a safety margin of 1.25		Pasco 62.5 kW.
Calculate Total Time per Year CIP Heater is Operating	520.00	hours/yr						
Calculate Effective Horsepower of CIP Heater (each)	5.20	hp	3.88	kW		Average HP of CIP heater assuming constant operation		
Calculate Total Number of CIP/CEB Heaters	3.00	#						
Is Membrane Facility inside a CMU Building?	**Yes**	Y/N						
Do you have Particle Counters?	**Yes**	Y/N						
Do you have a Combined Permeate Header Magmeter?	**No**	Y/N						
Input Facility Depth of Burial	**0.00**	ft		mm	DB			
Input Cutback Slope	**1.50**	:1 (ft:ft)				Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.	**Notice! Cutback slope of 1:1 is recommended for depth of burial < 5 ft.**	
Input Over Excavation Depth	**1.00**	ft	**304.80**	mm	OEXD			
People Spaces:								
Are Other People Spaces (office, control room, lab) to be Included?	**No**	Y/N						
Input Space Requirements for Control Room	**0.00**	sf	**13.94**	m2				
Input Number of Offices Desired	**0.00**	#				Assumes 100 sf of office space per office		
Calculate Space Requirements for Offices	0.00	sf	0.00	m2				
Input Space Requirements for Storage Room	**0.00**	sf	**13.94**	m2				
Input Space Requirements for Wet Laboratory	**0.00**	sf	**23.23**	m2				
Input Space Requirements for Restrooms	**0.00**	sf	**23.23**	m2				
Input Space Requirements for Other Rooms	**0.00**	sf	**13.94**	m2		Includes conference room, break room and other spaces		

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Input Length to Width Ratio for Control Room	0.00	#				Should be equal to the ratios for the storage room and other rooms		
Calculate Control Room Length	0.00	ft	0.00	mm				
Calculate Control Room Width	0.00	ft	0.00	mm				
Input Length to Width Ratio for Office Space	2.00	#				Should be equal to the ratios for the Laboratory and restrooms		
Calculate Office Space Length	0.00	ft	0.00	mm				
Calculate Office Space Width	0.00	ft	0.00	mm				
Input Length to Width Ratio for Storage Room	1.50	#				Should be equal to the ratios for the control room and other rooms	Ratios for Control Room, Storage Room and Other Spaces should be Equal	
Calculate Storage Room Length	0.00	ft	0.00	mm				
Calculate Storage Room Width	0.00	ft	0.00	mm				
Input Length to Width Ratio for Laboratory Room	2.00	#				Should be equal to the ratios for the office space and restrooms	OKAY	
Calculate Laboratory Room Length	0.00	ft	0.00	mm				
Calculate Laboratory Room Width	0.00	ft	0.00	mm				
Input Length to Width Ratio for Restrooms	2.00					Should be equal to the ratios for the office space and the laboratory		
Calculate Restrooms Length	0.00	ft	0.00	mm				
Calculate Restrooms Width	0.00	ft	0.00	mm				
Input Length to Width Ratio for Other Rooms	1.50					Should be equal to the ratios for the control room and storage room		
Calculate Other Rooms Length	0.00	ft	0.00	mm				
Calculate Other Rooms Width	0.00	ft	0.00	mm				
Calculations for Each Side of the Hallway								
Calculate Other Spaces Length	0.00	ft	0.00	mm				
Calculate Other Spaces Width	0.00	ft	0.00	mm				
Input Hallway Width	5.00	ft	1,524.00	mm		Typically 4 to 6 feet		
Calculate Hallway Length	0.00	ft	0.00	mm				
Calculate Hallway Area	0.00	sf	0.00	m2				
Flowrates for Mechanical User Inputs:								
Number of Equal Capacity Membrane Subsystems	6.00	#						
Calculate Number of Active MF Trains (per Subsystem)	9.00	#						
Calculate Number of Standby MF Trains (per Subsystem)	1.00	#						
Calculate Total Number of MF Trains (per Subsystem)	10.00	#						
Calculate Feed Flow per Train	3.19	mgd	12.09	ML/d				
Calculate Permeate Flow per Train	3.10	mgd	11.73	ML/d				
Calculate Reverse Filtration Flow per Train	1.35	mgd	5.10	ML/d				
Calculate CIP Supply and Return Flow Per Train	3.37	mgd	12.76	ML/d				
Calculate Feedwater Influent Flow	29.28	mgd	110.83	ML/d				
Calculate Feed Pump Discharge Flow	7.19	mgd	27.20	ML/d				
Calculate Strainer Inffluent Flow	7.32	mgd	27.71	ML/d				
Calculate Strainer Effluent Flow	6.97	mgd	26.39	ML/d				
Calculate Membrane Influent Flow	28.75	mgd	108.81	ML/d				
Calculate Membrane Filtrate Flow	26.67	mgd	100.94	ML/d				
Calculate Air Scour Flow	351.00	scfm	9.94	m3/min				
Calculate Membrane Backwash Waste Flow Rate	1.35	mgd	5.10	ML/d				
Mechanical Sizing Requirements:								
Pipe Name	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**	**Unit (Metric)**
Feed Water Inlet Header	5.00	fps	1.52	m/s	42.00	in	1050.00	mm
Feed Pump Suction Lateral	7.00	fps	2.13	m/s	18.00	in	450.00	mm
Feed Pump Discharge Lateral	10.00	fps	3.05	m/s	16.00	in	400.00	mm
Strainer Effluent Lateral	8.00	fps	2.44	m/s	16.00	in	400.00	mm
Strainer Effluent Common Header	5.00	fps	1.52	m/s	42.00	in	1050.00	mm
Membrane Influent Common Header	5.00	fps	1.52	m/s	42.00	in	1050.00	mm
Membrane Influent Lateral	7.00	fps	2.13	m/s	12.00	in	300.00	mm
Membrane Filtrate Lateral	7.00	fps	2.13	m/s	12.00	in	300.00	mm
Common Membrane Filtrate/Permeate Header	5.00	fps	1.52	m/s	42.00	in	1050.00	mm
Reverse Filtration Header	5.00	fps	1.52	m/s	10.00	in	250.00	mm
Reverse Filtration Lateral	5.00	fps	1.52	m/s	10.00	in	250.00	mm
Backwash Waste Header	6.00	fps	1.83	m/s	14.00	in	350.00	mm
Backwash Waste Lateral	3.00	fps	0.91	m/s	12.00	in	300.00	mm
CIP Supply/Return Header	5.00	fps	1.52	m/s	14.00	in	350.00	mm
CIP Supply/Return Lateral	5.00	fps	1.52	m/s	14.00	in	350.00	mm
Air Scour Header	50.00	fps	15.24	m/s	6.00	in	150.00	mm
Air Scour Lateral	50.00	fps	15.24	m/s	6.00	in	150.00	mm
Strainer Inlet/Outlet (TO VERIFY SIZING)	0.60	fps	0.18	m/s	24.00	in	600.00	mm
Strainer Backwash Waste	6.18	fps	1.88	m/s	4.00	in	100.00	mm
Membrane Integrity Test Piping					2.00	in	50.00	mm
Membrane Influent Lateral (TO VERIFY SIZING)	6.10	fps	1.86	m/s	12.00	in	300.00	mm
Reverse Filtration Lateral (TO VERIFY SIZING)	3.82	fps	1.17	m/s	10.00	in	250.00	mm
Permeate Discharge Lateral (TO VERIFY SIZING)	6.10	fps	1.86	m/s	12.00	in	300.00	mm
Backwash Waste Lateral (TO VERIFY SIZING)	2.66	fps	0.81	m/s	12.00	in	300.00	mm

Pipe Name	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Length to First Train, ft**	**Pipe Length for Subsequent Trains, ft**	**# Elbows**
Feed Water Inlet Header	FWIH	Exposed	Steel	Cement Mortar	Paint	342.30	0.00	0.00
Feed Pump Suction Lateral	FPSL	Exposed	Steel	Cement Mortar	Paint	21.32	21.32	0.00
Feed Pump Discharge Lateral	FPDL	Exposed	Steel	Cement Mortar	Paint	8.00	8.00	0.00
Strainer Effluent Lateral	SEL	Exposed	Steel	Cement Mortar	Paint	17.62	17.62	1.00
Strainer Effluent Common Header	SECH	Exposed	Steel	Cement Mortar	Paint	411.30	0.00	0.00
Membrane Influent Common Header	MIH	Exposed	SST	None	None	570.50	0.00	0.00
Membrane Influent Lateral	MIL	Exposed	SST	None	None	45.12	45.12	1.00
Membrane Filtrate Lateral	MFL	Exposed	SST	None	None	36.62	36.62	1.00
Common Membrane Filtrate/Permeate Header	CMFPH	Exposed	SST	None	None	630.50	0.00	0.00
Reverse Filtration Header	RFH	Exposed	SST	None	None	654.57	0.00	8.00
Reverse Filtration Lateral	RFL	Exposed	SST	None	None	48.62	48.62	1.00
Backwash Waste Header	BWW	Exposed	DI	Cement Mortar	Paint	630.50	0.00	0.00
Backwash Waste Lateral	BWWL	Exposed	DI	Cement Mortar	Paint	44.28	44.28	1.00
CIP Supply/Return Header	CIPH	Exposed	PVC	None	None	16228.52	0.00	72.00
CIP Supply/Return Lateral	CIPL	Exposed	PVC	None	None	45.03	45.03	8.00
Air Scour Header	BPA	Exposed	SST	None	None	881.38	0.00	12.00
Air Scour Lateral	BPAL	Exposed	SST	None	None	37.03	37.03	1.00
Strainer Backwash Waste	SBWW	Exposed	Steel	Cement Mortar	Paint	361.80	10.00	30.00
Membrane Integrity Test Piping	MIT	Exposed	SST	None	None	630.50	36.62	69.00

Electrical User Inputs and Sizing Requirements:		
Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
Is there SWGR?	No	Y/N

Pneumatic Actuator Sizing

Valve Size (in)	**Number of Valve Strokes/hr**	**Air Volume Storage Required (in3)**	**Max Number of Simultaneous Valves in Operation**	**Air Flowrate Required (scfm)**
4.00	156.00	2808.00	78.00	26.53
6.00	5.94	106.95	25.00	8.50
8.00	0.00	0.00	0.00	0.00
10.00	52.00	2080.00	3.00	2.27
12.00	176.00	7040.00	133.00	100.53
14.00	1056.00	126720.00	4.00	9.07
16.00	20.00	4000.00	20.00	75.59
18.00	5.00	1000.00	5.00	18.90
20.00	60.00	30000.00	1.00	9.45

Electrical Equipment Lengths:						MCC		
Item	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**	**Number of MCC Sections for Motors, AFD's, & Breakers**
Feed Pump (Active)	24.00	190.00	Yes	0.00	0.00	120.00		
Feed Pump (Standby)	6.00	190.00	Yes	0.00	0.00	30.00		

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Reverse Filtration Pump (Active)	6.00	50.00	Yes	0.00	36.00	12.00		
Reverse Filtration Pump (Standby)	6.00	50.00	Yes	0.00	36.00	12.00		
Cleaning Solution Recirculation Pump (Active)	6.00	22.00	No	18.00	0.00	0.00		
Cleaning Solution Recirculation Pump (Standby)	0.00	22.00	No	0.00	0.00	0.00		
Neutralized Chemical Transfer Pump (Active)	6.00	10.00	No	12.00	0.00	0.00		
Neutralized Chemical Transfer Pump (Standby)	0.00	10.00	No	0.00	0.00	0.00		
Blower (Active)	6.00	33.10	**Yes**	0.00	36.00	12.00		
Blower (Standby)	6.00	33.10	**Yes**	0.00	36.00	12.00		
Compressor	6.00	5.00	**No**	12.00	0.00	0.00		
CIP Heater	18.00	87.64	**No**	54.00	0.00	0.00		
CEB Metering Pumps (Active)	1.00	1.00	**No**	2.00	0.00	0.00		
CEB Metering Pumps (Standby)	1.00	1.00	**No**	2.00	0.00	0.00		
CIP Metering Pumps (Active)	4.00	1.00	**No**	8.00	0.00	0.00		
CIP Metering Pumps (Standby)	4.00	1.00	**No**	8.00	0.00	0.00		
TOTAL		**8506.68**		**116.00**	**144.00**	**198.00**	**458.00**	**39.00**
Total Effective Load	6863.08							
Electrical Equipment Widths:								
Equipment	**Depth (ft)**							
MCC	1.67							
Small AFD's	2.08							
Large AFD's	0.00							
Switchgear	0.00							
Maximum Depth	**2.08**							
Clear Distances:								
Clear Distance	**Width**	**Length**	**Comment**					
CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet				
CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot				
CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero				
CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero				
CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero				
CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)					
CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet				
Contingency Length		**0.00**	Contingency length	Typically Zero				
Electric Room Length (ft):								
CD1	3.00							
MCC	75.00							
CD2	1.00							
Small AFD's	139.86							
CD3	0.00							
Large AFD's	0.00							
CD4	0.00							
Swithgear	0.00							
CD5	0.00							
Contingency	0.00							
Total Length	**75.00**							
Electric Room Width (ft):								
CD6	0.00					If there is no switchgear, this distance will be Zero.		
Maximum Equipment Depth	2.08							
CD7	3.00							
Total Width	**8.33**							

FACILITY DIMENSION CALCULATIONS FOR CHEMICAL ROOM:

Estimating Calculations for Chemical Room	**Sodium Hypochlorite**	**Citric Acid**	**Sodium Bisulfite**	**Sodium Hydroxide**	**Phosphoric Acid**		
Logic Tests ("1" = Yes, "0" = No):							
Is "Other" Chemical Used for CIP? (1 = Yes, 0 = No)	0	0	0	0	0		
If "Other" Chemical is Used, Which Chemical Does it Replace for CIP? (0 = Replaced Chemical)	1	1	1	1	0		
Is this Chemical Feed System Included for CEB?	1	0	0	0	0	**1**	
If Other Chemical is used, is this Chemical Feed System Included for CIP?	1	1	1	1	0	**4**	
Is the Method of Delivery "Tank Truck"?	1	1	0	1	1		
Number of Bulk Tanks (each)	2	1	0	1	0		
Diameter of Bulk Tank (ft)	10.00	10.00	10.00	10.00	10.00		
Height of Bulk Tank (ft)	14.00	13.00	0.00	10.00	13.00		
Volume of Each Bulk Tank (gallons)	8225.26	7637.74	0.00	5875.19	7637.74		
Bulk Tank Material	FRP	FRP	FRP	FRP	FRP		
Length of Module (Tank Truck) (ft)	32.00	18.00	0.00	18.00	0.00		
Length of Module (Tote) (ft)	0.00	0.00	12.00	0.00	0.00		
Length of Module (Drum) (ft)	0.00	0.00	0.00	0.00	0.00		
Width of Module (Tank Truck) (ft)	41.50	27.50	0.00	27.50	0.00		
Width of Module (Tote) (ft)	0.00	0.00	24.50	0.00	0.00		
Width of Module (Drum) (ft)	0.00	0.00	0.00	0.00	0.00		
Area of Module (SF)	1328.00	495.00	294.00	495.00	0.00		
Number of Bulk Tanks (each)	2.00	1.00	0.00	1.00	0.00		
Diameter of Bulk Tank (ft)	10.00	10.00	0.00	10.00	0.00		
Volume of Each Bulk Tank (gal)	7457.85	4838.71	0.00	2433.54	0.00		
Bulk Tank Material	FRP	FRP	NA	FRP	FRP		
Total Number of Metering Pumps (CEP + CIP)	4.00	2.00	2.00	2.00	0.00		
Containment Wall Height (ft)	2.03	3.51	1.20	2.94	0.00		
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Chemical Room Corridor							
Chemical Room Corridor Length	80.00	ft	24384.00	mm			
Chemical Room Corridor Width	8.00	ft	2438.40	mm			
Chemical Room Corridor Area	640.00	sf	59.46	m2			
Chemical Room Overall Dimensions (Including Corridor):							
Total Chemical Room Length	80.00	ft	24384.00	mm			
Total Chemical Room Width (for purposes of calculating Excavation) (Feet)	49.50	ft	15087.60	mm			
Chemical Room Excavation Length	84.00	ft	25603.20	mm			
Chemical Room Excavation Width	53.50	ft	16306.80	mm			
Chemical Room Excavation Depth	0.75	ft	228.60	mm			
Total Chemical Room Area	3960.00	sf	367.90	m2			

Estimating Dimensions:	**Value English**	**Unit (English)**	**Value Metric**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**	**User Comments**
Equipment Quantities per Membrane Subsystem								
Number of Membrane Trains	11.00	#				per Subsystem		
Number of Strainers	5.00	#				per Subsystem		
Number of Feed Pumps	5.00	#				per Subsystem		
Number of CIP Recirculation Pumps	2.00	#				per Subsystem		
Number of Neutralized Chemical Transfer Pumps	1.00	#				per Subsystem		

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Number of CIP Tanks	3.00	#				per Subsystem	
Number of Reverse Filtration Pumps	2.00	#				per Subsystem	
Number of Blowers	2.00	#				per Subsystem	
Number of Compressors	1.00	#				per Subsystem	
Building Width Dimensions							
Membrane Building Wall Width	1.00	ft	304.80	mm			
Membrane Train Clear Distance	3.00	ft	0.91	m		assumes 0.5 ft space between train pad and trench and between trench and wall	
Membrane Train Effluent Pipe Trench Width	0.00	ft	0.00	m	PTW1		
Membrane Train Length	33.21	ft	10.12	m			
Membrane Train Concrete Pad Length	34.21	ft	10.43	m			
Pipe Gallery Width	18.67	ft	5.69	m		assumes 0.5 ft space between train pad and trench	
Membrane Train Influent Pipe Trench Width	18.17	ft	5.54	m	PTW2		
Clear Distance Between Wall and Equipment, Between Trenches, Between Equipment, or Between Wall and Trench	8.00	ft	2.44	m			
Strainer Effluent Pipe Trench Width	8.17	ft	2.49	m	PTW3		
Clear Distance Between Trench and Equipment	6.00	ft	1828.80	mm	D1		
Feed Pump Length	10.95	ft	3.34	m			
Strainer Influent Pipe Trench Width	5.50	ft	1676.40	mm	PTW4		
Electrical Room Width	8.33	ft	2540.00	mm			
Strainer Length	4.50	ft	1371.60	mm			
Reverse Filtration Pump Length	7.96	ft	2427.26	mm			
Reverse Filtration Tank Diameter/Length	0.00	ft	0.00	m			
Clear Distance Between Wall and Equipment, or Between Equipment	5.00	ft	1524.00	mm			
CIP/CEB/EFM Tank Diameter	7.50	ft	2.29	m			
CIP Chemical Neutralization Tank Diameter	10.00	ft	3.05	m			
Pipe Gallery Width	4.67	ft	1422.40	mm			
CIP Pump Length	7.38	ft	2248.52	mm			
Neutralized Chemical Pump Length	6.81	ft	2076.86	mm			
Blower Clear Distance	4.00	ft	1219.20	mm			
Blower Width	10.69	ft	3.26	m			
Chemical Pump Width	3.00	ft	914.40	mm			
Clear Distance Around Chemical Pumps	3.00	ft	914.40	mm			
Compressor Length	7.08	ft	2159.00	mm			
Blower Room Width	162.13	ft	49.42	m			
Building Length Dimensions							
Membrane Train Width	5.92	ft	1803.40	mm			
Membrane Train Concrete Pad Width	6.92	ft	2108.20	mm			
Membrane Train Clear Distance	3.00	ft	914.40	mm			
CIP Pipe Gallery Width	5.83	ft	1778.00	mm			
Clear Distance Between Equipment or Between Equipment and Wall	10.00	ft	3048.00	mm		Fixed	
Blower Length	6.51	ft	1984.38	mm			
Compressor Width	3.42	ft	1041.40	mm			
Feed Pump Width	5.66	ft	1725.17	mm			
Feed Pump Clear Distance	6.00	ft	1828.80	mm			
Strainer Width	4.17	ft	1270.01	mm			
Strainer Clear Distance	4.00	ft	1219.20	mm			
Minimum Gallery Pipe Trench Width	6.83	ft	2.08	m	PTW5		
Reverse Filtration Pump Clear Distance	4.00	ft	1219.20	mm			
Reverse Filtration Pump Width	3.67	ft	1118.62	mm			
Reverse Filtration Tank Diameter/Width	0.00	ft	0.00	m			
Clear Distance Between CIP Pumps	4.00	ft	1219.20	mm			
CIP Pump Width	3.67	ft	1118.62	mm			
Neutralized Chemical Pump Width	3.67	ft	1118.62	mm			
Chemical Pump Length	3.00	ft	914.40	mm			
Electrical Room Length	75.00	ft	22.86	m			
Blower Room Length	28.10	ft	8.57	m			
Building Height Dimensions							
Membrane Train Height	11.50	ft	3.51	m			
Clear Height Above Membrane Trains	1.00	ft	304.80	mm			
Feed Pump Height	5.09	ft	1551.90	mm			
Strainer Height	11.08	ft	3.38	m			
Reverse Filtration Pump Height	3.61	ft	1099.24	mm			
Reverse Filtration Tank Height	0.00	ft	0.00	m			
CIP Pump Height	3.32	ft	1010.86	mm			
Neutralized Chemical Pump Height	3.04	ft	925.97	mm			
CIP Tank Height	8.00	ft	2.44	m			
CIP Chemicals Neutralization Tank Height	13.00	ft	3.96	m			
Blower Height	2.63	ft	800.10	mm			
Compressor Height	4.63	ft	1409.70	mm			
Chemical Pump Height	4.00	ft	1219.20	mm			
Membrane Train Effluent Pipe Trench Depth	0.00	ft	0.00	mm	PTD1		
Membrane Train Influent Pipe Trench Depth	18.67	ft	5689.60	mm	PTD2		
Strainer Effluent Pipe Trench Depth	5.00	ft	1524.00	mm	PTD3		
Strainer Influent Pipe Trench Depth	5.00	ft	1524.00	mm	PTD4		
Minimum Gallery Pipe Trench Depth	5.00	ft	1524.00	mm	PTD5		
Slab on Grade Thickness	1.00	ft	304.80	mm			
Equipment Pad Thickness	1.00	ft	304.80	mm			
Membrane Building Calculations							
Membrane Building Width Dimension Alt #4	70.38	ft	21.45	m			
Membrane Building Width Dimension Alt #1	110.50	ft	33.68	m			
Membrane Building Width Dimension Alt #2	96.01	ft	29.26	m			
Membrane Building Length Dimension Alt #5	690.50	ft	210.46	m			
Membrane Building Length Dimension Alt #1	124.08	ft	37.82	m			
Membrane Building Length Dimension Alt #2	114.17	ft	34.80	m			
Membrane Building Width (Excavation Purposes)	50.21	ft	15.30	m			
Membrane Building Length (Excavation Purposes)	690.50	ft	210.46	m			
CIP Area Calculations							
CIP Area Width	199.26	ft	60.74	m			
CIP Area Length	55.00	ft	16.76	m			
CIP Area	10959.42	sf	1018.16	m2			
Feed Pumps and Strainers Area Calculations							
Feed Pumps and Strainers Area Width	361.80	ft	110.28	m			
Feed Pumps and Strainers Area Length	63.12	ft	19.24	m			
Feed Pumps and Strainers Area	22836.91	sf	2121.62	m2			
Feed Pumps and Strainers Area Width (Excavation Purposes)	361.80	ft	110.28	m			
Feed Pumps and Strainers Area Length (Excavation Purposes)	43.45	ft	13.24	m			
Reverse Filtration Area Calculations							
Reverse Filtration System Area Width	116.04	ft	35.37	m			
Reverse Filtration System Area Length	19.96	ft	6.08	m			
Reverse Filtration System Area	2316.56	sf	215.22	m2			

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Reverse Filtration Area Width (Excavation Purposes)	116.04	ft	35.37	m				
Reverse Filtration Area Length (Excavation Purposes)	19.96	ft	6.08	m				
Facility Dimensions								
Membrane Building Width	70.38	ft	21.45	m	MBW			
Membrane Building Length	690.50	ft	210.46	m	MBL			
Membrane Building Area	48593.94	sf	4514.52	m2				
Feed Pumps and Strainer Area Width	361.80	ft	110.28	m	FPSAW			
Feed Pumps and Strainer Area Length	63.12	ft	19.24	m	FPSAL			
Feed Pumps and Strainer Area	22836.91	sf	2121.62	m2				
Reverse Filtration System Area Width	116.04	ft	35.37	m	RFAW			
Reverse Fitlration System Area Length	19.96	ft	6.08	m	RFAL			
Reverse Filtration System Area	2316.56	sf	215.22	m2				
CIP Area Width	199.26	ft	60.74	m	CAW			
CIP Area Length	55.00	ft	16.76	m	CAL			
CIP Area	10959.42	sf	1018.16	m2				
Blower Room Width	162.13	ft	49.42	m	BRW			
Blower Room Length	28.10	ft	8.57	m	BRL			
Blower Room Area	4556.39	sf	423.30	m2				
Electric Room Width	8.33	ft	2.54	m	ERW			
Electric Room Length	75.00	ft	22.86	m	ERL			
Electric Room Area	625.00	sf	58.06	m2				
People Spaces Area Width	0.00	ft	0.00	m	PSAW			
People Spaces Area Length	0.00	ft	0.00	m	PSAL			
People Spaces Building Area	0.00	sf	0.00	m2				
CIP Chemicals Storage Area Width	80.00	ft	24.38	m	CCSAW			
CIP Chemicals Storage Area Length	49.50	ft	15.09	m	CCSAL			
CIP Chemicals Storage Area	3960.00	sf	367.90	m2				
Calculations for Pipe Trenches								
Membrane Effluent Pipe Trench 1 Length	80.08	ft	24.41	m				
Membrane Effluent Pipe Trench 1 Width	0.00	ft	0.00	m				
Membrane Effluent Pipe Trench 1 Wall Height	0.00	ft	0.00	mm				
Membrane Influent Pipe Trench 2 Length	8.00	ft	2.44	m				
Membrane Influent Pipe Trench 2 Width	18.17	ft	5.54	m				
Membrane Influent Pipe Trench 2 Wall Height	18.67	ft	5689.60	mm				
Strainer Effluent Pipe Trench 3 Length	361.80	ft	110.28	m				
Strainer Effluent Pipe Trench 3 Width	8.17	ft	2.49	m				
Strainer Effluent Pipe Trench 3 Wall Height	5.00	ft	1524.00	mm				
Strainer Influent Pipe Trench 4 Length	361.80	ft	110.28	m				
Strainer Influent Pipe Trench 4 Width	5.50	ft	1676.40	mm				
Strainer Influent Pipe Trench 4 Wall Height	5.00	ft	1524.00	mm				
Building Excavation Dimensions								
Membrane Building Excavation Width	54.21	ft	16.52	m				
Membrane Building Excavation Length	694.50	ft	211.68	m				
Feed Pump and Strainer Area Excavation Width	365.80	ft	111.50	m				
Feed Pump and Strainer Area Excavation Length	47.45	ft	14.46	m				
Reverse Filtration System Area Excavation Width	120.04	ft	36.59	m				
Reverse Filtration System Area Excavation Length	23.96	ft	7.30	m				
CIP Area Excavation Width	203.26	ft	61.95	m				
CIP Area Excavation Length	59.00	ft	17.98	m				
Blower Room Excavation Width	166.13	ft	50.63	m				
Blower Room Excavation Length	32.10	ft	9.79	m				
Electric Room Excavation Width	12.33	ft	3.76	m				
Electric Room Excavation Length	79.00	ft	24.08	m				
People Spaces Excavation Width	4.00	ft	1.22	m				
People Spaces Excavation Length	4.00	ft	1.22	m				
CIP Chemicals Storage Area Excavation Width	84.00	ft	25.60	m				
CIP Chemicals Storage Area Excavation Length	53.50	ft	16.31	m				
Facility Excavation Depth	2.00	ft	609.60	mm				
Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"		
Slab on Grade Thickness	1.00	ft	304.80	mm				
Membrane Building Wall Thickness	**12.00**	in	**304.80**	mm	MBWW	Model based on 12"		
Membrane Building Wall Thickness	1.00	ft	304.80	mm	MBWW			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 12"		
Elevated Slab Thickness	1.00	ft	304.80	mm				
Input Equipment Pad Thickness	**1.00**	ft	**304.80**	mm				
Input Chemical Bulk Storage Pad Thickness	**3.00**	ft	**914.40**	mm				
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**							
Tanks (Installed Cost per Gallon)								
FRP	***$ 4.25***							
Polyethylene (PE)	***$ 2.25***							
Phenolic Lined Steel (PLS)	***$ 6.41***							
Chemical Feed Pumps (Cost per Each)	***$ 10,658.90***	***40E***						

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write	Reference
SITEWORK:								
Membrane Building Excavation	3309.71	CY	2530.45	m3	***$6.72***	$22,251		***02E***
Membrane Building Imported Structural Backfill	2788.72	CY	2132.13	m3	***$50.94***	$142,062		***02SB***
Membrane Building Native Backfill	166.38	CY	127.21	m3	***$8.27***	$1,375		***02B***
Membrane Building Haul Excess	3143.33	CY	2403.25	m3	***$8.27***	$25,981		***02HE***
Membrane Feed/Effluent Pipe Trench Area Excavation	679.85	CY	519.79	m3	***$6.72***	$4,571		***02E***
Membrane Feed/Effluent Pipe Trench Area Imported Structural Backfill	10.77	CY	8.23	m3	***$50.94***	$548		***02SB***
Membrane Feed/Effluent Pipe Trench Area Native Backfill	506.53	CY	387.27	m3	***$8.27***	$4,187		***02B***
Membrane Feed/Effluent Pipe Trench Area Haul Excess	173.32	CY	132.51	m3	***$8.27***	$1,433		***02HE***
Strainer Inlet/Outlet Pipe Trench Area Excavation	2172.41	CY	1660.92	m3	***$6.72***	$14,605		***02E***
Strainer Inlet/Outlet Pipe Trench Area Imported Structural Backfill	294.80	CY	225.39	m3	***$50.94***	$15,018		***02SB***
Strainer Inlet/Outlet Pipe Trench Area Native Backfill	1023.98	CY	782.89	m3	***$8.27***	$8,463		***02B***
Strainer Inlet/Outlet Pipe Trench Area Haul Excess	1148.42	CY	878.03	m3	***$8.27***	$9,492		***02HE***
Feed Pump and Strainer Area Excavation	1542.97	CY	1179.68	m3	***$6.72***	$10,373		***02E***
Feed Pump and Strainer Area Imported Structural Backfill	1285.82	CY	983.08	m3	***$50.94***	$65,502		***02SB***
Feed Pump and Strainer Area Native Backfill	91.83	CY	70.21	m3	***$8.27***	$759		***02B***
Feed Pump and Strainer Area Haul Excess	1451.13	CY	1109.47	m3	***$8.27***	$11,994		***02HE***
Reverse Filtration System Area Excavation	274.49	CY	209.86	m3	***$6.72***	$1,845		***02E***
Reverse Filtration System Area Imported Structural Backfill	213.08	CY	162.91	m3	***$50.94***	$10,855		***02SB***
Reverse Filtration System Area Native Backfill	32.00	CY	24.47	m3	***$8.27***	$264		***02B***
Reverse Filtration System Area Haul Excess	242.49	CY	185.40	m3	***$8.27***	$2,004		***02HE***

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CIP Area Excavation	1060.20	CY	810.58	m3	$6.72	$7,128		02E
CIP Area Imported Structural Backfill	888.33	CY	679.18	m3	$50.94	$45,253		02SB
CIP Area Native Backfill	58.28	CY	44.56	m3	$8.27	$482		02B
CIP Area Haul Excess	1001.92	CY	766.03	m3	$8.27	$8,281		02HE
Blower Room Excavation	491.80	CY	376.01	m3	$6.72	$3,306		02E
Blower Room Imported Structural Backfill	395.06	CY	302.04	m3	$50.94	$20,125		02SB
Blower Room Native Backfill	44.05	CY	33.68	m3	$8.27	$364		02B
Blower Room Haul Excess	447.75	CY	342.33	m3	$8.27	$3,701		02HE
Electric Room Excavation	103.57	CY	79.18	m3	$6.72	$696		02E
Electric Room Imported Structural Backfill	72.17	CY	55.18	m3	$50.94	$3,677		02SB
Electric Room Native Backfill	20.30	CY	15.52	m3	$8.27	$168		02B
Electric Room Haul Excess	83.27	CY	63.66	m3	$8.27	$688		02HE
People Spaces Excavation	3.32	CY	2.54	m3	$6.72	$22		02E
People Spaces Imported Structural Backfill	1.19	CY	0.91	m3	$50.94	$60		02SB
People Spaces Native Backfill	1.78	CY	1.36	m3	$8.27	$15		02B
People Spaces Haul Excess	1.54	CY	1.18	m3	$8.27	$13		02HE
Chemical Room Excavation	144.63	CY	110.57	m3	$6.72	$972		02E
Chemical Room Imported Structural Backfill	166.44	CY	127.26	m3	$50.94	$8,479		02SB
Chemical Room Native Backfill	4.30	CY	3.29	m3	$8.27	$36		02B
Chemical Room Haul Excess	140.33	CY	107.29	m3	$8.27	$1,160		02HE
Allowance for Misc Items	5%				$458,208.21	$22,910		
Subtotal						$481,119		
CONCRETE:								
Membrane Building Slab on Grade	1856.28	CY	1419.23	m3	$490.62	$910,723		03S
Feed Pump and Strainer Area Slab on Grade	877.44	CY	670.85	m3	$490.62	$430,484		03S
Reverse Filtration System Area Slab on Grade	96.02	CY	73.41	m3	$490.62	$47,109		03S
CIP Area Slab on Grade	424.89	CY	324.85	m3	$490.62	$208,456		03S
Blower Room Slab on Grade	182.99	CY	139.91	m3	$490.62	$89,780		03S
Electric Room Slab on Grade	29.47	CY	22.53	m3	$490.62	$14,458		03S
People Spaces Slab on Grade	0.15	CY	0.11	m3	$490.62	$73		03S
CIP Chemical Room Slab on Grade	117.31	CY	89.69	m3	$490.62	$57,552		03S
Membrane Effluent Pipe Trench #1 Walls	0.00	CY	0.00	m3	$880.79	$0		03W
Membrane Influent Pipe Trench #2 Walls	11.06	CY	8.46	m3	$880.79	$9,743		03W
Strainer Effluent Pipe Trench #3 Walls	134.00	CY	102.45	m3	$880.79	$118,026		03W
Strainer Effluent Pipe Trench #4 Walls	134.00	CY	102.45	m3	$880.79	$118,026		03W
CIP Chemical Room Containment Walls:								
Sodium Hypochlorite	3.63	CY	2.78	m3	$880.79	$3,197		03W
Citric Acid	2.25	CY	1.72	m3	$880.79	$1,979		03W
Sodium Bisulfite	1.80	CY	1.38	m3	$880.79	$1,588		03W
Sodium Hydroxide	2.25	CY	1.72	m3	$880.79	$1,979		03W
Phosphoric Acid	0.00	CY	0.00	m3	$880.79	$0		03W
Pump Pads:								
Feed Pumps	14.74	CY	11.27	m3	$490.62	$7,233		03P
Reverse Filtration Pumps	3.10	CY	2.37	m3	$490.62	$1,521		03P
Cleaning Solution Recirculation Pumps	2.90	CY	2.22	m3	$490.62	$1,422		03P
Neutralized Chemical Transfer Pumps	1.35	CY	1.03	m3	$490.62	$663		03P
Blower and Compressor Pads:								
Blowers	6.50	CY	4.97	m3	$490.62	$3,190		03P
Compressors	1.32	CY	1.01	m3	$490.62	$649		03P
Liquid CIP Chemical Transfer Pumps Pads:								
Sodium Hypochlorite	2.22	CY	1.70	m3	$490.62	$1,090		03P
Citric Acid	2.22	CY	1.70	m3	$490.62	$1,090		03P
Sodium Bisulfite	2.22	CY	1.70	m3	$490.62	$1,090		03P
Sodium Hydroxide	2.22	CY	1.70	m3	$490.62	$1,090		03P
Phosphoric Acid	0.00	CY	0.00	m3	$490.62	$0		03P
Tank Pads:								
CIP / Chemical Neutralization Tanks	37.83	CY	28.92	m3	$490.62	$18,560		03P
Reverse Filtration Tank	0.00	CY	0.00	m3	$490.62	$0		03P
Sodium Hypochlorite	21.12	CY	16.15	m3	$490.62	$10,361		03P
Citric Acid	10.56	CY	8.07	m3	$490.62	$5,181		03P
Sodium Bisulfite	0.00	CY	0.00	m3	$490.62	$0		03P
Sodium Hydroxide	10.56	CY	8.07	m3	$490.62	$5,181		03P
Phosphoric Acid	0.00	CY	0.00	m3	$490.62	$0		03P
Allowance for Misc Items	5%				$2,071,495.11	$103,575		
Subtotal						$2,175,070		
MASONRY:	**High**							
CMU Building	93848.22	SF	8718.78	m2	$198.37	$18,616,378		04BH
Subtotal						$18,616,378		
METALS:								
Membrane Effluent Pipe Trench #1 Grating	0.00	SF	0.00	m2	$90.92	$0		05G
Membrane Influent Pipe Trench #2 Grating	145.33	SF	13.50	m2	$90.92	$13,213		05G
Strainer Effluent Pipe Trench #3 Grating	2954.70	SF	274.50	m2	$90.92	$268,636		05G
Strainer Effluent Pipe Trench #4 Grating	1989.90	SF	184.87	m2	$90.92	$180,918		05G
Stairs to Access Chemical Rooms	4.00	EA			$8,327.28	$33,309		
Grating for Wet Well in CIP Chemical Containment Rooms	4.00	EA			$1,669.06	$6,676		
Allowance for Misc Items	5%				$502,752.61	$25,138		
Subtotal						$527,890		
DOORS & WINDOWS:								
Roll-Up Door	2.00	EA			$5,400.90	$10,802		
Single Entry Door (4' wide)	7.00	EA			$2,082.51	$14,578		08FD
Double Entry Door (6' wide)	1.00	EA			$2,082.51	$2,083		08FD
Allowance for Misc Items	10%				$27,461.89	$2,746		
Subtotal						$30,208		
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**	
Membrane Equipment (Pall - 12 inch Rack Train)	3776760.00	SF	350872.49	m2	$17.81	$67,276,604		40E
Includes:								
Microfiltration modules								
Permeate pumps								
Air blowers								
Reverse Filtration Pumps								
CIP tanks and pumps								
Neutralization pump and tank								
Interconnecting piping								
Pilot plant								
Control system								
Pumps:								
Feed Pump (Active) (4991 gpm each, 190 hp each)	24.00	EA			$242,409.03			40E
Feed Pump (Standby) (4991 gpm each, 190 hp each)	6.00	EA			$242,409.03			40E
Reverse Filtration Pump (Active) (936 gpm each, 50 hp each)	6.00	EA			$97,251.76			40E
Reverse Filtration Pump (Standby) (936 gpm each, 50 hp each)	6.00	EA			$97,251.76			40E
Cleaning Solution Recirculation Pump (Active) (22 hp each)	6.00	EA			$128,763.21			40E
Cleaning Solution Recirculation Pump (Standby) (22 hp each)	0.00	EA			$128,763.21			40E
CIP Tank (2500 gallons each)	18.00	EA			$6,407.05			
Air Scour Blower (Active) (351 scfm each)	6.00	EA						
Air Scour Blower (Standby) (351 scfm each)	6.00	EA						
Neutralized Chemical Transfer Pump (Active) (10 hp each)	6.00	EA			$3,446.79			
Neutralized Chemical Transfer Pump (Standby) (10 hp each)	0.00	EA			$3,446.79			

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Strainers (Active)	24.00	EA			$132,820.76			40E
Strainers (Standby)	6.00	EA			$132,820.76			40E
Compressor (Active) (5hp)	6.00	EA			$24,035.80			40E
CIP Heater (65 kw each)	18.00	EA			$14,307.02			
Reverse Filtration Tank (0 gal each)	0.00	EA			$0.00	$0		
Chemical Storage Area:								
Sodium Hypochlorite								
Bulk Tank (10'diameter, 14' high, FRP, 8225 gal each)	2.00	EA			$15,829.11	$31,658		
Metering Pump	4.00	EA			$10,658.90	$42,636		
Citric Acid								
Bulk Tank (10'diameter, 13' high, FRP, 7638 gal each)	1.00	EA			$14,862.23	$14,862		
Metering Pump	2.00	EA			$10,658.90	$21,318		
Sodium Bisulfite								
Bulk Tank (None)	0.00	EA			$0.00	$0		
Metering Pump	2.00	EA			$10,658.90	$21,318		
Sodium Hydroxide								
Bulk Tank (10'diameter, 10' high, FRP, 5875 gal each)	1.00	EA			$11,961.59	$11,962		
Metering Pump	2.00	EA			$10,658.90	$21,318		
Phosphoric Acid								
Bulk Tank (10'diameter, 13' high, FRP, 7638 gal each)	0.00	EA			$14,862.23	$0		
Metering Pump	0.00	EA			$10,658.90	$0		
Allowance for Misc Items	4%				$67,441,674.61	$2,697,667		
Subtotal						$70,139,342		
I&C:								
Instruments								
Feed Water Inlet Header Magmeter (FWIH, 42 inch)	6.00	EA			$45,061.33	$270,368		
Reverse Filtration Header Magmeter (RFH, 10 inch)	6.00	EA			$7,680.41	$46,082		
Common Membrane Filtrate/Permeate Header Magmeter (CMFPH, 42 inch)	0.00	EA			$45,061.33	$0		
CIP Supply/Return Header Magmeter (CIPH, 14 inch)	1.00	EA			$8,487.92	$8,488		
Air Scour Header Magmeter (BPA, 6 inch)	6.00	EA			$7,977.22	$47,863		
Isolation Valve Actuators (Electric)	25.00	EA				$0		
Isolation Valve Actuators (Pneumatic)	465.00	EA				$0		
Turbidimeters	10.00	EA				$0		
Particle Counters	10.00	EA				$0		
Level Transmitters	18.00	EA				$0		
Differential Pressure Transmitters	10.00	EA				$0		
Air Scour Differential Pressure Transmitter	2.00	EA				$0		
Air Scour Discharge Pressure Indicator Transmitter	2.00	EA				$0		
Air Scour Blowoff Valve	1.00	EA				$0		
CIP Chemical Tank Radar Level Transmitters	4.00	EA			$1,043.16	$4,173		
CIP Chemical Tank Beacons	4.00	EA			$1,043.16	$4,173		
CIP Chemical Day Tank Differential Pressure Transmitter	0.00	EA			$1,043.16	$0		
CIP Chemical Drum or Tote Weigh Scale	1.00	EA			$1,390.89	$1,391		
CIP Chemical Metering Pump Discharge Pressure Switch	10.00	EA			$695.44	$6,954		
CIP Chemical Magmeter	10.00	EA			$695.44	$6,954		
CIP Chemical Sump Pump Float Switch	4.00	EA			$347.72	$1,391		
CIP Chemical Eyewash	4.00	EA			$1,043.16	$4,173		
Number of Analog I/O Counts	173.00	EA				$0		
Number of Digital I/O Counts	234.00	EA				$0		
Number of Local Panels	10.00	EA				$0		
Number of PLC's	2.00	EA				$0		
I&C Conduit Wire	568352.92	LF	173233.97	m	$12.06	$6,853,756		
Allowance for Misc Items	5%				$7,255,766.19	$362,788		
Subtotal						$7,618,554		
CONVEYING SYSTEMS:								
Monorail Hoist	2	EA			$4,091.32	$8,183		14MH
Hoist Rail	615	LF	187.50	m	$41.33	$25,422		14MR
Allowance for Misc Items	10%				$33,604.56	$3,360		
Subtotal						$36,965		
MECHANICAL:								
Pipe:								
Feed Water Inlet Header (FWIH, 42 inch, Steel)	342.30	LF	104.33	m	$970.77	$332,293		
Feed Pump Suction Lateral (FPSL, 18 inch, Steel)	106.59	LF	32.49	m	$416.04	$44,347		
Feed Pump Discharge Lateral (FPDL, 16 inch, Steel)	40.00	LF	12.19	m	$369.82	$14,793		
Strainer Effluent Lateral (SEL, 16 inch, Steel)	88.12	LF	26.86	m	$369.82	$32,590		
Strainer Effluent Common Header (SECH, 42 inch, Steel)	411.30	LF	125.36	m	$970.77	$399,276		
Membrane Influent Common Header (MIH, 42 inch, SST)	570.50	LF	173.89	m	$1,532.93	$874,534		
Membrane Influent Lateral (MIL, 12 inch, SST)	2977.70	LF	907.60	m	$437.98	$1,304,169		
Membrane Filtrate Lateral (MFL, 12 inch, SST)	2416.70	LF	736.61	m	$437.98	$1,058,463		
Common Membrane Filtrate/Permeate Header (CMFPH, 42 inch, SST)	630.50	LF	192.18	m	$1,532.93	$966,510		
Reverse Filtration Header (RFH, 10 inch, SST)	654.57	LF	199.51	m	$364.98	$238,905		
Reverse Filtration Lateral (RFL, 10 inch, SST)	583.40	LF	177.82	m	$364.98	$212,931		
Backwash Waste Header (BWW, 14 inch, DI)	630.50	LF	192.18	m	$121.38	$76,530		
Backwash Waste Lateral (BWWL, 12 inch, DI)	531.40	LF	161.97	m	$104.04	$55,287		
CIP Supply/Return Header (CIPH, 14 inch, PVC)	16228.52	LF	4946.45	m	$125.96	$2,044,131		
CIP Supply/Return Lateral (CIPL, 14 inch, PVC)	540.40	LF	164.71	m	$125.96	$68,068		
Air Scour Header (BPA, 6 inch, SST)	881.38	LF	268.64	m	$218.99	$193,012		
Strainer Backwash Waste (SBWW, 4 inch, Steel)	661.80	LF	201.72	m	$92.45	$61,186		
Membrane Integrity Test Piping (MIT, 2 inch, SST)	3047.20	LF	928.79	m	$73.00	$222,435		
Elbows:								
Feed Water Inlet Header (FWIH, 42 inch, Steel)	0.00	EA			$5,846.39	$0		
Feed Pump Suction Lateral (FPSL, 18 inch, Steel)	0.00	EA			$2,505.60	$0		
Feed Pump Discharge Lateral (FPDL, 16 inch, Steel)	0.00	EA			$2,227.20	$0		
Strainer Effluent Lateral (SEL, 16 inch, Steel)	5.00	EA			$2,227.20	$11,136		
Strainer Effluent Common Header (SECH, 42 inch, Steel)	0.00	EA			$5,846.39	$0		
Membrane Influent Common Header (MIH, 42 inch, SST)	0.00	EA			$7,959.34	$0		
Membrane Influent Lateral (MIL, 12 inch, SST)	66.00	EA			$2,274.10	$150,090		
Membrane Filtrate Lateral (MFL, 12 inch, SST)	66.00	EA			$2,274.10	$150,090		
Common Membrane Filtrate/Permeate Header (CMFPH, 42 inch, SST)	0.00	EA			$7,959.34	$0		
Reverse Filtration Header (RFH, 10 inch, SST)	88.00	EA			$1,895.08	$166,767		
Reverse Filtration Lateral (RFL, 10 inch, SST)	11.00	EA			$1,895.08	$20,846		
Backwash Waste Header (BWW, 14 inch, DI)	0.00	EA			$2,547.57	$0		
Backwash Waste Lateral (BWWL, 12 inch, DI)	11.00	EA			$2,183.63	$24,020		
CIP Supply/Return Header (CIPH, 14 inch, PVC)	72.00	EA			$503.43	$36,247		
CIP Supply/Return Lateral (CIPL, 14 inch, PVC)	528.00	EA			$503.43	$265,810		
Air Scour Header (BPA, 6 inch, SST)	12.00	EA			$1,137.05	$13,645		
Strainer Backwash Waste (SBWW, 4 inch, Steel)	30.00	EA			$556.80	$16,704		
Membrane Integrity Test Piping (MIT, 2 inch, SST)	69.00	EA			$379.02	$26,152		
Tee:								
Feed Water Inlet Header (FWIH, 42 inch, Steel)	30.00	EA			$13,320.29	$399,609		
Feed Pump Suction Lateral (FPSL, 18 inch, Steel)	0.00	EA			$5,708.70	$0		
Feed Pump Discharge Lateral (FPDL, 16 inch, Steel)	0.00	EA			$5,074.40	$0		
Strainer Effluent Lateral (SEL, 16 inch, Steel)	0.00	EA			$5,074.40	$0		
Strainer Effluent Common Header (SECH, 42 inch, Steel)	36.00	EA			$13,320.29	$479,530		
Membrane Influent Common Header (MIH, 42 inch, SST)	66.00	EA			$11,160.02	$736,561		
Membrane Influent Lateral (MIL, 12 inch, SST)	0.00	EA			$3,188.58	$0		
Membrane Filtrate Lateral (MFL, 12 inch, SST)	0.00	EA			$3,188.58	$0		
Common Membrane Filtrate/Permeate Header (CMFPH, 42 inch, SST)	66.00	EA			$11,160.02	$736,561		
Reverse Filtration Header (RFH, 10 inch, SST)	66.00	EA			$2,657.15	$175,372		
Reverse Filtration Lateral (RFL, 10 inch, SST)	0.00	EA			$2,657.15	$0		
Backwash Waste Header (BWW, 14 inch, DI)	11.00	EA			$4,230.18	$46,532		

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Backwash Waste Lateral (BWWL, 12 inch, DI)	0.00	EA			$3,625.87	$0		
CIP Supply/Return Header (CIPH, 14 inch, PVC)	312.00	EA			$779.06	$243,066		
CIP Supply/Return Lateral (CIPL, 14 inch, PVC)	0.00	EA			$779.06	$0		
Air Scour Header (BPA, 6 inch, SST)	72.00	EA			$1,594.29	$114,789		
Strainer Backwash Waste (SBWW, 4 inch, Steel)	30.00	EA			$1,268.60	$38,058		
Membrane Integrity Test Piping (MIT, 2 inch, SST)	72.00	EA			$531.43	$38,263		
Valves:								
Feed Water Inlet Header (FWIH, 42 inch, STL)	0.00	EA			$42,759.05	$0		
Feed Pump Suction Lateral (FPSL, 18 inch, STL)	5.00	EA			$18,325.31	$91,627		
Feed Pump Discharge Lateral (FPDL, 16 inch, STL)	15.00	EA			$16,289.16	$244,337		
Strainer Effluent Lateral (SEL, 16 inch, STL)	5.00	EA			$16,289.16	$81,446		
Strainer Effluent Common Header (SECH, 42 inch, STL)	0.00	EA			$42,759.05	$0		
Membrane Influent Common Header (MIH, 42 inch, SST)	0.00	EA			$37,214.68	$0		
Membrane Influent Lateral (MIL, 12 inch, SST)	66.00	EA			$10,632.76	$701,762		
Membrane Filtrate Lateral (MFL, 12 inch, SST)	66.00	EA			$10,632.76	$701,762		
Common Membrane Filtrate/Permeate Header (CMFPH, 42 inch, SST)	0.00	EA			$37,214.68	$0		
Reverse Filtration Header (RFH, 10 inch, SST)	3.00	EA			$8,860.64	$26,582		
Reverse Filtration Lateral (RFL, 10 inch, SST)	11.00	EA			$8,860.64	$97,467		
Backwash Waste Header (BWW, 14 inch, DI)	0.00	EA			$12,404.89	$0		
Backwash Waste Lateral (BWWL, 12 inch, DI)	11.00	EA			$10,632.76	$116,960		
CIP Supply/Return Header (CIPH, 14 inch, PVC)	0.00	EA			$12,404.89	$0		
CIP Supply/Return Lateral (CIPL, 14 inch, PVC)	264.00	EA			$12,404.89	$3,274,892		
Air Scour Header (BPA, 6 inch, SST)	24.00	EA			$5,316.38	$127,593		
Strainer Backwash Waste (SBWW, 4 inch, STL)	30.00	EA			$4,072.29	$122,169		
Membrane Integrity Test Piping (MIT, 2 inch, SST)	78.00	EA				$0		
Allowance for Misc Items	2%				$17,675,905.08	$353,518		
Subtotal						$18,029,423		
ELECTRICAL:								
# MCC Sections	45.00	EA			$10,730.27	$482,862		26MCC
Switchgear	0.00	EA			$4,935.92	$0		26SG
Adjustable Frequency Drives								
Feed Pump (Active) (190 hp each)	24.00	EA			$33,780.67	$810,736		
Feed Pump (Standby) (190 hp each)	6.00	EA			$33,780.67	$202,684		
Cleaning Solution Recirculation Pump (Active) (22 hp each)	0.00	EA			$15,422.17	$0		
Cleaning Solution Recirculation Pump (Standby) (22 hp each)	0.00	EA			$15,422.17	$0		
Neutralized Chemical Transfer Pump (Active) (10 hp each)	0.00	EA			$11,750.46	$0		
Neutralized Chemical Transfer Pump (Standby) (10 hp each)	0.00	EA			$11,750.46	$0		
Blower (Active) (33 hp each)	6.00	EA			$10,176.88	$61,061		
Blower (Standby) (33 hp each)	6.00	EA			$10,176.88	$61,061		
Compressor (5 hp each)	0.00	EA			$13,206.03	$0		
CIP Heater (88 hp each)	0.00	EA			$13,206.03	$0		
CIP Metering Pumps (Active) (1 hp each)	0.00	EA			$9,521.22	$0		
CIP Metering Pumps (Standby) (1 hp each)	0.00	EA			$20,357.66	$0		
Electrical Conduit & Wire	5620.86	LF	1713.24	m	$12.06	$67,782		
Allowance for Misc Items	10%				$1,686,186.60	$168,619		
Subtotal						$1,854,805		
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**		
Item 1 Description	0.00		0.00		0.00	$0		
Item 2 Description	0.00		0.00		0.00	$0		
Item 3 Description	0.00		0.00		0.00	$0		
Item 4 Description	0.00		0.00		0.00	$0		
Item 5 Description	0.00		0.00		0.00	$0		
Item 6 Description	0.00		0.00		0.00	$0		
Item 7 Description	0.00		0.00		0.00	$0		
Item 8 Description	0.00		0.00		0.00	$0		
Item 9 Description	0.00		0.00		0.00	$0		
Item 10 Description	0.00		0.00		0.00	$0		
Item 11 Description	0.00		0.00		0.00	$0		
Item 12 Description	0.00		0.00		0.00	$0		
Item 13 Description	0.00		0.00		0.00	$0		
Item 14 Description	0.00		0.00		0.00	$0		
Item 15 Description	0.00		0.00		0.00	$0		
Subtotal						$0		
Subtotal						$119,509,755		
ALLOWANCES:		**User Override**						
Finishes Allowance	2.00%		$124,489,328	$2,489,787				
I&C Allowance	1.00%		$124,489,328	$1,244,893				
Mechanical Allowance	0.00%		$124,489,328	$0				
Electrical Allowance	1.00%		$124,489,328	$1,244,893				
					Facility Cost Name			
Facility Cost	**160,000,000**	**GPD**	**$0.78**	**$124,489,328**				
Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.95**	**$151,263,068**				
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$1.64**	**$262,375,045**				
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$1.35**	**$215,934,354**				
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$1.64**	**$262,375,045**				

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	B	C	D	E	F	G	H	I
1	***Ozone - Serpentine***							
2	**PROCESS DESIGN CRITERIA**							
3	**Is This Facility Included in My Project? No**							
4	**Type of Feed Gas: Delivered LOX**							
5	**Type of Dissolution: Diffused Bubble**							
6	**Type of Contactor: Serpentine**							
7	**Number of parallel trains or contactors: Minimum of 2**							
8								
9	**Process User Inputs:**	**Value (English)**	**Value (English)**	**Value (Metric)**	**Value (Metric)**	**Name**	**Red Flags**	**Comment**
10	1.) Input Summer Maximum Plant Flow Rate	**160.00**	mgd	**567.81**	ML/d			
11	2.) Input Winter Maximum Plant Flow Rate	**100.00**	mgd	**378.54**	ML/d			
12	3.) Input Maximum Oxidation Flow Rate	**160.00**	mgd	**567.81**	ML/d			
13	4.) Input Number of Contactors	**2**	each	2.00	each			Typically 2 minimum.
14								
15	**Process User Inputs:**	**Value (English)**	**Value (English)**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Value (Metric)**	**Value (Metric)**
16	Ozone Chemistry and Contactor Sizing:	**Summer**	**Winter**	**Oxidation**		**Summer**	**Winter**	**Oxidation**
17	4.) Input Water Temperature	77.00	42.80	42.80	degrees F	**25.00**	**6.00**	**6.00**
18	Calculate Maximum Plant Flow Rate	160.00	100.00	160.00	mgd	605.67	378.54	605.67
19	5.) Input Ozone Immediate Demand	**0.40**	**0.40**	**1.00**	mg/L	0.40	0.40	1.00
20	6.) Input Ozone Residual Development to Ozone Transferred Ratio	**0.40**	**0.40**	**0.40**	Slope development line	0.40	0.40	0.40
21	Calculate Ozone Residual Intercept	-0.16	-0.16	-0.40	mg/L	-0.16	-0.16	-0.40
22	7.) Input Ozone Residual Decay Rate	**0.30**	**0.15**	**0.15**	1/min	0.30	0.15	0.15
23	8.) Input Ozone Transfer Efficiency	**95.00%**	**95.00%**	**95.00%**		95.00%	95.00%	95.00%
24	9.) Input Hydraulic Retention Time for Disinfection Cell at Max Flow	**5.00**	8.00	5.00	minutes	5.00	8.00	5.00
25	10.) Input Short Circuiting Factor for Disinfection Cell	**0.60**				0.60	0.00	0.00
26	Calculate T10 Time for Disinfection Cell	3.00	4.80	3.00	minutes	3.00	4.80	3.00
27	Calculate Disinfection Cell Water Volume, Each Train	37,133.49	37,133.49	37,133.49	cf	1,051.50	1,051.50	1,051.50
28	Calculate Required Disinfection Contactor Water Volume, Each Train	37,133.49			cf	1,051.50		
29	11.) Input Hydraulic Retention Time for AOP Contactor at Max Flow	**5.00**	8.00	5.00	minutes	5.00	8.00	5.00
30	12.) Input Short Circuiting Factor for AOP Contactor	**0.60**	0.60	0.60		0.60	0.60	0.60
31	Calculate T10 Time for AOP Contactor	3.00	4.80	3.00	minutes	3.00	4.80	3.00
32	Calculate AOP Contactor Water Volume, Each Train	37,133.49	37,133.49	37,133.49	cf	1,051.50	1,051.50	1,051.50
33	Calculate Required AOP Contactor Water Volume, Each Train	37,133.49			cf	1,051.50		
34	13.) Input Desired Cryptosporidium Log Inactivation	**0.0**	**0.0**	**0.0**	-log	0.00	0.00	0.00
35	Calculate Required Cryptosporidium Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
36	14.) Input Desired Giardia Log Inactivation	**0.0**	**0.0**	**0.0**	-log	0.00	0.00	0.00
37	Calculate Required Giardia Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
38	15.) Input Desired Virus Log Inactivation	**0.0**	**0.0**	**0.0**	-log	0.00	0.00	0.00
39	Calculate Required Virus Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
40	Calculate Controlling Required Pathogen Inactivation CT	0.00	0.00	0.00	mg-min/L	0.00	0.00	0.00
41	16.) Input Design Applied Ozone Dose	**1.50**	**1.50**	**3.00**	mg/L	1.50	1.50	3.00
42	Calculate Transferred Ozone Dose	1.43	1.43	2.85	mg/L	1.43	1.43	2.85
43	Calculate Ozone Generation Capacity	2,002.90	1,251.81	4,005.79	lb/d	908.50	567.81	1,817.00
44	17.) Input if Hydrogen Peroxide required	**No**	**No**	**No**	Y/N	No	No	No
45	Calculate Initial Residual in Disinfection Contactor	0.41	0.41	0.74	mg-min/L	0.41	0.41	0.74
46	Calculate End Residual in Disinfection Contactor	0.09	0.12	0.35	mg-min/L	0.09	0.12	0.35
47	Calculate CT Achieved in Disinfection Contactor	0.27	0.59	1.05	mg-min/L	0.27	0.59	1.05
48	Calculate Initial Residual in AOP Contactor	0.09	0.12	0.35	mg-min/L	0.09	0.12	0.35
49	Calculate End Residual in AOP Contactor	0.02	0.04	0.17	mg-min/L	0.02	0.04	0.17
50	Calculate CT Achieved in AOP Contactor	0.06	0.18	0.50	mg-min/L	0.06	0.18	0.50
51	Calculate Total CT Achieved in Full Contactor	0.34	0.77	1.54	mg-min/L	0.34	0.77	1.54
52	**Process User Inputs:**	**Value (English)**	**Value (English)**	**Value (Metric)**	**Value (Metric)**	**Name**	**Red Flags**	**Comment**
53	18.) Input Contactor Side Water Depth	**20.00**	ft	**6,096.00**	mm	SWD		Typically 20 ft for Good Transfer Efficiency
54	Distance from Top of SWD to Roof of Building	3.00	ft		mm	FB		Fixed
55	19.) Input Desired AOP Contactor Length to Width Ratio	**20.00**						Typically 20 to 40:1 to Promote Plug Flow
56	20.) Input Odd Number of Passes, Minimum 3 Passes	**3**	#			NP		
57	Calculate Pass Water Width	9.64	ft	2,936.76	mm	SPW		
58	Calculate Pass Water Length	64.23	ft	19,578.37	mm	SPL		
59	Calculate Contactor Water Width	31.25	ft	9,523.50	mm	CW		

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	B	C	D	E	F	G	H	I
60	Calculate Injection Cell Length	12.33	ft	3,758.11	mm	ICL		
61	Calculate Disinfection Cell Water Length	59.42	ft	18,112.11	mm	DCL		
62	Calculate Upflow Cell Water Length Required	9.90	ft	3,018.69	mm	UCL		
63	Calculate Overflow Channel Length	10.00	ft	3,048.00	mm	OFL		
64	Calculate Effluent Weir Distance from Contactor Outlet	9.64	ft	2,936.76	mm	EWCL		
65	Calculate Effluent Weir Head	2.46	ft	749.74	mm	WH		
66	Ozone Generation and Off-Gas Destruction Sizing:							
67	Calculate Ozone Design Dose	3.00	mg/L	3.00	mg/L			Maximum of Design Applied Ozone Dose
68	Calculate Design Daily Ozone Generation Capacity	4,005.79	lb/d	1,817.00	kg/d			Maximum of Ozone Generation Capacity
69	21.) Input Design Ozone Weight Percent	**10%**						Either 10% or 12%
70	Calculate Design Daily Oxygen Usage	40,057.92	lb/d	18,169.97	kg/d			
71	Calculate Ozone Generation Capacity at 10% Weight	4,005.79	lb/d	1,817.00	kg/d			
72	Standby Ozone Generation Capacity Provided at 10% Weight	0%						Fixed
73	Calculate Ozone Generation Capacity at 8% Weight	6,409.27	lb/d	2,907.19	kg/d			
74	Standby Ozone Capacity Provided at 8% Weight	60%						Fixed
75	Convert Design Daily Oxygen Usage from lb/d to scfm	335.00	scfm	9.49	m3/min			Assumes gaseous oxygen density of 0.08304 lb/ft3 at standard conditions of 1 atm and 20 deg C.
76	Calculate Number of Porous Plate Dome Diffusers for Dissolution	335.00	#					Based on 1 scfm per 7-inch diameter Sanitaire Ozone dome diffuser at 20-inch water headloss.
77	Calculate Minimum Area Required to Accommodate Diffusers	770.49	sf	71.58	m2			Based on 1 diffuser per 2.3 square foot (i.e., spacing at 18 inches)
78	22.) Input Number of Active Ozone Generators	**2**	#					
79	23.) Input Number of Standby Ozone Generators	**1**	#					Typically 1 or Rely on Higher Production Capacity at Lower Ozone Concentration
80	Calculate Design Ozone Generator Capacity, Each	2,002.90	lb/d	908.50	kg/d			
81	Calculate Total Number of Generators	3	#					
82	24.) Select Ozone Cooling Water System	**Closed Loop**					**Open loop is not acceptable**	
83	25.) Input Ozone Generator and Power Supply Unit Energy Consumption	**4.70**	kWh/lb	**10.36**	kWh/kg			Typically 4.5 to 7 kWh/lb
84	26.) Input Ozone Generator and Power Supply Unit Energy Consumption Conversion to Waste Heat	**85%**						Typically 85% to 95%
85	Calculate Maximum Waste Heat Generation Rate	60,705.24	BTU/min	25,618.97	kWh/d			
86	27.) Input Design Temperature Rise for Heat Rejection Water	**7.50**	degrees F	-13.61	degrees C			Typically 5 to 10 deg F
87	28.) Input Heat Exchanger Efficiency	**90%**						Typically 70% to 90%
88	Calculate Preliminary Heat Rejection Water Flow Rate	1,077.64	gpm	67.99	L/s			Confirm cooling water requirement with ozone generator supplier or specify refrigerant chiller system.
89	Calculate Preliminary Cooling Pump Horsepower, Each	9.72	hp	7.25	kW			Assume 25 ft TDH and 70% pump efficiency
90	29.) Input Design Days of Liquid Oxygen Storage at Design Ozone Weight Percent	**30.00**	days					
91	Calculate Total Liquid Oxygen Storage	1,201,737.60	lb	545,099.01	kg			
92	Convert Total Liquid Oxygen Storage from lb to gallons	126,232.94	gal	477,843.67	L			
93	Calculate Minimum Days of Liquid Oxygen Storage at 10% Ozone	30.00	days					
94	Calculate Minimum Days of Liquid Oxygen Storage at 8% Ozone	15.00	days					
95	30.) Input Number of Liquid Oxygen Storage Tanks	**3**	#					Typically 2 or More
96	Calculate Volume of Liquid Oxygen Storage Tank, Each	42,077.65	gal	159,281.22	L			
97	31.) Input Liquid Oxygen Storage Tank, Diameter	**12.00**	ft	**3,657.60**	mm	DLOX		Typically 14' or Less
98	32.) Indicate Orientation of LOX Tank	**Horizontal**						Use Horizontal Only if There is an Aesthetic Concern
99	Calculate Liquid Oxygen Storage Tank Length/Height	49.74	ft	15,159.41	mm	LLOX		
100	Calculate Number of Liquid Oxygen Vaporizers	3	#			#VP		Fixed to Equal Number of Tanks, Minimum of 2
101	Liquid Oxygen Vaporizer Footprint, each	24.00	sf	2.23	m2	VPFP		Fixed
102	Number of Active Thermal Catalytic Ozone Destructors	2	#					Fixed to Equal Number of Contactors
103	33.) Input Number of Standby Thermal Catalytic Ozone Destructors	**1**	#					
104	34.) Input Design Ozone Weight % in Ozone Off-Gas to Thermal Catalytic Ozone Destructors	**2.40%**						Typically assume worst case ozone transfer efficiency to contactor and highest ozone production concentration in the feed gas. If 80% transfer worst case at 12% ozone concentration, then (1-0.8)*0.12*100 = 2.4%.
105	35.) Do Destruct Units Need Enclosure for Noise Concerns?	**Yes**						Locate Indoors if Noise is a Concern

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	B	C	D	E	F	G	H	I
106	Calculate Capacity of Thermal Catalytic Ozone Destructor, Each	230.31	scfm	6.52	m3/min			Assumes 110% of the gas flow at 8% ozone by weight. Assumes gaseous oxygen density of 0.08304 lb/ft3 at standard conditions of 1 atm and 20 deg C.
107	36.) Input Cooling Water Flow per Generator - value to come from Vendor	700.00	gpm	44.16	L/s			
108	37.) Input Cooling Water Flow per PSU - value to come from Vendor	20.00	gpm	1.26	L/s			
109	Calculate Cooling Pump Horsepower, Each	6.49	hp	4.84	kW			Assume 25 ft TDH and 70% pump efficiency
110	38.) Input Distance from LOX Pad to Generation Room	20.00	ft	6,096.00	mm			
111	39.) Input Distance from Generation Room to Upstream End of Contactor	150.00	ft	45,720.00	mm			
112	40.) Input Distance from Middle of Contactor to Destruct Room	50.00	ft	15,240.00	mm			
113	41.) Input Ozone Generation Bldg Depth of Burial	0.00	ft	914.40	mm			
114	42.) Input Ozone Generation Bldg Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
115	43.) Input Ozone Generation Bldg Over Excavation Depth	1.00	ft	609.60	mm			
116	44.) Input LOX Pad Depth of Burial	0.00	ft	609.60	mm			
117	45.) Input LOX Pad Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
118	46.) Input LOX Pad Over Excavation Depth	1.00	ft	609.60	mm			
119	47.) Input Ozone Contactor Depth of Burial	10.00	ft	3,048.00	mm			
120	48.) Input Ozone Contactor Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
121	49.) Input Ozone Contactor Over Excavation Depth	1.00	ft	609.60	mm			
122								
123	**Mechanical Sizing Requirements:**							
124	**Pipe Name**	**Input Velocity (fps, fpm)**				**Standard Pipe Size (inches)**	**Nominal Pipe Size (mm)**	**Name**
125	Influent Pipe	5.00	fps	1.52	m/s	72.00	1800.00	75.32316612
126	Effluent Pipe	5.00	fps	1.52	m/s	72.00	1800.00	
127	Overflow Pipe	5.00	fps	1.52	m/s	96.00	2050.00	
128	Total LOX Pipe	2.00	fps	0.61	m/s	1.50	40.00	
129	Total GOX Pipe Upstream of PRV	1,800.00	fpm	9.14	m/s	3.00	80.00	
130	Total GOX Pipe Downstream of PRV	1,800.00	fpm	9.14	m/s	6.00	150.00	
131	Individual GOX Pipe Downstream of PRV	1,800.00	fpm	9.14	m/s	4.00	100.00	
132	Nitrogen	1,800.00	fpm	9.14	m/s	1.00	25.00	
133	Header Ozone Gas PIpe	1,800.00	fpm	9.14	m/s	6.00	150.00	
134	Individual Ozone Generator Gas Pipe	1,900.00	fpm	9.65	m/s	4.00	100.00	
135	Individual Ozone Contactor Gas Pipe	1,800.00	fpm	9.14	m/s	4.00	100.00	
136	Ozone Off-Gas Pipe per Train	1,800.00	fpm	9.14	m/s	6.00	150.00	
137	Ozone Off-Gas Pipe Combined	1,800.00	fpm	9.14	m/s	8.00	200.00	
138	Ozone Off-Gas Pipe per Destruct Unit	1,800.00	fpm	9.14	m/s	6.00	150.00	
139	Total Cooling Water Pipe (open loop)	7.00	fps	2.13	m/s	8.00	200.00	
140	Individual Skid Cooling Water Pipe (open loop)	7.00	fps	2.13	m/s	6.00	150.00	
141	Total Cooling Water Pipe (closed loop)	7.00	fps	2.13	m/s	12.00	300.00	
142	Individual Generator Cooling Water Pipe (closed loop)	7.00	fps	2.13	m/s	8.00	200.00	
143	Individual PSU Cooling Water Pipe (closed loop)	7.00	fps	2.13	m/s	1.50	40.00	
144								
145	**Mechanical Material Requirements: Note to User: Only piping, valves, and fittings outside of Ozone Supplier Skids are summarized below.**							

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	B	C	D	E	F	G	H	I
146	**Pipe Name**	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Comments**	**Red Flags**
147	Influent Pipe	OZI	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
148	Effluent Pipe	OZW	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
149	Overflow Pipe	OF	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
150	LOX Pipe	LOX	Exposed	Copper	NA	NA		
151	Total GOX Pipe Upstream of PRV	GOX	Exposed	**304 SST**	NA	NA		
152	Total GOX Pipe Downstream of PRV	GOX	Exposed	**316 SST**	NA	NA		
153	Individual GOX Pipe Downstream of PRV	GOX	Exposed	**316 SST**	NA	NA		
154	Header Ozone Gas PIpe	O3	Exposed	316 SST	NA	NA		
155	Individual Ozone Generator Gas Pipe	O3	Exposed	316 SST	NA	NA		
156	Individual Ozone Contactor Gas Pipe	O3	Exposed	316 SST	NA	NA		
157	Nitrogen	N2	Exposed	Copper	NA	NA		
158	Ozone Off-Gas Pipe per Train	OZG	Exposed	316 SST	NA	NA		
159	Ozone Off-Gas Pipe Combined	OZG	Exposed	316 SST	NA	NA		
160	Ozone Off-Gas Pipe per Destruct Unit	OZG	Exposed	316 SST	NA	NA		
161	Total Cooling Water Pipe (open loop)	CWS/CWR	**Buried**	**Steel**	**Cement Mortar**	**Cement Mortar**		
162	Individual Skid Cooling Water Pipe (open loop)	CWS/CWR	Exposed	**Steel**	**Cement Mortar**	**Cement Mortar**		
163	Total Cooling Water Pipe (closed loop)	GCWS/GCWR	Exposed	304 SST	NA	NA		
164	Individual Generator Cooling Water Pipe (closed loop)	GCWS/GCWR	Exposed	304 SST	NA	NA		
165	Individual PSU Cooling Water Pipe (closed loop)	GCWS/GCWR	Exposed	304 SST	NA	NA		
166								
167	Electrical User Inputs and Sizing Requirements:							
168	50.) Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N					
169	51.) Is there SWGR?	No						
170								
171	Electrical Equipment Lengths:							**MCC**
172	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
173	Ozone Generators/Destruct (Active)	2.00	525.99	**No**	24.00	0.00	0.00	
174	Ozone Generators/Destruct (Standby)	1.00	525.99	**No**	12.00	0.00	0.00	
175	Cooling Water Pumps (Active)	2.00	6.49	**No**	4.00	0.00	0.00	
176	Cooling Water Pumps (Standby)	1.00	6.49	**No**	2.00	0.00	0.00	
177	TOTAL		**1597.46**		**42.00**	**0.00**	**0.00**	**42.00**
178								
179	Electrical Equipment Widths:							
180	**Equipment**	**Depth (ft)**						
181	MCC	1.67						
182	Small AFD's	0.00						
183	Large AFD's	0.00						
184	Switchgear	0.00						
185	Maximum Depth	**1.67**						
186								
187	Clear Distances:							
188	**Clear Distance**	**Width**	**Length**	**Comment**				
189	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
190	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
191	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
192	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
193	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
194	CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
195	CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet			
196	Contingency Length		**0.00**	Contingency length	Typically Zero			
197								
198	Electric Room Length (ft):							
199	CD1	3.00						
200	MCC	16.67						
201	CD2	1.00						
202	Small AFD's	0.00						
203	CD3	0.00						
204	Large AFD's	0.00						
205	CD4	0.00						
206	Swithgear	0.00						
207	CD5	0.00						
208	Contingency	0.00						
209	Total Length	**20.67**						
210								
211	Electric Room Width (ft):							
212	CD6	0.00	If there is no switchgear, this distance will be Zero.					
213	Maximum Equipment Depth	1.67						
214	CD7	3.00						
215	Total Width	**4.67**						
216								
217	**Estimating Dimensions:**	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
218	**Ozone Contactor Facility:**							
219	Basin Width	66.82	ft	20366.78	mm	Total BW		
220	Basin Length	163.56	ft	49853.10	mm	BL		

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	B	C	D	E	F	G	H	I
221	Basin Divider Wall Length	150.56	ft	45890.70	mm			
222	Walls							
223	Perimeter and Divider Wall Height (Walls 11, 12, 13, 14) (SWD + FB)	23.00	ft	7010.40	mm	PDWH		
224	Wall 1 Height (SWD)	20.00	ft	6096.00	mm	CIWH-1		
225	Wall 2 Height (SWD - 3)	17.00	ft	5181.60	mm	CIWH-2		
226	Wall 3 Height (SWD + FB - 4)	19.00	ft	5791.20	mm	CIWH-3		
227	Wall 4 Height (SWD - 3)	17.00	ft	5181.60	mm	CIWH-4		
228	Wall 5 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-5		
229	Wall 6 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-6		
230	Wall 7 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-7		
231	Wall 8 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-8		
232	Wall 9 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-9		
233	Wall 10 Height (SWD + FB)	23.00	ft	7010.40	mm	CIWH-10		
234	Wall 15 Height (SWD - WH)	17.54	ft	5346.26	mm	CIWH-15		
235	Perimeter Wall Thickness (Walls 11, 12, 13)	**1.50**	ft	**457.20**	mm	WPT	Model based on 1.5'	
236	Wall 1 Thickness	**1.00**	ft	**304.80**	mm	W1T		
237	Wall 2 Thickness	**1.33**	ft	**405.38**	mm	W2T	Model based on 1.33'	
238	Wall 3 Thickness	**1.17**	ft	**356.62**	mm	W3T	Model based on 1.17'	
239	Wall 4 Thickness	**1.33**	ft	**405.38**	mm	W4T	Model based on 1.33'	
240	Wall 5 Thickness	**1.17**	ft	**356.62**	mm	W5T	Model based on 1.17'	
241	Wall 6 Thickness	**1.33**	ft	**405.38**	mm	W6T	Model based on 1.33'	
242	Wall 7 Thickness	**1.17**	ft	**356.62**	mm	W7T	Model based on 1.17'	
243	Wall 8 Thickness	**1.33**	ft	**405.38**	mm	W8T	Model based on 1.33'	
244	Wall 9 Thickness	**1.00**	ft	**304.80**	mm	W9T		
245	Wall 10 Thickness	**1.00**	ft	**304.80**	mm	W10T		
246	Wall 15 Thickness	**1.17**	ft	**356.62**	mm	W15T	Model based on 1.17'	
247	Contactor Divider Walls 14 Thickness	**1.33**	ft	**405.38**	mm	W14T	Model based on 1.33'	
248	Wall 1 Length	31.25	ft	9523.50	mm	W1L		
249	Wall 2 Length	31.25	ft	9523.50	mm	W2L		
250	Wall 3 Length	31.25	ft	9523.50	mm	W3L		
251	Wall 4 Length	31.25	ft	9523.50	mm	W4L		
252	Wall 5 Length (ft)	76.21	ft	23228.36	mm	W5L		
253	Wall 6 Length (ft)	54.60	ft	16641.62	mm	W6L		
254	Wall 7 Length	54.60	ft	16641.62	mm	W7L		
255	Wall 8 Length	54.60	ft	16641.62	mm	W8L		
256	Wall 9 Length	54.60	ft	16641.62	mm	W9L		
257	Wall 10 Length	54.60	ft	16641.62	mm	W10L		
258	Wall 15 Length	9.64	ft	2936.76	mm	W15L		
259	Slab on Grade							
260	Slab on Grade Width	70.82	ft	21585.98	mm			
261	Slab on Grade Length	167.56	ft	51072.30	mm			
262	Slab on Grade Thickness	**18.00**	in	**457.20**	mm		Model based on 18"	
263	Slab on Grade Thickness	1.50	ft	457.20	mm	SOGT		
264	Elevated Slab							
265	Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
266	Elevated Slab Thickness	1.00	ft	304.80	mm	ESLBT		
267	Excavation							
268	Excavation Width	74.82	ft	22805.18	mm			
269	Excavation Length	171.56	ft	52291.50	mm			
270	Excavation Depth	12.50	ft	3810.00	mm			
271								
272	Ozone Generator Building:							
273	Ozone Generator Width	**8.00**	ft	**2,438.40**	mm	WOG	Model is based on 8'	
274	Ozone Generator Length	**16.00**	ft	**4,876.80**	mm	LOG	Model is based on 16'	
275	Clear Distance Around Ozone Generators	**10.00**	ft	**3,048.00**	mm	CDG	Model is based on 10'	
276	Number of Ozone Generators	3.00		3.00			Input	
277	Closed Loop Cooling Skid Length	**10.00**	ft	**3,048.00**	mm	LOC	Model is based on 10'	
278	Closed Loop Cooling Skid Width	**8.00**	ft	**2,438.40**	mm	WOC	Model is based on 8'	
279	Wall Height	12.50	ft	3810.00	mm			
280	Building Width	64.00	ft	19507.20	mm	GBW		
281	Building Length	56.00	ft	17068.80	mm	GBL		
282	Building Area	3584.00	sf	332.96	m2			
283	Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
284	Slab on Grade Thickness	1.00	ft	304.80	mm	TGB		
285	Excavation							
286	Excavation Width	68.00	ft	20726.40	mm			
287	Excavation Length	60.00	ft	18288.00	mm			
288	Excavation Depth	2.00	ft	609.60	mm			
289								
290	**Ozone Destruct Room (attached to Ozone Generation Building):**							
291	Width	20.00	ft	6096.00	mm	DBW	Fixed	
292	Length	36.00	ft	10972.80	mm	DBL		
293	Height	12.50	ft	3810.00	mm		Fixed	
294	Slab on Grade Thickness	12.00	in	304.80	mm		Model based on 12"	
295	Slab on Grade Thickness	1.00	ft	304.80	mm			
296	Indoor Ozone Destruct Building Area	720.00	sf	66.89	m2			
297	Excavation							
298	Excavation Width	24.00	ft	7315.20	mm			
299	Excavation Length	40.00	ft	12192.00	mm			
300	Excavation Depth	2.00	ft	609.60	mm			
301								
302	**Electrical Room (in Ozone Generation Building:**							
303	Width	4.67	ft	1422.40	mm	ERW	Fixed	
304	Length	20.67	ft	6299.20	mm	ERL		

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	B	C	D	E	F	G	H	I
305	Height	12.50	ft	3810.00	mm		Fixed	
306	Slab on Grade Thickness	12.00	in	304.80	mm		Model based on 12"	
307	Slab on Grade Thickness	1.00	ft	304.80	mm			
308	Indoor Electrical Room Area	96.44	sf	8.96	m2			
309	Excavation							
310	Excavation Width	8.67	ft	2641.60	mm			
311	Excavation Length	24.67	ft	7518.40	mm			
312	Excavation Depth	2.00	ft	609.60	mm			
313								
314	**Outdoor Ozone Destruct Pad:**							
315	Width	0.00	ft	0.00	mm	DBW	Fixed	
316	Length	0.00	ft	0.00	mm	DBL		
317	Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
318	Slab on Grade Thickness	0.00	ft	0.00	mm	SOG2		
319								
320	LOX Tank Pad: Horizontal Tanks							
321	Clear Distance Around Tanks	**6.00**	ft	**1,828.80**	mm	CDT	Model is based on 6'	
322	LOX Vaporizer Length & Clear Distance	**14.00**	ft	**4,267.20**	mm		Model is based on 14'	
323	Width	60.00	ft	18288.00	mm	LPW		
324	Length	75.74	ft	23084.21	mm	LPL		
325	Area of Tank Pad	4544.14	sf	422.16	m2			
326	Allowance for Other Equipment (additional 10% area)	454.41	sf	42.22	m2			
327	Total Pad Area	4998.55	sf	464.38	m2			
328	Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
329	Slab on Grade Thickness	1.00	ft	304.80	mm	TLOX		
330	Excavation							
331	Excavation Width	64.00	ft	19507.20	mm			
332	Excavation Length	79.74	ft	24303.41	mm			
333	Excavation Depth	2.00	ft	609.60	mm			
334								
335	**COST ESTIMATE**							
336	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
337								
338	SITEWORK:							
339	Ozone Generator Building							
340	Excavation	359.73	CY	275.03	m3	***$6.72***	$2,418	
341	Imported Structural Backfill	302.22	CY	231.07	m3	***$50.94***	$15,396	
342	Native Backfill	18.96	CY	14.50	m3	***$8.27***	$157	
343	Haul Excess	340.76	CY	260.53	m3	***$8.27***	$2,817	
344	Ozone Destruct Room							
345	Excavation	90.26	CY	69.01	m3	***$6.72***	$607	
346	Imported Structural Backfill	71.11	CY	54.37	m3	***$50.94***	$3,623	
347	Native Backfill	9.48	CY	7.25	m3	***$8.27***	$78	
348	Haul Excess	80.78	CY	61.76	m3	***$8.27***	$668	
349	LOX Tank Pad							
350	Excavation	447.22	CY	341.92	m3	***$6.72***	$3,007	
351	Imported Structural Backfill	378.01	CY	289.01	m3	***$50.94***	$19,256	
352	Native Backfill	21.29	CY	16.28	m3	***$8.27***	$176	
353	Haul Excess	425.92	CY	325.64	m3	***$8.27***	$3,520	
354	Ozone Contactor							
355	Excavation	9051.14	CY	6920.10	m3	***$6.72***	$60,851	
356	Imported Structural Backfill	950.83	CY	726.96	m3	***$50.94***	$48,437	
357	Native Backfill	2138.72	CY	1635.17	m3	***$8.27***	$17,677	
358	Haul Excess	6912.43	CY	5284.93	m3	***$8.27***	$57,133	
359	Electrical Room							
360	Excavation	23.27	CY	17.79	m3	***$6.72***	$156	
361	Imported Structural Backfill	15.84	CY	12.11	m3	***$50.94***	$807	
362	Native Backfill	4.94	CY	3.78	m3	***$8.27***	$41	
363	Haul Excess	18.33	CY	14.01	m3	***$8.27***	$151	
364	Allowance for Misc Items	5%				$236,975.89	$11,849	
365	Subtotal						$248,825	
366								
367	CONCRETE:							
368	Contactor Basin:							
369	Foundation	659.26	CY	504.04	m3	***$541.11***	$356,728	
370	Perimeter Walls	588.75	CY	450.13	m3	***$880.79***	$518,566	
371	Divider Wall	170.58	CY	130.42	m3	***$880.79***	$150,245	
372	Wall 1	46.29	CY	35.39	m3	***$880.79***	$40,771	
373	Wall 2	52.33	CY	40.01	m3	***$880.79***	$46,092	
374	Wall 3	51.45	CY	39.34	m3	***$880.79***	$45,317	
375	Wall 4	52.33	CY	40.01	m3	***$880.79***	$46,092	
376	Wall 5	151.91	CY	116.14	m3	***$880.79***	$133,800	
377	Wall 6	123.72	CY	94.59	m3	***$880.79***	$108,968	
378	Wall 7	0.00	CY	0.00	m3	***$880.79***	$0	
379	Wall 8	0.00	CY	0.00	m3	***$880.79***	$0	
380	Wall 9	0.00	CY	0.00	m3	***$880.79***	$0	
381	Wall 10	0.00	CY	0.00	m3	***$880.79***	$0	
382	Wall 15	14.65	CY	11.20	m3	***$880.79***	$12,901	
383	Elevated Roof Slab	404.78	CY	309.48	m3	***$1,333.77***	$539,884	
384								
385	Ozone Destruct Pad:							
386	Slab on Grade	26.67	CY	20.39	m3	***$490.62***	$13,083	
387	Ozone Generator Building:							
388	Slab on Grade	132.74	CY	101.49	m3	***$490.62***	$65,125	
389	Electrical Room:							
390	Slab on Grade	3.57	CY	2.73	m3	***$490.62***	$1,752	
391	LOX Tank and Vaporizer Pad:							
392	Slab on Grade	185.13	CY	141.54	m3	***$490.62***	$90,828	
393								
394	Allowance for Misc Items	5%				$2,170,152.97	$108,508	
395	Subtotal						$2,278,661	
396								

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	B	C	D	E	F	G	H	I
397	MASONRY:	**High**						
398	Ozone Generator/ Building (incl Elec Room)	3680.44	SF	341.92	m2	***$198.37***	$730,078	
399	Ozone Destruct Building	720.00	SF	66.89	m2	***$198.37***	$142,824	
400	Subtotal	4400.44					$872,902	
401								
402	METALS:							
403	Handrail	488.76	LF	148.97	m	***$90.92***	$44,437	
404	Perforated Plate in Inlet Cell	618.89	SF	57.50	m2	***$108.25***	$66,998	
405	Perforated Plates in Serpentine Cells	770.80	SF	71.61	m2	***$108.25***	$83,443	
406	3' x 3' SS Air Tight Checker Plate Covers Over Inlet Cells	4.00	EA			***$1,798.69***	$7,195	
407	3' x 3' SS Air Tight Checker Plate Covers Over Contactor Cells	6.00	EA			***$1,798.69***	$10,792	
408	Ladder	10.00	EA			***$1,915.27***	$19,153	
409	Stairway	39	Risers			***$495.92***	$19,341	
410	Allowance for Misc Items	10%				$251,358.33	$25,136	
411	Subtotal						$276,494	
412								
413	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
414	Ozone System (Including Ozone Generators, Diffusion System, Instrumentation & Valves, Ozone Destruct Units, and Cooling System for Closed Loop System)	6008.69	lb/d	2725.50	kg/d	***$1,810.82***	$10,880,670	
415	LOX Tanks and Vaporizers	126233	gal	477843.67	L	***$44.62***	$5,632,532	
416	Cooling Pumps for Open Loop Cooling System (Note: Cooling Pumps are included in OSS scope for Closed Loop system) (9.72 hp each)	2	EA			***$15,753.71***	$31,507	
417	Gates at Inlet	2	EA			***$9,614.74***	$19,229	
418	Gates at Outlet	2	EA			***$9,614.74***	$19,229	
419	Allowance for Misc Items	10%				$16,583,168.99	$1,658,317	
420	Subtotal						$18,241,486	
421								
422	INSTRUMENTS & CONTROLS:							
423	Instruments							
424	Inlet and Outlet Isolation Gate Actuator	4	EA			***$6,409.82***	$25,639	
425	Level Transmitters	2	EA			***$11,264.12***	$22,528	
426	Open Loop Cooling Water Flowmeters	1	EA			***$6,954.43***	$6,954	
427	Ozone Residual Analyzers	4	EA			***$6,954.43***	$27,818	
428	Pressure Transmitters (LOX)	3	EA					
429	Level Transmitters (LOX)	3	EA					
430	Isolation Valve Actuators (LOX)	3	EA					
431	Isolation Valve Actuators (GOX)	4	EA					
432	Control Valve Actuators (GOX)	3	EA					
433	Temperature Transmitters (GOX)	4	EA					
434	Pressure Transmitters (GOX)	1	EA					
435	Dewpoint Analyzers (GOX)	1	EA					
436	Flowmeter (GOX)	3	EA					
437	Dewpoint Analyzers (Nitrogen)	1	EA					
438	Nitrogen Compressor	2	EA					
439	Control Valve Actuators (Nitrogen)	1	EA					
440	Pressure Transmitters (Nitrogen)	1	EA					
441	Temperature Transmitters (Ozone)	3	EA					
442	Isolation Valve Actuators (Ozone)	3	EA					
443	Ozone Concentration Analyzers (Ozone)	3	EA					
444	Flowmeter (Ozone)	2	EA					
445	Control Valve Actuators (Ozone)	2	EA					
446	Ozone Concentration Analyzers (Off-gas)	4	EA					
447	Control Valve Actuators (Off-gas)	3	EA					
448	Isolation Valve Actuators (Off-gas)	3	EA					
449	Temperature Transmitters (Off-gas)	6	EA					
450	Pressure Differential Transmitters (Off-gas)	3	EA					
451	Destruct Blower	3	EA					
452	Closed Loop Cooling Water Pumps	3	EA					
453	Isolation Valve Actuators (Closed Loop Cooling)	6	EA					
454	Temperature Transmitters (Closed Loop Cooling)	6	EA					
455	Flowmeters (Closed Loop Cooling)	6	EA					
456	Ambient Ozone Analyzers	2	EA					
457	Ambient Oxygen Analyzers	1	EA					
458	Number of Analog I/O Counts	139	EA			***$264.27***	$36,786	
459	Number of Digital I/O Counts	143	EA			***$62.59***	$8,938	
460	Number of Local Panels	1	EA			***$13,074.33***	$13,074	

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	B	C	D	E	F	G	H	I
461	Number of PLC's	1	EA					
462	I&C Conduit & Wire	6,998	LF	2133.08	m	$12.06	$84,392	
463	Allowance for Misc Items	5%				$226,130.09	$11,307	
464	Subtotal						$237,437	
465								
466	MECHANICAL:							
467	Pipe:							
468	Influent Pipe-OZI (72-inch, Buried, Steel)	0.00	LF	0.00	m	$1,506.86	$0	
469	Effluent Pipe-OZW (72-inch, Buried, Steel)	0.00	LF	0.00	m	$1,506.86	$0	
470	Overflow Pipe-OF (96-inch, Buried, Steel)	0.00	LF	0.00	m	$2,009.15	$0	
471	LOX Pipe-LOX (1.5-inch, Exposed, Copper)	114.00	LF	34.75	m	$105.58	$12,036	
472	Total GOX Pipe Upstream of PRV-GOX (3-inch, Exposed, 304 SST)	62.00	LF	18.90	m	$109.49	$6,789	
473	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	123.00	LF	37.49	m	$215.04	$26,450	
474	Individual GOX Pipe Downstream of PRV-GOX (4-inch, Exposed, 316 SST)	99.00	LF	30.18	m	$143.36	$14,193	
475	Header Ozone Gas PIpe-O3 (1-inch, Exposed, 316 SST)	51.00	LF	15.54	m	$35.84	$1,828	
476	Individual Ozone Generator Gas Pipe-O3 (6-inch, Exposed, 316 SST)	153.00	LF	46.63	m	$215.04	$32,901	
477	Individual Ozone Contactor Gas Pipe-O3 (4-inch, Exposed, 316 SST)	313.33	LF	95.50	m	$143.36	$44,920	
478	Nitrogen-N2 (4-inch, Exposed, Copper)	36.00	LF	10.97	m	$281.55	$10,136	
479	Ozone Off-Gas Pipe per Train-OZG (6-inch, Exposed, 316 SST)	100.00	LF	30.48	m	$215.04	$21,504	
480	Ozone Off-Gas Pipe Combined-OZG (8-inch, Exposed, 316 SST)	10.00	LF	3.05	m	$286.72	$2,867	
481	Ozone Off-Gas Pipe per Destruct Unit-OZG (6-inch, Exposed, 316 SST)	45.00	LF	13.72	m	$215.04	$9,677	
482	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	230.82	LF	70.35	m	$167.43	$38,646	
483	Individual Skid Cooling Water Pipe (open loop)-CWS/CWR (6-inch, Exposed, Steel)	70.00	LF	21.34	m	$125.57	$8,790	
484	Total Cooling Water Pipe (closed loop)-GCWS/GCWR (12-inch, Exposed, 304 SST)	88.00	LF	26.82	m	$437.98	$38,542	
485	Individual Generator Cooling Water Pipe (closed loop)-GCWS/GCWR (8-inch, Exposed, 304 SST)	123.00	LF	37.49	m	$291.99	$35,914	
486	Individual PSU Cooling Water Pipe (closed loop)-GCWS/GCWR (1.5-inch, Exposed, 304 SST)	108.00	LF	32.92	m	$54.75	$5,913	
487	Elbows							
488	LOX Pipe-LOX (1.5-inch, Exposed, Copper)	30.00	EA			$284.26	$8,528	
489	Total GOX Pipe Upstream of PRV-GOX (3-inch, Exposed, 304 SST)	3.00	EA			$568.52	$1,706	
490	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	10.00	EA			$1,268.32	$12,683	
491	Individual GOX Pipe Downstream of PRV-GOX (4-inch, Exposed, 316 SST)	3.00	EA			$845.55	$2,537	
492	Header Ozone Gas PIpe-O3 (1-inch, Exposed, 316 SST)	1.00	EA			$211.39	$211	
493	Individual Ozone Generator Gas Pipe-O3 (6-inch, Exposed, 316 SST)	3.00	EA			$1,268.32	$3,805	
494	Individual Ozone Contactor Gas Pipe-O3 (4-inch, Exposed, 316 SST)	10.00	EA			$845.55	$8,455	
495	Nitrogen-N2 (4-inch, Exposed, Copper)	2.00	EA			$758.03	$1,516	
496	Ozone Off-Gas Pipe per Train-OZG (6-inch, Exposed, 316 SST)	6.00	EA			$1,268.32	$7,610	
497	Ozone Off-Gas Pipe per Destruct Unit-OZG (6-inch, Exposed, 316 SST)	9.00	EA			$1,268.32	$11,415	
498	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	2.00	EA			$1,113.60	$2,227	
499	Individual Skid Cooling Water Pipe (open loop)-CWS/CWR (6-inch, Exposed, Steel)	3.00	EA			$835.20	$2,506	
500	Individual Generator Cooling Water Pipe (closed loop)-GCWS/GCWR (8-inch, Exposed, 304 SST)	12.00	EA			$1,516.07	$18,193	
501	Individual PSU Cooling Water Pipe (closed loop)-GCWS/GCWR (1.5-inch, Exposed, 304 SST)	12.00	EA			$284.26	$3,411	
502	Tees							
503	LOX Pipe-LOX (1.5-inch, Exposed, Copper)	3.00	EA			$398.57	$1,196	
504	Total GOX Pipe Upstream of PRV-GOX (3-inch, Exposed, 304 SST)	4.00	EA			$797.14	$3,189	
505	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	5.00	EA			$1,762.53	$8,813	
506	Header Ozone Gas PIpe-O3 (1-inch, Exposed, 316 SST)	5.00	EA			$293.76	$1,469	
507	Ozone Off-Gas Pipe Combined-OZG (8-inch, Exposed, 316 SST)	5.00	EA			$2,350.04	$11,750	
508	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	2.00	EA			$2,537.20	$5,074	
509	Total Cooling Water Pipe (closed loop)-GCWS/GCWR (12-inch, Exposed, 304 SST)	12.00	EA			$3,188.58	$38,263	
510	Individual Generator Cooling Water Pipe (closed loop)-GCWS/GCWR (8-inch, Exposed, 304 SST)	6.00	EA			$2,125.72	$12,754	
511	Crosses							
512	End Caps							
513	Valves							
514	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	4.00	EA			$8,144.58	$32,578	
515	Wall Pipes:							
516	Influent Pipe-OZI (72-inch, Buried, Steel)	2.00	EA			$15,068.63	$30,137	
517	Effluent Pipe-OZW (72-inch, Buried, Steel)	2.00	EA			$15,068.63	$30,137	
518	Overflow Pipe-OF (96-inch, Buried, Steel)	1.00	EA			$20,091.51	$20,092	
519	Total GOX Pipe Downstream of PRV-GOX (6-inch, Exposed, 316 SST)	1.00	EA			$2,150.42	$2,150	
520	Individual Ozone Contactor Gas Pipe-O3 (4-inch, Exposed, 316 SST)	2.00	EA			$1,433.61	$2,867	
521	Ozone Off-Gas Pipe Combined-OZG (8-inch, Exposed, 316 SST)	1.00	EA			$2,867.23	$2,867	

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	B	C	D	E	F	G	H	I
522	Total Cooling Water Pipe (open loop)-CWS/CWR (8-inch, Buried, Steel)	1.00	EA			*$1,674.29*	$1,674	
523	Allowance for Misc Items	10%				$600,920.09	$60,092	
524	Subtotal						$661,012	
525								
526	ELECTRICAL:							
527	# MCC Sections	10.00	EA			*$10,730.27*	$107,303	
528	Switchgear	0.00	EA			*$49,359.23*	$0	
529	Adjustable Frequency Drives							
530	Ozone Generators/Destruct (Active) (526 hp each)	0.00	EA			***$77,840.33***	$0	
531	Ozone Generators/Destruct (Standby) (526 hp each)	0.00	EA			***$77,840.33***	$0	
532	Cooling Water Pumps (Active) (6 hp each)	0.00	EA			***$9,717.06***	$0	
533	Cooling Water Pumps (Standby) (6 hp each)	0.00	EA			***$9,717.06***	$0	
534	Electrical Conduit & Wire	981.36	LF	299.12	m	*$12.06*	$11,834	
535	Allowance for Misc Items	10%				$119,136.88	$11,914	
536	Subtotal						$131,051	
537								
538	**USER DEFINED ESTIMATE ITEMS:**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
539	Item 1 Description	0.00		0.00		0.00	$0	
540	Item 2 Description	0.00		0.00		0.00	$0	
541	Item 3 Description	0.00		0.00		0.00	$0	
542	Item 4 Description	0.00		0.00		0.00	$0	
543	Item 5 Description	0.00		0.00		0.00	$0	
544	Item 6 Description	0.00		0.00		0.00	$0	
545	Item 7 Description	0.00		0.00		0.00	$0	
546	Item 8 Description	0.00		0.00		0.00	$0	
547	Item 9 Description	0.00		0.00		0.00	$0	
548	Item 10 Description	0.00		0.00		0.00	$0	
549	Item 11 Description	0.00		0.00		0.00	$0	
550	Item 12 Description	0.00		0.00		0.00	$0	
551	Item 13 Description	0.00		0.00		0.00	$0	
552	Item 14 Description	0.00		0.00		0.00	$0	
553	Item 15 Description	0.00		0.00		0.00	$0	
554	Subtotal						$0	
555								
556	Subtotal						$22,947,867	
557								
558	ALLOWANCES:		**User Override**					
559	Finishes Allowance	2.00%		$24,943,334	$498,866.68			
560	I&C Allowance	2.00%		$24,943,333.77	$498,866.68			
561	Mechanical Allowance	2.00%		$24,943,333.77	$498,866.68			
562	Electrical Allowance	2.00%		$24,943,333.77	$498,866.68			
563								
564	**Facility Cost**	**4,006**	**lb/d Ozone**	**$6,227**	**$24,943,334**			
565	**Facility Cost with Standard Additional Project Costs Added**	**4,006**	**lb/d Ozone**	**$7,566**	**$30,307,861**			
566	**Facility Cost with Standard Additional Project Costs and Contractor Markups Added**	**4,006**	**lb/d Ozone**	**$13,124**	**$52,570,838**			
567	**Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)**	**4,006**	**lb/d Ozone**	**$10,801**	**$43,265,738**			
568	**Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added**	**4,006**	**lb/d Ozone**	**$13,124**	**$52,570,838**			

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	B	C	D	E	F	G	H	I
1	***Filters***							
2								
3	**Is This Facility Included in My Project? No**							
4	Assumptions:							
5								
6	Based on Denver Water Reuse Project							
7	2 Basins @ 15 MGD each							
8	***If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.***							
9	FILTER PARAMETRIC DESIGN APPROACH							
10	BASIS: DENVER REUSE PLANT, HDPE DUAL LATERAL UNDERDRAIN WITH MEDIA SUPPORT CAP, FRONT FLUME, & CONSTANT EFFLUENT FLOW CONTROL							
11								
12								
13	**Process User Inputs:**	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
14	Is this a Seawater Desalination Application?	**No**	Y/N					
15	Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	**No**	Y/N				Fixed	
16	Input Filtration System Maximum Design Flow Rate	**160.00**	mgd	**567.81**	ML/d	Q		
17	Input Filtration System Minimum Design Flow Rate	**15.00**	mgd	**56.78**	ML/d			
18	Select HDPE Underdrain System Type	**LS**	Type			UT		LSL = Leopold Type SL; LS = Leopold Type S; TLP = Tetra Type LP; NP = IDI or GF Nozzle/Plenum Type
19	Calculate Underdrain Profile Depth	1.08	ft	329.18	mm	UPD		LSL = 0.67 ft; LS = 1.08 ft; TLP = 0.75 ft; NP = 2.5625.
20	Input Bottom Media Effective Size	**0.60**	mm			BMES		
21	Input Bottom Media Uniformity Coefficient	**1.40**	#			BMUC		
22	Input Bottom Media Depth	**0.00**	in		mm	BMD		
23	Select Bottom Media Material	**Sand**	Type					
24	Input Middle Media Effective Size	**1.10**	mm			MMES		
25	Input Middle Media Uniformity Coefficient	**1.50**	#			MMUC		
26	Input Middle Media Depth	**0.00**	in	**0.00**	mm	MMD		
27	Select Middle Media Material	**Anthracite**	Type					
28	Input Top Media Effective Size	**1.10**	mm			TMES		
29	Input Top Media Uniformity Coefficient	**1.50**	#			TMUC		
30	Input Top Media Depth	**84.00**	in	**2,133.60**	mm	TMD		
31	Select Top Media Material	**GAC**	Type					
32	Calculate Total Media Depth	7.00	ft	2133.60	mm	MD		
33	Input GAC Replacement Frequency, if Applicable (number per year)	**0.00**	#					
34	Input GAC Apparent Density (Bulk Density), if Applicable	**29.00**	lb/cf	**464.54**	kg/m3			Typically about 29 lb/cf for most GAC products.
35	Input Maximum Design Filtration Hydraulic Loading Rate	**10.00**	gpm/sf	**24.45**	m/h	FHLR		Typical Range: 3 - 10 gpm/sf
36	Input Minimum Design Filtration Hydraulic Loading Rate	**2.00**	gpm/sf	**4.89**	m/h			
37	Calculate Active Filter Area	11,111.11	sf	1032.26	m2	AFA		
38	Calculate Emtpy Bed Contact Time at Maximum Design Filtration Hydraulic Loading Rage	5.24	min			EBCT		
39	Calculate Emtpy Bed Contact Time at Minimum Design Filtration Hydraulic Loading Rage	55.85	min			EBCT		
40	Input Number of Active Filters with Maximum Design Flow Rate	**6**	#			#AF		Typical Range: ≥ 3.
41	Calculate Individual Filter Area	1,851.85	sf	172.04	m2	IFA		
42	Calculate Individual Filter Dimension in Direction of Underdrain Lateral	30.00	ft	9144.00	mm	IFW		For Leopold Type SL (LSL), IFW < 16 ft; For Leopold Type S (LS), IFW < 48 ft; For Tetra Type LP (TLP), IFW < 30 ft.
43	Optionial: Input Individual Filter Dimension in Direction of Underdrain Lateral (overwrites above calculation)	**30.00**	ft	**9,144.00**	mm		**Warning! Input an overide only when matching existing filter dimensions or accomodating site constraints.**	Only enter override value when matching existing conditions or accomodating site constraints.
44	Calculate Individual Filter Dimension Perpendicular to Underdrain Lateral	61.75	ft	18821.40	mm	IFL		
45	Input Number of Standby Filters with Maximum Design Flow Rate	**2**	#			#SF		Typically 1 minimum
46	Calculate Total Number of Filters	8	#			#TF		Should be even number. If not, add active or standby filter
47	Input Desired Filter Bed Expansion During Backwash	**25.00%**				BEX		Typically 20-30%.
48	Calculate Media Expansion Depth	1.40	ft	426.72	mm	EXD		
49	Input Maximum Water Temperature	77.00	degrees F	**25.00**	degrees C	MWT		
50	Input Maximum Backwash Supply Hydraulic Loading Rate	**25.00**	gpm/sf	**61.12**	m/h	BWSHLR		Calculate from CH2M Backwash Rate Program
51	Calculate Maximum Backwash Supply Flow Rate	66.69	mgd	252.45	ML/d	BWSFR		
52	Input Filter Media Clean Bed Head Loss at Maximum Design Filtration Hydraulic Loading Rate	**2.50**	ft	**762.00**	mm	CBH		Calculate from CH2M HILL Clean Bed Head Loss Program
53	Input Underdrain Head Loss at Maximum Design Filtration Hydraulic Loading Rate	**0.50**	ft	**152.40**	mm	UDH		Determine from CH2M HILL Filter Design Guide. Typically 1-foot

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	B	C	D	E	F	G	H	I
54	Input Filter Effluent Piping Head Loss from Seal Weir Back to Filter Box with FE FCV 80% Open	1.50	ft	457.20	mm	FPH		Calculate from WinHydro. Typically 2 to 4 feet
55	Input Filter Influent/Backwash Wastewater Gullet Channel Width	5.00	ft	5.00	mm	GCW		Typically 4 ft. minimum for access
56	Input Filter Influent Channel / Backwash Wastewater Channel Width	5.00	ft	5.00	mm	FI/BWCW		Typically 4 ft. minimum for access
57	Calcualte Filter Influent Isolation Gate Width	42.00	in	1066.80	mm			Typically requires 9 inches of concrete on both sides of gate.
58	Calculate Number of Isolation Gates	2	#					
59	Input Distance from Bottom of Wash Trough to Top of Expanded Media	12.00	in	304.80	mm	DTM		Typically 3 inches minimum
60	Input % Area of Wash Trough Coverage per Filter	25.00%				WT%A		Typically 25%
61	Calculate Wash Trough Coverage per Filter = IFW * IFL * WT%A / 100	463.13	sf	43.03	m2	WTC		
62	Input Wash Trough Width	3.00	ft	914.40	mm	WTW		Typically 1.5 ft minimum
63	Select Wash Trough Type	Media Retaining	Type			WTYP		Conventional or Media Retaining Type
64	Calculate Number of Wash Troughs per Filter	5	#			#WT		
65	Calculate Depth of Wash Trough	2.47	ft	752.51	mm	WTD		Includes 0.25 feet freeboard and 0.25 feet trough bottom thickness
66	Calculate Distance Between Troughs	9.35	ft	2849.88	mm	DBT		Full Size Space between each trough, and Half Size Space between each end trough and wall.
67	Calculate Distance from Top of Media to Top of Trough	5.22	ft	1590.71	mm	TMTT		
68	Calculate Ratio Distance Between Troughs: Distance from Top of Media to Top of Trough	1.79	:1			RATIO		Typically between 1.0 to 2.0 (If error, change percent coverage or trough width)
69	Select Backwash Design Basis	Time	Type					Time = Based off backwash duration. Filter Box Volumes = Based off # of filter vessel volumes for BW cycle.
70	Input Backwash Duration	8.00	min					Typically 8 to 30 minutes.
71	Input Number of Filter Box Volumes per Backwash	3.00	#					Typically target at least 3 filter box volumes.
72	Calculate Typical Backwash Volume per Event	370,500.00	gal	1402.50	m3			
73	Calculate Backwash Duration		min					Typically 8 to 30 minutes.
74	Calculate Number of Filter Box Volumes per Backwash	2.19	#				Warning! Consider increasing BW duration.	Typically target at least 3 filter box volumes.
75	Include Filter Drain-Down?	Yes	Y/N					
76	Calculate Filter Drain-Down Volume per Event	66,232.14	gal	250.72	m3			
77	Input Distance from Top of Wash Trough to Top of Gullet Channel Wall	4.00	ft	1,219.20	mm	DTG		Typically 0.5 to 6 feet
78	Input Terminal Filter Head Loss Build-Up	10.00	ft	3,048.00	mm	THL		Typically 8 to 12 feet, confirm with hydraulic analysis
79	Input Freeboard Above Operating Water Surface	3.00	ft	914.40	mm	FB		Typically 1 to 3 feet
80	Calculate Gullet Channel Height	17.30	ft	5272.69	mm	GCH		
81	Calculate Gullet Channel Fill Height	1.58	ft	481.58	mm	GCF		
82	Calculate Filter Box Depth Based on Filter Seal Weir Set at the Same Elevation as the Top of the Filter Underdrain	20.08	ft	6120.38	mm	FBD		Setting Seal Weir and Top of Underdrain at Same Elevation Assures No Negative Pressure & Filter Air Binding
83	Calculate Backwash Waste Channel Height	11.80	ft	3596.29	mm	BWWCH		
84	Calculate Backwash Waste Channel Fill Height	1.58	ft	481.58	mm	BWWCF		
85	Calculate Filter Influent Channel Height	7.28	ft	2219.29	mm	FICH		Assumes top of filter influent valve = top of gullet channel
86	Input Filter Seal Weir Head	1.50	ft	1.00	mm	SWH		Typically < 2 feet
87	Calculate Filter Seal Weir Length	40.47	ft	12334.13	mm	SWL		Typically Use Trough Style Weirs to Reduce Area of Seal Weir Box
88	Input Length of Each Seal Weir Trough	5.00	ft	1,524.00	mm	SWTL		Typically < 20 feet to avoid intermediate structural support
89	Calculate Number of Seal Weir Troughs	4	#			#SWT		
90	Input Seal Weir Trough Width	2.00	ft	609.60	mm	SWTW		Typically 1.5 ft minimum
91	Calculate Depth of Wash Trough	5.87	ft	1787.73	mm	SWTD		Includes 0.25 feet freeboard and 0.25 feet trough bottom thickness
92	Calculate Seal Weir Box Width	16.00	ft	4876.80	mm	SWBW		
93	Calculate Seal Weir Box Depth	27.87	ft	8493.33	mm	SWBD		
94	Calculate Filter Flume Depth Below Underdrain Floor	6.50	ft	1981.20	mm	FFD		
95	Input Clear Distance Between Filter Effluent Piping in Gallery for Access	12.00	ft	3,657.60	mm	GCD1		Typically 8 ft minimum
96	Input Clear Distance Between Filter Effluent Piping & Filter Box in Gallery for Access	4.00	ft	1,828.80	mm	GCD2		Typically 3 ft minimum
97	Input Clear Distance Between Filter Effluent Piping & Filter End Wall for Access	6.00	ft	6.00	mm	GCD3		Typically 6 ft minimum
98	Calculate Filter Gallery Width	43.34	ft	13209.52	mm	FGW		
99	Input Clear Distance Between Filter Effluent Piping & Gallery Floor	2.00	ft	609.60	mm	GCD4		Typically 1 to 3 feet
100	Include Filter to Waste?	Yes	Y/N					
101	Input Filter to Waste Duration	15.00	min					Typically 10 to 30 minutes
102	Calculate Filter to Waste Volume per Event	277,777.78	gal	1051.50	m3			

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	B	C	D	E	F	G	H	I
103	Calculate Total Wastewater Volume per Backwash	714,509.92	gal	2704.71	m3			Use this volume to size backwash equalization basin
104	Include Air Scour Backwash?	**Yes**	Y/N					
105	Input Backwash Air Scour Loading Rate	**2.00**	scfm/sf	0.61	m/min	ALR		Typically 2 to 4 scfm/sf
106	Calculate Air Scour Blower Capacity per Blower	3,705.00	scfm	104.91	m3/min	ASBC		
107	Input Number of Air Scour Blowers	**2.00**	#			NASB		Typically 1 duty and 1 standby
108	Calculate Approximate Blower Outlet Gage Pressure at Standard Conditions	8.39	psig	57.87	kPa	BOP		Includes 1 psig of air piping losses, calculate actual. Typically, total ≤ 10 psig
109	Calculate Blower Horsepower at Standard Conditions (sea level, 20 deg C, 36% RH) per Blower	164.00	hp	122.29	kW	BHP		Revise for actual elevation and air temperature range. Warning... If Blower Horsepower exceeds 200, the Blower Building may be undersized.
110	Are filters covered?	**No**	Y/N					
111	Include Particle Counters?	**Yes**	Y/N					
112	Include a Combined FE Magmeter?	**No**	Y/N					
113	Input Depth of Burial	**0.00**	ft	**0.00**	mm	DB		
114	Input Cutback Slope	**1.00**	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
115	Input Over Excavation Depth	**1.00**	ft	**304.80**	mm	OEXD		
116	Mechanical Sizing Requirements:							
117	**Pipe Name**	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**
118	Air Scour Pipe	**2,500.00**	fpm	**762.00**	m/s	18.00	in	450.00
119	Filter Influent Header Pipe	**5.00**	fps	**1.52**	m/s	96.00	in	2050.00
120	Filter Influent Pipe	**3.00**	fps	**0.91**	m/s	54.00	in	1350.00
121	Filter Effluent Pipe	**5.00**	fps	**1.52**	m/s	42.00	in	1050.00
122	Filter Control Valve Pipe	**8.00**	fps	**2.44**	m/s	36.00	in	900.00
123	Filter Effluent Header Pipe	**5.00**	fps	**1.52**	m/s	96.00	in	2050.00
124	Filter to Waste	**5.00**	fps	**1.52**	m/s	42.00	in	1050.00
125	Backwash Supply Pipe	**6.00**	fps	**1.83**	m/s	60.00	in	1500.00
126	Backwash Waste Pipe	**6.00**	fps	**1.83**	m/s	60.00	in	1500.00
127								
128	Mechanical Material Requirements:							
129	**Pipe Name**	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Diameter**	**Pipe Length**
130	Air Scour Pipe	BAW	Exposed	**316 SST**	**None**	**None**	18.00	792.35
131	Filter Influent Header Pipe	FIH	Buried	**DI**	**Cement Mortar**	**Tape Coating**	96.00	0.00
132	Filter Influent Pipe	FIH	Encased	**DI**	**Cement Mortar**	**Fusion Bonded Epoxy**	54.00	0.00
133	Filter Effluent Pipe	FE	Exposed	**DI**	**Cement Mortar**	**Paint**	42.00	173.35
134	Filter Effluent Pipe	FE	Encased	**DI**	**Cement Mortar**	**Fusion Bonded Epoxy**	42.00	173.35
135	Filter Control Valve Pipe	FCV	Exposed	**DI**	**Cement Mortar**	**Paint**	36.00	192.00
136	Filter Effluent Header Pipe	FEH	Encased	**DI**	**Cement Mortar**	**Fusion Bonded Epoxy**	96.00	259.50
137	Filter to Waste	FTW	Exposed	**DI**	**Cement Mortar**	**Paint**	42.00	80.32
138	Filter to Waste	FTW	Encased	**DI**	**Cement Mortar**	**Fusion Bonded Epoxy**	42.00	542.00
139	Backwash Supply Pipe	BWS	Exposed	**DI**	**Cement Mortar**	**Paint**	60.00	594.40
140	Backwash Supply Pipe	BWS	Encased	**DI**	**Cement Mortar**	**Fusion Bonded Epoxy**	60.00	48.00
141	Backwash Waste Pipe	BWW	Encased	**DI**	**Cement Mortar**	**Fusion Bonded Epoxy**	60.00	10.00
142								
143	Electrical User Inputs and Sizing Requirements:							
144	Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N					
145	Is there SWGR?	No						
146								**MCC**
147	**Item**	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
148	Air Scour Blowers	2	164.00	**No**	12.00	0.00	0.00	
149	**User Defined Item #1**	**0**	**0.00**	**No**	0.00	0.00	0.00	
150	**User Defined Item #2**	**0**	**0.00**	**No**	0.00	0.00	0.00	

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	B	C	D	E	F	G	H	I
151	**User Defined Item #3**	**0**	**0.00**	**No**	0.00	0.00	0.00	
152	TOTAL		328.00		12.00	0.00	0.00	12.00
153								
154	Electrical Equipment Widths:							
155	**Equipment**	**Depth (ft)**						
156	MCC	1.67						
157	Small AFD's	0.00						
158	Large AFD's	0.00						
159	Switchgear	0.00						
160	Maximum Depth	1.67						
161								
162	Clear Distances:							
163	**Clear Distance**	**Width**	**Length**	**Comment**				
164	CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet			
165	CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot			
166	CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero			
167	CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero			
168	CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero			
169	CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
170	CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet			
171	Contingency Length		**0.00**	Contingency length	Typically Zero			
172								
173	Electric Room Length (ft):							
174	CD1	3.00						
175	MCC	11.67						
176	CD2	1.00						
177	Small AFD's	0.00						
178	CD3	0.00						
179	Large AFD's	0.00						
180	CD4	0.00						
181	Swithgear	0.00						
182	CD5	0.00						
183	Contingency	0.00						
184	Total Length	15.67						
185								
186	Electric Room Width (ft):							
187	CD6	0.00	If there is no switchgear, this distance will be Zero.					
188	Maximum Equipment Depth	1.67						
189	CD7	3.00						
190	Total Width	4.67						
191								
192	**COST TABLE FOR MEDIA:**	**Quantity (CF)**	**$/CF (Uninstalled Cost)**	**$/CF (Escalated and Installed Cost)**				
193	Silica Sand	0.00	15.00	***$ 22.11***				
194	Antracite Coal	0.00	20.00	***$ 29.49***				
195	Garnet Sand	0.00	45.00	***$ 66.34***				
196	GAC	103,740.00	45.00	***$ 66.34***				
197								
198	**Estimating Dimensions:**	**Value English**	**Unit (English)**	**Value Metric**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
199	Backwash Supply Pipe Tee Length	7.50	ft	2286.00	mm	BWSTL		Lookup Value
200	Backwash Supply Pipe Tee Width	6.25	ft	1905.00	mm	BWSTW		Lookup Value
201	Backwash Supply Pipe Elbow Length	8.17	ft	2489.96	mm	BWSEL		Lookup Value
202	Backwash Supply Isolation Valve Length	1.67	ft	508.00	mm	BWSVL		Lookup Value
203	Backwash Supply - Flowmeter Reducer Length	8.00	ft	2438.40	mm	BWSFMRL		
204	Flowmeter Length	3.83	ft	1168.40	mm	FML		Lookup Value
205	Filter Control Valve Length	1.25	ft	381.00	mm	FCVL		Lookup Value
206	Flowmeter - Filter Effluent Increaser Length	2.00	ft	609.60	mm	FMFERL		
207	Filter Effluent Pipe Tee Length	5.50	ft	1676.40	mm	FETL		Lookup Value
208	Filter Effluent Pipe Tee Width	4.50	ft	1371.60	mm	FETW		Lookup Value
209	Filter Effluent Pipe Elbow Length	5.90	ft	1798.83	mm	FEEL		Lookup Value
210	Filter Effluent and Filter to Waste Isolation Valve Length	1.25	ft	381.00	mm	FEVL		Lookup Value
211	Filter Effluent Header Pipe Cross Length	11.00	ft	3352.80	mm	FEHCL		Lookup Value
212	Filter Effluent Header Pipe Cross Width	11.00	ft	3352.80	mm	FEHCW		Lookup Value
213	Filter to Waste Header Pipe Tee Length	5.50	ft	1676.40	mm	FTWHTL		Lookup Value
214	Filter to Waste Pipe Elbow Length	4.50	ft	1371.60	mm	FTWEL		Lookup Value
215	Total Length of Individual Filter Piping	59.90	ft	18258.79	mm			
216	Filter (per Each):							
217	Slab on Grade (Includes Filter, Gulllet Channel, Filter Influent/Backwash Wastewater Channel):							
218	Length = IFL + FEWT	63.25	ft	19278.60	mm	FSOGL		
219	Width = IFW+GWT+GCW+(2*FI/BWCST)+FI/BWCW	45.67	ft	13919.20	mm	FSOGW		
220	Concrete Thickness	**24.00**	in	**551.18**	mm			Model based on 24"
221	Concrete Thickness	2.00	ft	609.60	mm	FSOGT		

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	B	C	D	E	F	G	H	I
222	Pipe Gallery Wall:							
223	Length = IFL + FEWT	63.25	ft	19278.60	mm			
224	Height = FBD + FFD	26.58	ft	8101.58	mm			
225	Concrete Thickness	**18.00**	in	**551.18**	mm			Model based on 18"
226	Concrete Thickness	1.50	ft	457.20	mm	PGWT		
227	Gullet Wall:							
228	Length = IFL	61.75	ft	18821.40	mm			
229	Height = GCH	17.30	ft	5272.69	mm			
230	Concrete Thickness	**14.00**	in	**500.38**	mm			Model based on 14"
231	Concrete Thickness	1.17	ft	355.60	mm	GWT		
232	Filter Influent / Backwash Waste Channel Walls:							
233	Number of Walls (2 per filter)	2.00	#			#W		Fixed
234	Length = IFL + FEWT	63.25	ft	19278.60	mm			
235	Height = FBD	20.08	ft	6120.38	mm			
236	Concrete Thickness	**18.00**	in	**500.38**	mm			Model based on 18"
237	Concrete Thickness	1.50	ft	457.20	mm	FI/BWCST		
238	Filter Influent / Backwash Waste Channel Lower Elevated Slab:							
239	Length = IFL + FEWT	63.25	ft	19278.60	mm			
240	Width = FI/BWCW	5.00	ft	1524.00	mm			
241	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
242	Concrete Thickness	1.00	ft	304.80	mm	FICLEST		
243	Filter Influent / Backwash Waste Channel Upper Elevated Slab:							
244	Length = IFL + FEWT	63.25	ft	19278.60	mm			
245	Width = FI/BWCW + (2 * FI/BWCWT)	8.00	ft	2438.40	mm			
246	Concrete Thickness	**9.00**	in	**228.60**	mm			Model based on 9"
247	Concrete Thickness	0.75	ft	228.60	mm	FICUEST		
248	End Walls: (For Entire Filter Complex)							This accounts for common walls on individual filters
249	Number of Walls	8.00	#					
250	Width = PGWT + IFW + GWT + GCW + (2* FI/BWCWT) + FI/BWCW	45.67	ft	13919.20	mm			
251	Height = FBD	20.08	ft	6120.38	mm			
252	Concrete Thickness	**18.00**	in	**500.38**	mm			Model based on 18"
253	Concrete Thickness	1.50	ft	457.20	mm	FEWT		
254	Common Filter Influent Channel:							
255	Slab on Grade:							
256	Length = FI/BWCW + FI/BWCST	6.50	ft	1981.20	mm			
257	Width = 2*(FSOGW+PGWT)+FGW	137.67	ft	41962.32	mm			
258	Concrete Thickness	**24.00**	in	**457.20**	mm			Model based on 24"
259	Concrete Thickness	2.00	ft	609.60	mm	FISOGT		
260	Common Filter Influent Channel Wall:							
261	Length = 2*(FSOGW+PGWT)+FGW	137.67	ft	41962.32	mm			
262	Height = FICH	7.28	ft	2219.29	mm			
263	Concrete Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
264	Concrete Thickness	1.50	ft	457.20	mm	FIWCST		
265	Common Filter Influent Channel Elevated Slab:							
266	Length = 2*(FSOGW+PGWT)+FGW	137.67	ft	41962.32	mm			
267	Width = FI/BWCW + FI/BWCWT + FEWT	8.00	ft	2438.40	mm			
268	Concrete Thickness	**9.00**	in	**228.60**	mm			Model based on 9"
269	Concrete Thickness	0.75	ft	228.60	mm	FICEST		
270	Filter Gallery:							
271	Slab on Grade:							
272	Length = (#TF/2*FSOGL)+SCW	277.00	ft	84429.60	mm			
273	Width = FGW + (2*PGWT)	46.34	ft	14123.92	mm			
274	Concrete Thickness = FEPHSS + 24	120.00	in	3048.00	mm			
275	Concrete Thickness	10.00	ft	3048.00	mm	FGSOGT		
276	Filter Gallery Elevated Slab:							
277	Length = (#TF/2*FSOGL)+SCW	277.00	ft	84429.60	mm			
278	Width = FGW+(2*PGWT)	46.34	ft	14123.92	mm			
279	Concrete Thickness	**8.00**	in	**304.80**	mm			Model based on 8"
280	Concrete Thickness	0.67	ft	203.20	mm	FGEST		
281	Blower Room:							
282	Slab on Grade:							
283	Length	20.00	ft	6096.00	mm			Fixed
284	Width = FSOGW	45.67	ft	13919.20	mm			
285	Concrete Thickness	**12.00**	in	**609.60**	mm			Model based on 24"
286	Concrete Thickness	1.00	ft	304.80	mm			
287	Walls:							
288	Height = FBD	20.08	ft	6120.38	mm			
289	Concrete Thickness	**8.00**	in	**500.38**	mm			Model based on 8"
290	Concrete Thickness	0.67	ft	203.20	mm			
291	Stair Case:							
292	Slab on Grade:							
293	Length	24.00	ft	7315.20	mm			Fixed
294	Width	24.00	ft	7315.20	mm	SCW		Fixed
295	Concrete Thickness	**12.00**	in	**609.60**	mm			Model based on 24"
296	Concrete Thickness	1.00	ft	304.80	mm			
297	Walls:							
298	Height = FBD	20.08	ft	6120.38	mm			
299	Concrete Thickness	**8.00**	in	**203.20**	mm			Model based on 8"
300	Concrete Thickness	0.67	ft	203.20	mm			
301	Electrical Room:							
302	Slab on Grade:							

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	B	C	D	E	F	G	H	I
303	Length	17.00	ft	5181.60	mm			
304	Width	6.00	ft	1828.80	mm			
305	Concrete Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
306	Concrete Thickness	1.00	ft	304.80	mm			
307	Walls:							
308	Height = FBD	10.00	ft	3048.00	mm			Fixed
309	Concrete Thickness	**8.00**	in	**304.80**	mm			Model based on 8"
310	Concrete Thickness	0.67	ft	203.20	mm			
311	Overall Dimensions:							
312	Total Filter SOG Length = (#TF/2*FSOGL)+FEWT+SCW+FI/BWCW+(2*FI/BWCST)+2(FSOGT)	259.50	ft	79095.60	mm	SOGL		
313	Total Filter SOG Width = 2*(FSOGW+FSOGT+PGWT)+FGW	137.67	ft	41962.32	mm	SOGW		
314	Total Filter Building Area	35725.80	sf	3319.04	m2	BA		
315	Blower Room Area	913.33	sf	84.85	m2	BRA		
316	Stair Case Area	576.00	sf	53.51	m2	SCA		
317	Electrical Room Area	102.00	sf	9.48	m2	ERA		
318	Total Building Area	37317.13	sf	3466.87	m2	TBA		
319	Filter Building Excavation Length	263.50	ft	80314.80	mm	EVD		
320	Filter Building Excavation Width	141.67	ft	43181.52	mm	EVD		
321	Stair Case Excavation Length	28.00	ft	8534.40	mm			
322	Stair Case Excavation Width	28.00	ft	8534.40	mm			
323	Blower Room Excavation Length	24.00	ft	7315.20	mm			
324	Blower Room Excavation Width	49.67	ft	15138.40	mm			
325	Electrical Room Excavation Length	21.00	ft	6400.80	mm			
326	Electrical Room Excavation Width	10.00	ft	3048.00	mm			
327	Filter Building Excavation Depth (DB + FGSOGT + FFD)	16.50	ft	5029.20	mm	EVD		
328	Stair Case Excavation Depth	16.50	ft	5029.20	mm			
329	Blower Room Excavation Depth	1.00	ft	304.80	mm			
330	Electrical Room Excavation Depth	1.00	ft	304.80	mm			
331								
332	**COST ESTIMATE**							
333	**Description**	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
334	SITEWORK:							
335	Filters							
336	Excavation	30126.38	CY	23033.27	m3	***$6.72***	$202,542	
337	Imported Structural Backfill	2765.22	CY	2114.16	m3	***$50.94***	$140,865	
338	Native Backfill	4085.48	CY	3123.57	m3	***$8.27***	$33,768	
339	Haul Excess	26040.90	CY	19909.70	m3	***$8.27***	$215,236	
340	Stair Case:							
341	Excavation	1169.03	CY	893.79	m3	***$6.72***	$7,859	
342	Imported Structural Backfill	58.07	CY	44.40	m3	***$50.94***	$2,958	
343	Native Backfill	564.67	CY	431.72	m3	***$8.27***	$4,667	
344	Haul Excess	604.36	CY	462.07	m3	***$8.27***	$4,995	
345	Blower Room:							
346	Excavation	52.50	CY	40.14	m3	***$6.72***	$353	
347	Imported Structural Backfill	88.30	CY	67.51	m3	***$50.94***	$4,498	
348	Native Backfill	2.73	CY	2.09	m3	***$8.27***	$23	
349	Haul Excess	49.77	CY	38.05	m3	***$8.27***	$411	
350	Electrical Room:							
351	Excavation	10.00	CY	7.64	m3	***$6.72***	$67	
352	Imported Structural Backfill	15.56	CY	11.89	m3	***$50.94***	$792	
353	Native Backfill	1.15	CY	0.88	m3	***$8.27***	$9	
354	Haul Excess	8.85	CY	6.77	m3	***$8.27***	$73	
355	Allowance for Misc Items	5%				$619,117.21	$30,956	
356	Subtotal						$650,073	
357								
358	CONCRETE:							
359	Filters							
360	Foundation (Includes Filter, Gulllet Channel, Filter Influent/Backwash Wastewater Channel) (FSOGW * FSOGL * FOSGT) / 27 *#TF	1711.65	CY	1308.65	m3	***$541.11***	$926,186	
361	Pipe Gallery Wall	747.19	CY	571.27	m3	***$880.79***	$658,123	
362	Gullet Wall	369.26	CY	282.32	m3	***$880.79***	$325,238	
363	Filter Influent / Backwash Waste Channel Walls	1128.94	CY	863.14	m3	***$880.79***	$994,365	
364	Filter Influent / Backwash Waste Channel Lower Elevated Slab	93.70	CY	71.64	m3	***$1,333.77***	$124,979	
365	Filter Influent / Backwash Waste Channel Upper Elevated Slab	112.44	CY	85.97	m3	***$1,333.77***	$149,975	
366	End Walls	407.55	CY	311.59	m3	***$880.79***	$358,967	
367	Gullet Channel Fill	144.54	CY	110.51	m3	***$416.36***	$60,182	
368	Backwash Waste Channel Fill	144.54	CY	110.51	m3	***$416.36***	$60,182	
369	Common Filter Influent							
370	Slab on Grade	66.29	CY	50.68	m3	***$490.62***	$32,521	
371	Common Influent Channel Wall	111.38	CY	85.15	m3	***$880.79***	$98,101	
372	Common Influent Channel Elevated Slab	30.59	CY	23.39	m3	***$1,333.77***	$40,805	
373	Filter Gallery							
374	Slab on Grade	4753.97	CY	3634.67	m3	***$490.62***	$2,332,375	
375	Filter Gallery Elevated Slab	316.93	CY	242.31	m3	***$1,333.77***	$422,712	
376	Pipe Supports	10.00	CY	7.65	m3	***$41.33***		
377	Blower Room							
378	Slab on Grade	33.83	CY	25.86	m3	***$490.62***	$16,596	
379	Blower Room Walls	32.56	CY	24.89	m3	***$880.79***	$28,677	
380	Stair Case							
381	Slab on Grade	21.33	CY	16.31	m3	***$490.62***	$10,466	
382	Stair Case Walls	23.80	CY	18.20	m3	***$880.79***	$20,962	
383	Electrical Room							
384	Slab on Grade	3.78	CY	2.89	m3	***$490.62***	$1,853	
385	Electrical Room Walls	11.36	CY	8.68	m3	***$880.79***	$10,004	
386	Allowance for Misc Items	5%				$6,673,267.63	$333,663	
387	Subtotal						$7,006,931	
388								

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	B	C	D	E	F	G	H	I
389	MASONRY:	**High**						
390	CMU Filter Building	0.00	SF	0.00	m2	***$198.37***	$0	
391	Blower Room	913.33	SF	84.85	m2	***$198.37***	$181,175	
392	Electrical Room	102.00	SF	9.48	m2	***$198.37***	$20,233	
393	Subtotal	1,015.33					$201,409	
394								
395	METALS:							
396	Metal Guardrail with Pickets	1590.67	LF	484.84	m	***$91.60***	$145,705	
397	Filter Access Hatch	42.25	SF	3.93	m2	***$139.09***	$5,876	
398	Stairs (FBD * 12/8)	30	Risers			***$495.92***	$14,878	
399	Allowance for Misc Items	10%				$166,459.14	$16,646	
400	Subtotal						$183,105	
401								
402	THERMAL & MOISTURE PROTECTION:							
403	Concrete Liner	0.00	SF	0.00	m2	**$16.00**	$0	
404	Allowance for Misc Items	10%				$0.00	$0	
405	Subtotal						$0	
406								
407	EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
408	Fabricated Slide Gates, 42-inch	2	EA			***$16,916.59***	$33,833	
409	Underdrain - Leopold Type S	14,820.00	SF	1376.82	m2	***$105.76***	$1,567,394	
410	Wash Troughs							
411	Conventional	0.00	LF	0.00	m	***$371.13***	$0	
412	Media Retaining	1,246.67	LF	379.98	m	***$841.56***	$1,049,143	
413	Media							
414	Bottom Media - Sand (ES=0.6 UC=1.4)	0.00	CF	0.00	m3	***$22.11***	$0	
415	Middle Media - Anthracite (ES=1.1 UC=1.5)	0.00	CF	0.00	m3	***$29.49***	$0	
416	Top Media - GAC (ES=1.1 UC=1.5)	103,740.00	CF	2937.59	m3	***$66.34***	$6,882,286	
417	Air Scour Blowers (164 hp each)	2	EA			***$175,429.57***	$350,859	
418	Allowance for Misc Items	10%				$9,883,516.31	$988,352	
419	Subtotal						$10,871,868	
420								
421	INSTRUMENTS & CONTROLS:							
422	Instruments							
423	Filter Effluent Magmeter (42-inch)	8	EA			***$50,731.65***	$405,853	
424	Combined Filter Effluent Magmeter (96-inch)	0	EA			***$108,659.86***	$0	
425	Isolation Valve Actuators	48	EA			***$6,409.82***	$307,672	
426	Control Valve Actuators	8	EA			***$6,409.82***	$51,279	
427	Turbidimeters	8	EA			***$4,956.21***	$39,650	
428	Particle Counters	8	EA			***$10,700.91***	$85,607	
429	Level Transmitters	8	EA			***$11,264.12***	$90,113	
430	Differential Pressure Transmitters	8	EA			***$11,264.12***	$90,113	
431	Filter Influent Level Transmitter	2	EA			***$11,264.12***	$22,528	
432	Air Scour Differential Pressure Transmitter	2	EA			***$11,264.12***	$22,528	
433	Air Scour Discharge Pressure Indicator Transmitter	2	EA			***$11,264.12***	$22,528	
434	Number of Analog I/O Counts	82	EA			***$264.27***	$21,564	
435	Number of Digital I/O Counts	293	EA			***$62.59***	$18,326	
436	Number of PLC's	2	EA			***$13,074.33***	$26,149	
437	I&C Conduit & Wire	26,469.00	LF	8067.75	m	***$12.06***	$319,189	
438	Allowance for Misc Items	10%				$1,523,099.29	$152,310	
439	Subtotal						$1,675,409	
440								
441	CONVEYING SYSTEMS:							
442	Monorail Hoist (3 Ton)	1	EA			***$4,091.32***	$4,091	
443	Hoist Rail	397.17	LF	121.06	m	***$41.33***	$16,414	
444	Allowance for Misc Items	5%				$20,505.01	$1,025	
445	Subtotal						$21,530	
446								
447	MECHANICAL:							
448	Pipe							
449	Air Scour Pipe-BAW (18-inch , Exposed , 316 SST , None , None)	792.35	LF	241.51	m	***$645.13***	$511,168	
450	Filter Influent Header Pipe-FIH (96-inch , Buried , DI , Cement Mortar , Tape Coating)	0.00	LF	0.00	m	***$832.31***	$0	
451	Filter Influent Pipe-FIH (54-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	0.00	LF	0.00	m	***$468.18***	$0	
452	Filter Effluent Pipe-FE (42-inch , Exposed , DI , Cement Mortar , Paint)	173.35	LF	52.84	m	***$364.14***	$63,124	
453	Filter Effluent Pipe-FE (42-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	173.35	LF	52.84	m	***$364.14***	$63,124	
454	Filter Control Valve Pipe-FCV (36-inch , Exposed , DI , Cement Mortar , Paint)	192.00	LF	58.52	m	***$312.12***	$59,927	
455	Filter Effluent Header Pipe-FEH (96-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	259.50	LF	79.10	m	***$832.31***	$215,986	
456	Filter to Waste-FTW (42-inch , Exposed , DI , Cement Mortar , Paint)	80.32	LF	24.48	m	***$364.14***	$29,248	
457	Filter to Waste-FTW (42-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	542.00	LF	165.20	m	***$364.14***	$197,363	
458	Backwash Supply Pipe-BWS (60-inch , Exposed , DI , Cement Mortar , Paint)	594.40	LF	181.17	m	***$520.20***	$309,205	
459	Backwash Supply Pipe-BWS (60-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	48.00	LF	14.63	m	***$520.20***	$24,969	
460	Backwash Waste Pipe-BWW (60-inch , Encased , DI , Cement Mortar , Fusion Bonded Epoxy)	10.00	LF	3.05	m	***$520.20***	$5,202	
461	Elbows							
462	Air Scour Pipe-BAW (18-inch , 316 SST)	32	EA			***$3,804.96***	$121,759	
463	Filter Influent Header Pipe-FIH (96-inch , DI)	0	EA			***$17,469.08***	$0	
464	Filter Influent Pipe-FIH (54-inch , DI)	0	EA			***$9,826.36***	$0	
465	Filter Effluent Pipe-FE (42-inch , DI)	8	EA			***$7,642.72***	$61,142	
466	Filter Effluent Pipe-FE (42-inch , DI)	8	EA			***$7,642.72***	$61,142	
467	Filter Control Valve Pipe-FCV (36-inch , DI)	0	EA			***$6,550.90***	$0	
468	Filter Effluent Header Pipe-FEH (96-inch , DI)	0	EA			***$17,469.08***	$0	
469	Filter to Waste-FTW (42-inch , DI)	10	EA			***$7,642.72***	$76,427	
470	Filter to Waste-FTW (42-inch , DI)	0	EA			***$7,642.72***	$0	

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	B	C	D	E	F	G	H	I
471	Backwash Supply Pipe-BWS (60-inch , DI)	2	EA			$10,918.17	$21,836	
472	Backwash Supply Pipe-BWS (60-inch , DI)	2	EA			$10,918.17	$21,836	
473	Backwash Waste Pipe-BWW (60-inch , DI)	0	EA			$10,918.17	$0	
474	Tees							
475	Air Scour Pipe-BAW (18-inch , 316 SST)	8	EA			$5,287.59	$42,301	
476	Filter Influent Header Pipe-FIH (96-inch , DI)	0	EA			$29,006.98	$0	
477	Filter Influent Pipe-FIH (54-inch , DI)	0	EA			$16,316.42	$0	
478	Filter Effluent Pipe-FE (42-inch , DI)	8	EA			$12,690.55	$101,524	
479	Filter Effluent Pipe-FE (42-inch , DI)	0	EA			$12,690.55	$0	
480	Filter Control Valve Pipe-FCV (36-inch , DI)	0	EA			$10,877.62	$0	
481	Filter Effluent Header Pipe-FEH (96-inch , DI)	0	EA			$29,006.98	$0	
482	Filter to Waste-FTW (42-inch , DI)	0	EA			$12,690.55	$0	
483	Filter to Waste-FTW (42-inch , DI)	6	EA			$12,690.55	$76,143	
484	Backwash Supply Pipe-BWS (60-inch , DI)	10	EA			$18,129.36	$181,294	
485	Backwash Supply Pipe-BWS (60-inch , DI)	0	EA			$18,129.36	$0	
486	Backwash Waste Pipe-BWW (60-inch , DI)	0	EA			$18,129.36	$0	
487	Crosses							
488	Air Scour Pipe-BAW (18-inch , 316 SST)	4	EA			$7,050.12	$28,200	
489	Filter Influent Header Pipe-FIH (96-inch , DI)	0	EA			$38,675.97	$0	
490	Filter Influent Pipe-FIH (54-inch , DI)	0	EA			$21,755.23	$0	
491	Filter Effluent Pipe-FE (42-inch , DI)	0	EA			$16,920.74	$0	
492	Filter Effluent Pipe-FE (42-inch , DI)	0	EA			$16,920.74	$0	
493	Filter Control Valve Pipe-FCV (36-inch , DI)	0	EA			$14,503.49	$0	
494	Filter Effluent Header Pipe-FEH (96-inch , DI)	4	EA			$38,675.97	$154,704	
495	Filter to Waste-FTW (42-inch , DI)	0	EA			$16,920.74	$0	
496	Filter to Waste-FTW (42-inch , DI)	0	EA			$16,920.74	$0	
497	Backwash Supply Pipe-BWS (60-inch , DI)	0	EA			$24,172.48	$0	
498	Backwash Supply Pipe-BWS (60-inch , DI)	0	EA			$24,172.48	$0	
499	Backwash Waste Pipe-BWW (60-inch , DI)	0	EA			$24,172.48	$0	
500	Valves							
501	Air Scour Pipe-BAW (18-inch ,V500 - BFV)	8	EA			$15,949.15	$127,593	
502	Filter Influent Header Pipe-FIH (96-inch ,V500 - BFV)	0	EA			$85,062.12	$0	
503	Filter Influent Pipe-FIH (54-inch ,V500 - BFV)	8	EA			$47,847.44	$382,780	
504	Filter Effluent Pipe-FE (42-inch ,V500 - BFV)	8	EA			$37,214.68	$297,717	
505	Filter Effluent Pipe-FE (42-inch ,V500 - BFV)	0	EA			$37,214.68	$0	
506	Filter Control Valve Pipe-FCV (36-inch ,V500 - BFV)	8	EA			$31,898.29	$255,186	
507	Filter Effluent Header Pipe-FEH (96-inch ,V500 - BFV)	0	EA			$85,062.12	$0	
508	Filter to Waste-FTW (42-inch ,V500 - BFV)	8	EA			$37,214.68	$297,717	
509	Filter to Waste-FTW (42-inch ,V500 - BFV)	0	EA			$37,214.68	$0	
510	Backwash Supply Pipe-BWS (60-inch ,V500 - BFV)	8	EA			$53,163.82	$425,311	
511	Backwash Supply Pipe-BWS (60-inch ,V500 - BFV)	0	EA			$53,163.82	$0	
512	Backwash Waste Pipe-BWW (60-inch ,V500 - BFV)	8	EA			$53,163.82	$425,311	
513	Allowance for Misc Items	5%				$4,639,239.64	$231,962	
514	Subtotal						$4,871,202	
515								
516	ELECTRICAL:							
517	MCC's							
518	Sections	7	EA			$10,730.27	$75,112	
519	AFD's							
520	Air Scour Blowers (164 hp each)	0	EA			$30,371.24	$0	
521	Switchgear							
522	Units	0	EA			$49,359.23	$0	
523	Electrical Conduit & Wire	519.00	LF	158.19	m	$12.06	$6,259	
524	Allowance for Misc Items	5%				$81,370.48	$4,069	
525	Subtotal						$85,439	
526								
527	**USER DEFINED ESTIMATE ITEMS**	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
528	Item 1 Description	0.00		0.00		0.00	$0	
529	Item 2 Description	0.00		0.00		0.00	$0	
530	Item 3 Description	0.00		0.00		0.00	$0	
531	Item 4 Description	0.00		0.00		0.00	$0	
532	Item 5 Description	0.00		0.00		0.00	$0	
533	Item 6 Description	0.00		0.00		0.00	$0	
534	Item 7 Description	0.00		0.00		0.00	$0	
535	Item 8 Description	0.00		0.00		0.00	$0	
536	Item 9 Description	0.00		0.00		0.00	$0	
537	Item 10 Description	0.00		0.00		0.00	$0	
538	Item 11 Description	0.00		0.00		0.00	$0	
539	Item 12 Description	0.00		0.00		0.00	$0	
540	Item 13 Description	0.00		0.00		0.00	$0	
541	Item 14 Description	0.00		0.00		0.00	$0	
542	Item 15 Description	0.00		0.00		0.00	$0	
543	Subtotal						$0	
544								
545	Subtotal						$25,566,965.67	
546								
547	ALLOWANCES:		**User Override**					
548	Finishes Allowance	2.00%		$27,790,180	$555,803.60			
549	Mechanical Allowance	2.00%		$27,790,180	$555,803.60			
550	I&C Allowance	2.00%		$27,790,180	$555,803.60			
551	Electrical Allowance	2.00%		$27,790,180	$555,803.60			
552						Facility Cost Name		
553	Facility Cost	**160,000,000**	**GPD**	**$0.17**	**$27,790,180**	FLCFC01		
554	Facility Cost with Standard Additional Project Costs Added	**160,000,000**	**GPD**	**$0.21**	**$33,766,974**	FLCFC02		
555	Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**160,000,000**	**GPD**	**$0.37**	**$58,570,882**	FLCFC03		
556	Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**160,000,000**	**GPD**	**$0.30**	**$48,203,767**	FLCFC05		
557	Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**160,000,000**	**GPD**	**$0.37**	**$58,570,882**	FLCFC06		

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Concrete Clearwell

Is This Facility Included in My Project? Yes

If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Is this a Seawater Desalination Application?	No	Y/N					
Has the USER Contacted Equipment Suppliers to Obtain Equipment Quotes?	No	Y/N					
Input Maximum Plant Flow Capacity	160.00	mgd	567.81	ML/d	Qmax		
Conversion of Maximum Flow	247.56	cfs	7.01	m3/s	Qmax, cfs		
Is Clearwell to Provide Contact Time for Pathogen Inactivation by Free Chlorine?	Yes	Y/N					
Input pH Exiting Clearwell	8.00	ph units					
Input Free Chlorine Residual Exiting Clearwell	2.00	mg/L					
Input Water Temperature at Maximum Flow	33.80	degrees F	1.00	degrees C			
Input Desired Giardia Log Inactivation	1.00	log					Valid Range: 0.0 to 4.0 log.
Calculate Required Giardia Inactivation CT	111.28	mg-min/L					
Input Desired Virus Log Inactivation	2.00	log					Valid Range: 0.0 to 5.0 log.
Calculate Required Virus Inactivation CT	5.87	mg-min/L					
Calculate Controlling Required Pathogen Inactivation CT	111.28	mg-min/L					
Do you have baffling?	Yes	Y/N					
Input Type of Baffling Material	Concrete	Type				OKAY	
Input Clearwell Short-Circuiting Factor	0.50	#				OKAY	0.1 = no clearwell baffling, short distance between inlet and outlet to clearwell, high inlet and outlet flow velocities. 0.3 = no clearwell baffling, relatively long distance between inlet and outlet. 0.5 = Baffled inlet or outlet with some internal baffling. 0.7 = Well baffled clearwell with inlet and outlet place opposite to each other.
Calculate T10 Detention Time	55.64	min					
Calculate Theoretical Detention Time	111.28	min					
Calculate Disinfection Contact Volume Required	12,364,509.29	gal	46804.76	m3			
Input Storage Volume for Plant Shutdown	3,333,333.33	gal	11,829.41	m3			
Input Backwash Storage Volume	715,000.00	gal	3,293.31	m3			
Input Storage Volume for Fire Protection		gal	0.00	m3			
Input Storage Volume for Peak Hour Flow		gal	0.00	m3			
Calculate Total Clearwell Volume	16,412,842.62	gal	62129.37	m3			
Conversion of Total Clearwell Volume	2,194,078.65	cf	62129.40	m3			
Input Number of Clearwells of Equal Size	2	#					
Input Clearwell Maximum Side Water Depth	15.00	ft	4,572.00	mm	SWD		
Input Clearwell Freeboard	3.00	ft	914.40	mm	FB		
Select Circular or Rectangular Type	Rectangular	Type					
If Rectangular, Input Length to Width Ratio	2.00	:1					
Input Depth of Clearwell Burial	15.00	ft	4,572.00	mm	DB		
Input Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		
For Circular Tank, Calculate Clearwell Diameter	0.00	ft	0.00	mm			
For Rectangular Tank, Calculate Clearwell Length	382.46	ft	116572.32	mm			
For Rectangular Tank, Calculate Clearwell Width	191.23	ft	58286.16	mm			

Estimating Dimensions (per trian):	Value English	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Circular Clearwell (per Each)							
Water Volume of Each Tank	0.00	gal	0.00	m3			
Diameter	0.00	ft	0.00	mm			
Height	0.00	ft	0.00	mm			
Total Volume of Each Tank (including Freeboard)	0.00	gal	0.00	m3			
Slab on Grade Thickness	20.00	in	508.00	mm			Model based on 12"
Slab on Grade Thickness	1.67	ft	508.00	mm			
Wall Thickness	18.00	in	457.20	mm			Model based on 12"
Wall Thickness	1.50	ft	457.20	mm			
Slab on Grade Diameter	0.00	ft	0.00	mm			
Excavation Diameter	0.00	ft	0.00	mm			
Excavation Depth	0.00	ft	0.00	mm			
Rectangular Clearwell (per Each)							
Width	191.23	ft	58286.16	mm			
Length	382.46	ft	116572.32	mm			
Height = SWD + FB	18.00	ft	5486.40	mm			
Slab on Grade Thickness	17.00	in	431.80	mm			Rule: SWD in inches + 2 inches
Slab on Grade Thickness	1.42	ft	431.80	mm			
Wall Thickness	15.00	in	381.00	mm	Rectangular Clearwell Wall Thickness Override (in):		Rule: SWD in inches
Wall Thickness	1.25	ft	381.00	mm			

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Elevated Slab Thickness	**15.00**	in	**381.00**	mm			Model based on 12"
Elevated Slab Thickness	1.25	ft	381.00	mm			
Column Diameter	18.00	in	457.20	mm			Rule: 18" for SWD ≤ 30', 24" for SWD > 30'
Column Diameter	1.50	ft	457.20	mm			
Column Volume	31.81	cf	0.90	m3			
Column Volume	1.18	cy	0.90	m3			
Number of Columns (Each)	325.00	#					Rule: Columns on 15' centers
Slab on Grade Width	196.56	ft	59911.76	mm			
Slab on Grade Length	387.79	ft	118197.92	mm			
Excavation Width	200.56	ft	61130.96	mm			
Excavation Length	391.79	ft	119417.12	mm			
Excavation Depth	17.42	ft	5308.60	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Circular Clearwell							
Excavation	0	CY	0.00	m3	***$6.72***	$0	
Imported Structural Backfill	0	CY	0.00	m3	***$50.94***	$0	
Native Backfill	0	CY	0.00	m3	***$8.27***	$0	
Haul Excess	0	CY	0.00	m3	***$8.27***	$0	
Rectangular Clearwell							
Excavation	121,339	CY	92770.65	m3	***$6.72***	$815,774	
Imported Structural Backfill	11,641	CY	8900.26	m3	***$50.94***	$593,017	
Native Backfill	23,958	CY	18317.04	m3	***$8.27***	$198,018	
Haul Excess	97,382	CY	74453.60	m3	***$8.27***	$804,887	
Allowance for Misc Items	5%				$2,411,695.24	$120,585	
Subtotal						$2,532,280	
CONCRETE:							
Circular Clearwell							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Prestressed Concrete Tank (16412843 gallons)	0	EA			***$0.00***	$0	
Rectangular Clearwell							
Foundation	7,999	CY	6115.54	m3	***$541.11***	$4,328,207	
Columns	383	CY	292.73	m3	***$880.79***	$337,240	
Walls	1,912	CY	1462.04	m3	***$880.79***	$1,684,319	
Elevated Slab	6,905	CY	5279.42	m3	***$1,333.77***	$9,209,955	
Concrete Baffling	9,795	CY	7488.76	m3	***$880.79***	$8,627,308	
Allowance for Misc Items	5%				$24,187,028.83	$1,209,351	
Subtotal						$25,396,380	
METALS & PLASTICS:							
Polypropylene Baffling	0	SF	0.00	m2	***$13.91***	$0	
Stainless Steel Baffling	0	SF	0.00	m2	***$57.95***	$0	
Allowance for Misc Items	5%				$0.00	$0	
Subtotal						$0	
THERMAL & MOISTURE PROTECTION:							
Concrete Liner	0	SF	0.00	m2	**$16.00**	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$27,928,660	
ALLOWANCES:		**User Override**					
Metals Allowance	1.00%		$30,030,817	$300,308			
Finishes Allowance	2.00%		$30,030,817	$600,616			
Equipment Allowance	1.00%		$30,030,817	$300,308			
I&C Allowance	2.00%		$30,030,817	$600,616			
Mechanical Allowance	5.00%		$30,030,817	$1,501,541			
Electrical Allowance	1.00%		$30,030,817	$300,308			
Facility Cost	**16,412,843**	**Gallons**	**$1.92**	**$31,532,358**			
Facility Cost with Standard Additional Project Costs Added	**16,412,843**	**Gallons**	**$2.33**	**$38,313,977**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**16,412,843**	**Gallons**	**$4.05**	**$66,457,937**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**16,412,843**	**Gallons**	**$3.33**	**$54,694,804**			
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**16,412,843**	**Gallons**	**$4.05**	**$66,457,937**			

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Liquid Chemical Storage & Feed - (Aluminum Sulfate (Alum))

Located in Stand Alone Chemical Building

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N Overwrite Value					
Select Chemical	**Aluminum Sulfate (Alum)**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	48.50%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Al2(SO4)3-14H2O		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.34		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	5.42	lb/gal	649.90	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**15.00**	mgd	**56.78**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**90.00**	mgd	**283.91**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**567.81**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**2.50**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**5.00**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**15.00**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**3**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	312.95	lb/d	141.95	kg/d			
Average as "dry" chemical	3,755.43	lb/d	1703.43	kg/d			
Maximum as "dry" chemical	20,028.96	lb/d	9084.98	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.80	gph	3.03	L/h			
Average at feed concentration	9.62	gph	36.40	L/h			
Maximum at feed concentration	51.29	gph	194.15	L/h			
Calculate Chemical Metering Pump Flow Turndown	64.00	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	312.95	lb/d	141.95	kg/d			
Average	3,755.43	lb/d	1703.43	kg/d			
Maximum	20,028.96	lb/d	9084.98	kg/d			
Max Flow Average Dose Daily Usage	6,676.32	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	36,928.76	gal	139.79	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,024.02	gal	15.23	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	6,036.04	gal	22.85	m3			
Maximum of Above Delivery and Storage Volumes	4,936.66	cf	139.79	m3			
BULK TANKS:							
29.) Input Number of Tanks	**4**	#					
30.) Input Tank Diameter	**10.00**	ft	**3,048.00**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	15.71	ft	4789.59	mm			
Use this Tank Height (Liquid Height * 1.2)	19.00	ft	5791.20	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	9,302.38	gal	35.21	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	11,162.85	gal	42.26	m3			
31.) Input Number of Rows of Tanks	**2**	#					
Calculate Number of Tanks per Row	2	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	30.23	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**Yes**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**1**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	3,692.88	gal	13.98	m3			
Convert Day Tank Volume (per each)	493.67	cf	13.98	m3			
Calculate Day Tank Diameter (per each)	7.00	ft	2133.60	mm	DTD		
Calculate Day Tank Height (per each)	14.00	ft	4267.20	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	2	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	3	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**3**	#					
Calculate Total Number of Metering Pumps	7	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**Yes**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here	**17**	#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	None						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	39.00	ft	11887.20	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	9,672.00	gal	36.61	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	13,395.42	gal	50.71	m3			
Calculate 30% of All Tank Volume	13,395.42	gal	50.71	m3			
Calculate Maximum Volume + Fire Flow Volume	23,067.42	gal	87.32	m3			
Tank Pads Volume	942.48	cf	26.69	m3			
Tank Pads Volume	7,050.22	gal	26.69	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	30,117.65	gal	114.01	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	4,026.14	cf	114.01	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	685.80	mm			
49.) Input Depth of Burial	1.75	ft	533.40	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	6.50	in	150.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	4.00	in	100.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	39.00	8.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	39.00	8.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	101.00	28.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	101.00	28.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N
53.) Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	24.00	0.50	No	48.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**12.00**		**48.00**	**0.00**	**0.00**	**48.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	1.67

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	13.33						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	17.33						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Width	4.67						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.37***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	1						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	TRUE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	39.00	ft	11887.20	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	4	#					
Diameter of Bulk Tank	10.00	ft	3048.00	mm			
Volume of Each Bulk Tank	11162.85	gal	42.26	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	1	#					
Diameter of Day Tank	7.00	ft					
Volume of Each Day Tank	4030.38	gal	15.26	m3			
Number of Transfer Pumps	2	#					
Transfer Pump Capacity (each)	201.52	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	7	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	39.00	ft	11887.20	mm			
Width	8.00	ft	2438.40	mm			
Area	312.00	sf	28.99	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	18.67	ft	5689.60	mm			
Width	6.00	ft	1828.80	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	39.00	ft	11887.20	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	2418.00	sf	224.64	m2			
Corridor Area Length	39.00	ft	11887.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	312.00	sf	28.99	m2			
Electrical Area Length	18.67	ft	5689.60	mm			
Electrical Area Width	6.00	ft	1828.80	mm			
Electrical Room Area	112.00	sf	10.41	m2			
Chemical Facility Area	2842.00	sf	264.03	m2			
Covered Chemical Area (Building)	2842.00	sf	264.03	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	2954.00	sf	274.44	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	468.00	CY	357.82	m3	***$6.72***	$3,146	
Imported Structural Backfill	210.52	CY	160.95	m3	***$50.94***	$10,724	
Native Backfill	49.45	CY	37.81	m3	***$8.27***	$409	
Haul Excess	418.55	CY	320.01	m3	***$8.27***	$3,459	
Allowance for Misc Items	5%				$17,738.77	$887	
Subtotal						$18,626	
CONCRETE:							
Slab on Grade	76.83	CY	58.74	m3	***$490.62***	$37,693	
Containment Walls	11.22	CY	8.58	m3	***$880.79***	$9,884	
Bulk Tank Pads	68.42	CY	52.31	m3	***$490.62***	$33,566	
Day Tank Pads	3.52	CY	2.69	m3	***$490.62***	$1,727	
Transfer Pump Pads	1.33	CY	1.02	m3	***$490.62***	$654	
Metering Pump Pads	4.67	CY	3.57	m3	***$490.62***	$2,290	
Corridor							
Slab on Grade	10.83	CY	8.28	m3	***$490.62***	$5,315	
Electrical Room							
Slab on Grade	4.15	CY	3.17	m3	***$490.62***	$2,035	
Allowance for Misc Items	5%				$93,164.25	$4,658	
Subtotal						$97,822	
MASONRY:	**Moderate**						
Chemical Building	2730.00	SF	253.63	m2	***$198.37***	$541,542	
Electrical Room	112.00	SF	10.41	m2	***$165.31***	$18,514	
Subtotal	2842.00					$560,056	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	4	EA			***$26,489.89***	$105,960	
Day Tank	1	EA			***$11,442.30***	$11,442	
Transfer Pump	2	EA			***$10,658.90***	$21,318	
Metering Pump	7	EA			***$10,658.90***	$74,612	
Allowance for Misc Items	10%				$213,331.94	$21,333	
Subtotal						$234,665	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	4	EA			***$1,043.16***	$4,173	
Chemical Tank Beacons	4	EA			***$1,043.16***	$4,173	
Day Tank Differential Pressure Transmitter	1	EA			***$1,043.16***	$1,043	
Drum or Tote Weigh Scale	0	EA			***$1,390.89***	$0	
Metering Pump Discharge Pressure Switch	7	EA			***$695.44***	$4,868	
Magmeter	3	EA			***$695.44***	$2,086	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	18	EA			***$264.27***	$4,757	
Number of Digital I/O Counts	64	EA			***$62.59***	$4,006	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	819.00	LF	249.63	m	***$12.06***	$9,876	
Allowance for Misc Items	10%				$63,355.86	$6,336	
Subtotal						$69,691	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	39.00	LF	11.89	m	***$42.14***	$1,644	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	39.00	LF	11.89	m	***$28.95***	$1,129	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	101.00	LF	30.78	m	***$13.11***	$1,324	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	101.00	LF	30.78	m	***$13.11***	$1,324	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	8	EA			***$146.80***	$1,174	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	8	EA			***$84.65***	$677	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	28	EA			***$10.06***	$282	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	28	EA			***$10.06***	$282	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	2	EA			***$218.62***	$437	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	2	EA			***$124.01***	$248	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	7	EA			***$10.47***	$73	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	7	EA			***$10.47***	$73	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (6.5-inch, Exposed, PVC)	2	EA			***$72.81***	$146	
Chemical Transfer Pump Discharge Header Piping-CTDH (4-inch, Exposed, PVC)	2	EA			***$42.28***	$85	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$1,341.93***	$5,368	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$757.94***	$3,032	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	14	EA			***$57.14***	$800	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	14	EA			***$57.14***	$800	
Allowance for Misc Items	10%				$16,147.28	$1,615	
Subtotal						$20,535	
ELECTRICAL:							

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# MCC Sections	8	#			***$10,730.27***	$85,842	
Switchgear	0	EA			***$49,359.23***	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			***$8,931.12***	$0	
User Defined Item #1	0	EA			***$8,865.56***	$0	
User Defined Item #2	0	EA			***$8,865.56***	$0	
User Defined Item #3	0	EA			***$8,865.56***	$0	
Electrical Conduit & Wire	936.00	LF	285.29	m	***$12.06***	$11,287	
Allowance for Misc Items	10%				$97,129.35	$9,713	
Subtotal						$106,842	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$1,119,596	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$1,243,995	$24,880			
I&C Allowance	2.00%		$1,243,995	$24,880			
Mechanical Allowance	4.00%		$1,243,995	$49,760			
Electrical Allowance	2.00%		$1,243,995	$24,880			
					Facility Cost Name		
Facility Cost	**2,842**	**Building SF**	**$437.72**	**$1,243,995**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**2,842**	**Building SF**	**$531.86**	**$1,511,540**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**2,842**	**Building SF**	**$922.54**	**$2,621,858**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**2,842**	**Building SF**	**$759.25**	**$2,157,786**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**2,842**	**Building SF**	**$922.54**	**$2,621,858**	CFLFC06		

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Liquid Chemical Storage & Feed - (Liquid Polymer)
Located in Chemical Building A

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Liquid Polymer**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	100.00%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Polymer		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.10		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	9.18	lb/gal	1100.00	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**15.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**90.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**567.81**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**0.25**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**0.75**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**1.50**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**3**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	31.30	lb/d	14.20	kg/d			
Average as "dry" chemical	563.31	lb/d	255.52	kg/d			
Maximum as "dry" chemical	2,002.90	lb/d	908.50	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.05	gph	0.18	L/h			
Average at feed concentration	0.85	gph	3.23	L/h			
Maximum at feed concentration	3.03	gph	11.47	L/h			
Calculate Chemical Metering Pump Flow Turndown	64.00	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	31.30	lb/d	14.20	kg/d			
Average	563.31	lb/d	255.52	kg/d			
Maximum	2,002.90	lb/d	908.50	kg/d			
Max Flow Average Dose Daily Usage	1,001.45	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	3,272.73	gal	12.39	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,901.99	gal	18.56	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	7,352.99	gal	27.83	m3			
Maximum of Above Delivery and Storage Volumes	982.95	cf	27.83	m3			
BULK TANKS:							
29.) Input Number of Tanks	**1**	#					
30.) Input Tank Diameter	**10.00**	ft	**3,048.00**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	12.52	ft	3814.67	mm			
Use this Tank Height (Liquid Height * 1.2)	16.00	ft	4876.80	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	7,833.58	gal	29.65	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	9,400.30	gal	35.58	m3			
31.) Input Number of Rows of Tanks	**1**	#					
Calculate Number of Tanks per Row	1	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	71.81	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**Yes**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**1**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	218.18	gal	0.83	m3			
Convert Day Tank Volume (per each)	29.17	cf	0.83	m3			
Calculate Day Tank Diameter (per each)	3.00	ft	914.40	mm	DTD		
Calculate Day Tank Height (per each)	6.00	ft	1828.80	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	2	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	3	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**0**	#					
Calculate Total Number of Metering Pumps	4	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	A						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	24.00	ft	7315.20	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	5,952.00	gal	22.53	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	11,280.36	gal	42.70	m3			
Calculate 30% of All Tank Volume	2,820.09	gal	10.68	m3			
Calculate Maximum Volume + Fire Flow Volume	17,232.36	gal	65.23	m3			
Tank Pads Volume	235.62	cf	6.67	m3			
Tank Pads Volume	1,762.56	gal	6.67	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	18,994.91	gal	71.90	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	2,539.25	cf	71.90	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	685.80	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	1.50	in	40.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	24.00	8.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	24.00	8.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	86.00	16.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	86.00	16.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N					
53.) Is there SWGR?	No						

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	0.00	0.50	No	0.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	0.00
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	0.00

Clear Distances:

Clear Distance	Width	Length	Comment				
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet			
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot			
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero			
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero			

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	0.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	0.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	0.00						
CD7	3.00						
Total Width	0.00						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.42***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	1						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	TRUE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	24.00	ft	7315.20	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	1	#					
Diameter of Bulk Tank	10.00	ft	3048.00	mm			
Volume of Each Bulk Tank	9400.30	gal	35.58	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	1	#					
Diameter of Day Tank	3.00	ft					
Volume of Each Day Tank	317.26	gal	1.20	m3			
Number of Transfer Pumps	2	#					
Transfer Pump Capacity (each)	15.86	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	4	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	24.00	ft	7315.20	mm			
Width	8.00	ft	2438.40	mm			
Area	192.00	sf	17.84	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	0.00	ft	0.00	mm			
Width	0.00	ft	0.00	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	24.00	ft	7315.20	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	1488.00	sf	138.24	m2			
Corridor Area Length	24.00	ft	7315.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	192.00	sf	17.84	m2			
Electrical Area Length	0.00	ft	0.00	mm			
Electrical Area Width	0.00	ft	0.00	mm			
Electrical Room Area	0.00	sf	0.00	m2			
Chemical Facility Area	1680.00	sf	156.08	m2			
Covered Chemical Area (Building)	1680.00	sf	156.08	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	1680.00	sf	156.08	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	291.68	CY	223.00	m3	***$6.72***	$1,961	
Imported Structural Backfill	124.44	CY	95.14	m3	***$50.94***	$6,339	
Native Backfill	42.65	CY	32.61	m3	***$8.27***	$352	
Haul Excess	249.03	CY	190.40	m3	***$8.27***	$2,058	
Allowance for Misc Items	5%				$10,711.16	$536	
Subtotal						$11,247	
CONCRETE:							
Slab on Grade	48.34	CY	36.96	m3	***$490.62***	$23,716	
Containment Walls	6.11	CY	4.67	m3	***$880.79***	$5,383	
Bulk Tank Pads	17.10	CY	13.08	m3	***$490.62***	$8,392	
Day Tank Pads	1.43	CY	1.09	m3	***$490.62***	$699	
Transfer Pump Pads	1.33	CY	1.02	m3	***$490.62***	$654	
Metering Pump Pads	2.67	CY	2.04	m3	***$490.62***	$1,308	
Corridor							
Slab on Grade	6.67	CY	5.10	m3	***$490.62***	$3,271	
Electrical Room							
Slab on Grade	0.00	CY	0.00	m3	***$490.62***	$0	
Allowance for Misc Items	5%				$43,422.92	$2,171	
Subtotal						$45,594	
MASONRY:	**Moderate**						
Chemical Building	1680.00	SF	156.08	m2	***$198.37***	$333,256	
Electrical Room	0.00	SF	0.00	m2	***$165.31***	$0	
Subtotal	1680.00					$333,256	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	1	EA			***$22,771.38***	$22,771	
Day Tank	1	EA			***$3,608.62***	$3,609	
Transfer Pump	2	EA			***$10,658.90***	$21,318	
Metering Pump	4	EA			***$10,658.90***	$42,636	
Allowance for Misc Items	10%				$90,333.38	$9,033	
Subtotal						$99,367	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	1	EA			***$1,043.16***	$1,043	
Chemical Tank Beacons	1	EA			***$1,043.16***	$1,043	
Day Tank Differential Pressure Transmitter	1	EA			***$1,043.16***	$1,043	
Drum or Tote Weigh Scale	0	EA			***$1,390.89***	$0	
Metering Pump Discharge Pressure Switch	4	EA			***$695.44***	$2,782	
Magmeter	3	EA			***$695.44***	$2,086	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	11	EA			***$264.27***	$2,907	
Number of Digital I/O Counts	39	EA			***$62.59***	$2,441	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	288.00	LF	87.78	m	***$12.06***	$3,473	
Allowance for Misc Items	10%				$45,192.60	$4,519	
Subtotal						$49,712	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	24.00	LF	7.32	m	***$15.75***	$378	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	24.00	LF	7.32	m	***$13.11***	$315	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	86.00	LF	26.21	m	***$13.11***	$1,128	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	86.00	LF	26.21	m	***$13.11***	$1,128	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	8	EA			***$22.49***	$180	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	8	EA			***$10.06***	$80	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	16	EA			***$10.06***	$161	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	16	EA			***$10.06***	$161	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	2	EA			***$29.39***	$59	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	2	EA			***$10.47***	$21	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	4	EA			***$10.47***	$42	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	4	EA			***$10.47***	$42	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (1.5-inch, Exposed, PVC)	2	EA			***$11.75***	$24	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$173.94***	$696	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$57.14***	$229	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	8	EA			***$57.14***	$457	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	8	EA			***$57.14***	$457	
Allowance for Misc Items	10%				$4,896.78	$490	
Subtotal						$6,079	
ELECTRICAL:							

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# MCC Sections	0	#			$10,730.27	$0	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	0.00	LF	0.00	m	$12.06	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$556,613	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$618,459	$12,369			
I&C Allowance	2.00%		$618,459	$12,369			
Mechanical Allowance	4.00%		$618,459	$24,738			
Electrical Allowance	2.00%		$618,459	$12,369			
					Facility Cost Name		
Facility Cost	**1,680**	**Building SF**	**$368.13**	**$618,459**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**1,680**	**Building SF**	**$447.30**	**$751,470**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**1,680**	**Building SF**	**$775.88**	**$1,303,471**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**1,680**	**Building SF**	**$638.54**	**$1,072,755**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**1,680**	**Building SF**	**$775.88**	**$1,303,471**	CFLFC06		

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Liquid Chemical Storage & Feed - (Liquid Polymer)
Located in Chemical Building A

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Liquid Polymer**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	100.00%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Polymer		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.10		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	9.18	lb/gal	1100.00	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**15.00**	mgd	**56.78**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**90.00**	mgd	**283.91**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**567.81**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**0.05**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**0.10**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**0.25**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**2**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	6.26	lb/d	2.84	kg/d			
Average as "dry" chemical	75.11	lb/d	34.07	kg/d			
Maximum as "dry" chemical	333.82	lb/d	151.42	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.01	gph	0.05	L/h			
Average at feed concentration	0.17	gph	0.65	L/h			
Maximum at feed concentration	0.76	gph	2.87	L/h			
Calculate Chemical Metering Pump Flow Turndown	53.33	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			

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Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	6.26	lb/d	2.84	kg/d			
Average	75.11	lb/d	34.07	kg/d			
Maximum	333.82	lb/d	151.42	kg/d			
Max Flow Average Dose Daily Usage	133.53	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	Maximum	Type					
26.) Chemcial application used to calculate storage requirements	Average	Type					
27.) Input Minimum Number of Days of Storage	30.00	days					
Minimum Storage Volume	436.36	gal	1.65	m3			
28.) Choose Chemical Delivery Method	Tote	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	300.00	gal	1.14	m3			Assumes 300 gal per Tote.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Bulk Delivery Volume	300.00	gal	1.14	m3			
Maximum of Above Delivery and Storage Volumes	58.33	cf	1.65	m3			
BULK TANKS:							
29.) Input Number of Tanks	1	#					
30.) Input Tank Diameter	12.00	ft	3,657.60	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	0.00	ft	0.00	mm			
Use this Tank Height (Liquid Height * 1.2)	0.00	ft	0.00	mm			Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	0.00	gal	0.00	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	0.00	gal	0.00	m3			
31.) Input Number of Rows of Tanks	1	#					
Calculate Number of Tanks per Row	1	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	FRP	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	4.00	ft	1,219.20	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	41.25	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	2	#					
34.) Input Number of Rows of Totes or Drums	2	#					
Calculate Number of Totes or Drums per Row	1	#					
Length of Each Tote	4.00	ft	1219.20	mm			Fixed
Width of Each Tote	4.00	ft	1219.20	mm			Fixed
Diameter of Each Drum	2.50	ft	762.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	No	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	2	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max Flow/Dose (per tank)	0.00	gal	0.00	m3			
Convert Day Tank Volume (per each)	0.00	cf	0.00	m3			
Calculate Day Tank Diameter (per each)	0.00	ft	0.00	mm	DTD		
Calculate Day Tank Height (per each)	0.00	ft	0.00	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	0	#					Fixed
37.) Input Time to Fill Day Tank	20.00	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	2	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	0	#					
Calculate Total Number of Metering Pumps	3	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	4.00	ft	1,828.80	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	Yes	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	No	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	A						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	19.00	ft	5791.20	mm			
Calculate Containment Area Width	35.00	ft	10668.00	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	35.00	ft	10,668.00	mm			
Calculate Fire Sprinkler Water Volume	2,660.00	gal	10.07	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	360.00	gal	1.36	m3			
Calculate 30% of All Tank Volume	180.00	gal	0.68	m3			
Calculate Maximum Volume + Fire Flow Volume	3,020.00	gal	11.43	m3			
Tank Pads Volume	150.00	cf	4.25	m3			
Tank Pads Volume	1,122.08	gal	4.25	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	4,142.08	gal	15.68	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	553.72	cf	15.68	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	2,438.40	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		
Mechanical Sizing Requirements:							
Pipe Name	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Mechanical Material Requirements:							
Pipe Name	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Length**	**# Elbows**
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	54.00	12.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	54.00	12.00
						L+W	#MP*4
Electrical User Inputs and Sizing Requirements:							
52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N					
53.) Is there SWGR?	No						
Electrical Equipment Lengths:							**MCC**
Item	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
Metering Pumps	0.00	0.50	No	0.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**
Electrical Equipment Widths:							
Equipment	**Depth (ft)**						
MCC	0.00						
Small AFD's	0.00						
Large AFD's	0.00						
Switchgear	0.00						
Maximum Depth	0.00						
Clear Distances:							
Clear Distance	**Width**	**Length**	**Comment**				
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet			
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot			
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero			
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero			

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	0.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	0.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	0.00						
CD7	3.00						
Total Width	0.00						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$0.00***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	0						
Is Day Tank Required? (1 = Yes, 0 = No)	0						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	FALSE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	1					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	0.00	ft	0.00	mm			
Length of Module (Tote)	19.00	ft	5791.20	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tote)	35.00	ft	10668.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	0	#					
Diameter of Bulk Tank	12.00	ft	3657.60	mm			
Volume of Each Bulk Tank	0.00	gal	0.00	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	0	#					
Diameter of Day Tank	0.00	ft					
Volume of Each Day Tank	0.00	gal	0.00	m3			
Number of Transfer Pumps	0	#					
Transfer Pump Capacity (each)	0.00	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	3	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	19.00	ft	5791.20	mm			
Width	8.00	ft	2438.40	mm			
Area	152.00	sf	14.12	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	0.00	ft	0.00	mm			
Width	0.00	ft	0.00	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	19.00	ft	5791.20	mm			
Containment Area Width	35.00	ft	10668.00	mm			
Containment Area	665.00	sf	61.78	m2			
Corridor Area Length	19.00	ft	5791.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	152.00	sf	14.12	m2			
Electrical Area Length	0.00	ft	0.00	mm			
Electrical Area Width	0.00	ft	0.00	mm			
Electrical Room Area	0.00	sf	0.00	m2			
Chemical Facility Area	817.00	sf	75.90	m2			
Covered Chemical Area (Building)	817.00	sf	75.90	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	817.00	sf	75.90	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	150.12	CY	114.78	m3	***$6.72***	$1,009	
Imported Structural Backfill	60.52	CY	46.27	m3	***$50.94***	$3,083	
Native Backfill	28.13	CY	21.51	m3	***$8.27***	$232	
Haul Excess	121.99	CY	93.27	m3	***$8.27***	$1,008	
Allowance for Misc Items	5%				$5,332.99	$267	
Subtotal						$5,600	
CONCRETE:							
Slab on Grade	22.75	CY	17.39	m3	***$490.62***	$11,160	
Containment Walls	4.06	CY	3.10	m3	***$880.79***	$3,572	
Bulk Tank Pads	0.00	CY	0.00	m3	***$490.62***	$0	
Day Tank Pads	0.00	CY	0.00	m3	***$490.62***	$0	
Transfer Pump Pads	0.00	CY	0.00	m3	***$490.62***	$0	
Metering Pump Pads	2.00	CY	1.53	m3	***$490.62***	$981	
Corridor							
Slab on Grade	5.28	CY	4.04	m3	***$490.62***	$2,589	
Electrical Room							
Slab on Grade	0.00	CY	0.00	m3	***$490.62***	$0	
Allowance for Misc Items	5%				$18,302.71	$915	
Subtotal						$19,218	
MASONRY:	**High**						
Chemical Building	817.00	SF	75.90	m2	***$198.37***	$162,066	
Electrical Room	0.00	SF	0.00	m2	***$198.37***	$0	
Subtotal	817.00					$162,066	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	0	EA			***$0.00***	$0	
Day Tank	0	EA			***$0.00***	$0	
Transfer Pump	0	EA			***$0.00***	$0	
Metering Pump	3	EA			***$10,658.90***	$31,977	
Allowance for Misc Items	10%				$31,976.69	$3,198	
Subtotal						$35,174	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	0	EA			***$1,043.16***	$0	
Chemical Tank Beacons	0	EA			***$1,043.16***	$0	
Day Tank Differential Pressure Transmitter	0	EA			***$1,043.16***	$0	
Drum or Tote Weigh Scale	2	EA			***$1,390.89***	$2,782	
Metering Pump Discharge Pressure Switch	3	EA			***$695.44***	$2,086	
Magmeter	2	EA			***$695.44***	$1,391	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	9	EA			***$264.27***	$2,378	
Number of Digital I/O Counts	21	EA			***$62.59***	$1,314	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	171.00	LF	52.12	m	***$12.06***	$2,062	
Allowance for Misc Items	10%				$40,387.94	$4,039	
Subtotal						$44,427	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	***$13.11***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	***$13.11***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	54.00	LF	16.46	m	***$13.11***	$708	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	54.00	LF	16.46	m	***$13.11***	$708	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			***$10.06***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			***$10.06***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	12	EA			***$10.06***	$121	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	12	EA			***$10.06***	$121	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			***$10.47***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			***$10.47***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	3	EA			***$10.47***	$31	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	3	EA			***$10.47***	$31	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			***$5.65***	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			***$5.65***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			***$57.14***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			***$57.14***	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	6	EA			***$57.14***	$343	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	6	EA			***$57.14***	$343	
Allowance for Misc Items	10%				$2,428.48	$243	
Subtotal						$2,671	
ELECTRICAL:							

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# MCC Sections	0	#			$10,730.27	$0	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	0.00	LF	0.00	m	$12.06	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$280,514	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$311,682	$6,234			
I&C Allowance	2.00%		$311,682	$6,234			
Mechanical Allowance	4.00%		$311,682	$12,467			
Electrical Allowance	2.00%		$311,682	$6,234			
					Facility Cost Name		
Facility Cost	**817**	**Building SF**	**$381.50**	**$311,682**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**817**	**Building SF**	**$463.54**	**$378,715**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**817**	**Building SF**	**$804.05**	**$656,905**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**817**	**Building SF**	**$661.73**	**$540,632**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**817**	**Building SF**	**$804.05**	**$656,905**	CFLFC06		

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Liquid Chemical Storage & Feed - (Aluminum Sulfate (Alum))
Located in Chemical Building A

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N					
		Overwrite Value					
Select Chemical	**Aluminum Sulfate (Alum)**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	48.50%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Al2(SO4)3-14H2O		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.34		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	5.42	lb/gal	649.90	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**15.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**90.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**567.81**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**1.00**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**1.50**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**2.00**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**2**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**15.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**90.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**150.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**1.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**1.50**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**2.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**2**	#					
16.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	125.18	lb/d	56.78	kg/d			
Average as "dry" chemical	1,126.63	lb/d	511.03	kg/d			
Maximum as "dry" chemical	2,670.53	lb/d	1211.33	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.48	gph	1.82	L/h			
Average at feed concentration	4.33	gph	16.38	L/h			
Maximum at feed concentration	10.26	gph	38.83	L/h			
Calculate Chemical Metering Pump Flow Turndown	21.33	:1				**Note: Pump turndown is > 20, proceed with the design with caution**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	125.18	lb/d	56.78	kg/d			
Average as "dry" chemical	1,126.63	lb/d	511.03	kg/d			
Maximum as "dry" chemical	2,503.62	lb/d	1135.62	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.48	gph	1.82	L/h			
Average at feed concentration	4.33	gph	16.38	L/h			
Maximum at feed concentration	9.62	gph	36.40	L/h			

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Calculate Chemical Metering Pump Flow Turndown	20.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	250.36	lb/d	113.56	kg/d			
Average	2,253.26	lb/d	1022.06	kg/d			
Maximum	5,174.15	lb/d	2346.95	kg/d			
Max Flow Average Dose Daily Usage	3,880.61	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	30.00	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	21,464.84	gal	81.25	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,024.02	gal	15.23	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	6,036.04	gal	22.85	m3			
Maximum of Above Delivery and Storage Volumes	2,869.43	cf	81.25	m3			
BULK TANKS:							
29.) Input Number of Tanks	**3**	#					
30.) Input Tank Diameter	**10.00**	ft	**3,048.00**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	12.18	ft	3711.93	mm			
Use this Tank Height (Liquid Height * 1.2)	15.00	ft	4572.00	mm		**Verify tank height in relationship to the facility structure. Add more tanks or increase diameter if needed.**	Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	7,343.98	gal	27.80	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	8,812.78	gal	33.36	m3			
31.) Input Number of Rows of Tanks	**2**	#					
Calculate Number of Tanks per Row	2	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	30.79	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**Yes**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**2**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	477.00	gal	1.81	m3			
Convert Day Tank Volume (per each)	63.77	cf	1.81	m3			
Calculate Day Tank Diameter (per each)	4.00	ft	1219.20	mm	DTD		
Calculate Day Tank Height (per each)	8.00	ft	2438.40	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	2	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	4	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	2	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**2**	#					
Calculate Total Number of Metering Pumps	8	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**Yes**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	A						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	44.00	ft	13411.20	mm			
Calculate Containment Area Width	62.00	ft	18897.60	mm		**Note: verify that this dimension matches the Containment Area Width on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	
47.) Optional: User Overwrite of Containment Area Width	62.00	ft	18,897.60	mm			
Calculate Fire Sprinkler Water Volume	10,912.00	gal	41.31	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	10,575.33	gal	40.03	m3			
Calculate 30% of All Tank Volume	7,931.50	gal	30.02	m3			
Calculate Maximum Volume + Fire Flow Volume	21,487.33	gal	81.34	m3			
Tank Pads Volume	706.86	cf	20.02	m3			
Tank Pads Volume	5,287.67	gal	20.02	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	26,775.00	gal	101.35	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	3,579.30	cf	101.35	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm		**Note: verify that this dimension matches the Containment Wall Height on the other chemical rooms in this facility. If not, input the larger value in the user overwrite on the room with the shorter dimension**	120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	685.80	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	3.50	in	80.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	2.00	in	50.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	44.00	8.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	44.00	8.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	106.00	32.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	106.00	32.00
						L+W	#MP*4

Electrical User Inputs and Sizing Requirements:

52.) Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
53.) Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Metering Pumps	0.00	0.50	No	0.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	0.00
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	0.00

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero

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CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	0.00						
CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	0.00						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	0.00						
CD7	3.00						
Total Width	0.00						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.44***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	1						
Tank Truck without Day Tank (True or False)	FALSE						
Tank Truck with Day Tank (True or False)	TRUE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	44.00	ft	13411.20	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	62.00	ft	18897.60	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	3	#					
Diameter of Bulk Tank	10.00	ft	3048.00	mm			
Volume of Each Bulk Tank	8812.78	gal	33.36	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	2	#					
Diameter of Day Tank	4.00	ft					
Volume of Each Day Tank	752.02	gal	2.85	m3			
Number of Transfer Pumps	2	#					
Transfer Pump Capacity (each)	75.20	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	8	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	44.00	ft	13411.20	mm			
Width	8.00	ft	2438.40	mm			
Area	352.00	sf	32.70	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	0.00	ft	0.00	mm			
Width	0.00	ft	0.00	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	44.00	ft	13411.20	mm			
Containment Area Width	62.00	ft	18897.60	mm			
Containment Area	2728.00	sf	253.44	m2			
Corridor Area Length	44.00	ft	13411.20	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	352.00	sf	32.70	m2			
Electrical Area Length	0.00	ft	0.00	mm			
Electrical Area Width	0.00	ft	0.00	mm			
Electrical Room Area	0.00	sf	0.00	m2			
Chemical Facility Area	3080.00	sf	286.14	m2			
Covered Chemical Area (Building)	3080.00	sf	286.14	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	3080.00	sf	286.14	m2			

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Excavation Depth	3.50	ft	1066.80	mm			
COST ESTIMATE							
Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	505.10	CY	386.18	m3	***$6.72***	$3,396	
Imported Structural Backfill	228.15	CY	174.43	m3	***$50.94***	$11,622	
Native Backfill	51.72	CY	39.54	m3	***$8.27***	$427	
Haul Excess	453.38	CY	346.63	m3	***$8.27***	$3,747	
Allowance for Misc Items	5%				$19,192.84	$960	
Subtotal						$20,152	
CONCRETE:							
Slab on Grade	83.71	CY	64.00	m3	***$490.62***	$41,069	
Containment Walls	8.33	CY	6.37	m3	***$880.79***	$7,340	
Bulk Tank Pads	51.31	CY	39.23	m3	***$490.62***	$25,175	
Day Tank Pads	3.72	CY	2.85	m3	***$490.62***	$1,827	
Transfer Pump Pads	1.33	CY	1.02	m3	***$490.62***	$654	
Metering Pump Pads	5.33	CY	4.08	m3	***$490.62***	$2,617	
Corridor							
Slab on Grade	12.22	CY	9.34	m3	***$490.62***	$5,996	
Electrical Room							
Slab on Grade	0.00	CY	0.00	m3	***$490.62***	$0	
Allowance for Misc Items	5%				$84,678.13	$4,234	
Subtotal						$88,912	
MASONRY:	**Moderate**						
Chemical Building	3080.00	SF	286.14	m2	***$198.37***	$610,970	
Electrical Room	0.00	SF	0.00	m2	***$165.31***	$0	
Subtotal	3080.00					$610,970	
METALS:							
Canopy	0.00	SF	0.00	m2	***$41.80***	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Bulk Tank	3	EA			***$21,531.87***	$64,596	
Day Tank	2	EA			***$4,525.86***	$9,052	
Transfer Pump	2	EA			***$10,658.90***	$21,318	
Metering Pump	8	EA			***$10,658.90***	$85,271	
Allowance for Misc Items	10%				$180,236.30	$18,024	
Subtotal						$198,260	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	3	EA			***$1,043.16***	$3,129	
Chemical Tank Beacons	3	EA			***$1,043.16***	$3,129	
Day Tank Differential Pressure Transmitter	2	EA			***$1,043.16***	$2,086	
Drum or Tote Weigh Scale	0	EA			***$1,390.89***	$0	
Metering Pump Discharge Pressure Switch	8	EA			***$695.44***	$5,564	
Magmeter	4	EA			***$695.44***	$2,782	
Sump Pump Float Switch	1	EA			***$347.72***	$348	
Eyewash	1	EA			***$1,043.16***	$1,043	
Number of Analog I/O Counts	21	EA			***$264.27***	$5,550	
Number of Digital I/O Counts	68	EA			***$62.59***	$4,256	
Number of Local Panels	1	EA			***$13,074.33***	$13,074	
Number of PLCs	1	EA			***$13,908.86***	$13,909	
I&C Conduit & Wire	968.00	LF	295.05	m	***$12.06***	$11,673	
Allowance for Misc Items	10%				$66,543.53	$6,654	
Subtotal						$73,198	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (3.5-inch, Exposed, PVC)	44.00	LF	13.41	m	***$26.31***	$1,158	
Chemical Transfer Pump Discharge Header Piping-CTDH (2-inch, Exposed, PVC)	44.00	LF	13.41	m	***$18.39***	$809	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	106.00	LF	32.31	m	***$13.11***	$1,390	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	106.00	LF	32.31	m	***$13.11***	$1,390	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (3.5-inch, Exposed, PVC)	8	EA			***$72.22***	$578	
Chemical Transfer Pump Discharge Header Piping-CTDH (2-inch, Exposed, PVC)	8	EA			***$34.92***	$279	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	32	EA			***$10.06***	$322	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	32	EA			***$10.06***	$322	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (3.5-inch, Exposed, PVC)	2	EA			***$105.08***	$210	
Chemical Transfer Pump Discharge Header Piping-CTDH (2-inch, Exposed, PVC)	2	EA			***$48.31***	$97	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	8	EA			***$10.47***	$84	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	8	EA			***$10.47***	$84	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (3.5-inch, Exposed, PVC)	2	EA			***$36.17***	$72	
Chemical Transfer Pump Discharge Header Piping-CTDH (2-inch, Exposed, PVC)	2	EA			***$17.86***	$36	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			***$5.65***	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$641.14***	$2,565	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			***$290.74***	$1,163	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	16	EA			***$57.14***	$914	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	16	EA			***$57.14***	$914	
Allowance for Misc Items	10%				$10,441.32	$1,044	
Subtotal						$13,452	
ELECTRICAL:							

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# MCC Sections	0	#			***$10,730.27***	$0	
Switchgear	0	EA			***$49,359.23***	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			***$8,931.12***	$0	
User Defined Item #1	0	EA			***$8,865.56***	$0	
User Defined Item #2	0	EA			***$8,865.56***	$0	
User Defined Item #3	0	EA			***$8,865.56***	$0	
Electrical Conduit & Wire	0.00	LF	0.00	m	***$12.06***	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	
Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$1,016,303	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$1,129,225	$22,585			
I&C Allowance	2.00%		$1,129,225	$22,585			
Mechanical Allowance	4.00%		$1,129,225	$45,169			
Electrical Allowance	2.00%		$1,129,225	$22,585			
					Facility Cost Name		
Facility Cost	**3,080**	**Building SF**	**$366.63**	**$1,129,225**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**3,080**	**Building SF**	**$445.48**	**$1,372,086**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**3,080**	**Building SF**	**$772.72**	**$2,379,968**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**3,080**	**Building SF**	**$635.94**	**$1,958,711**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**3,080**	**Building SF**	**$772.72**	**$2,379,968**	CFLFC06		

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On-Site Sodium Hypochlorite Generation

Is This Facility Included in My Project? Yes

Assumptions:

1. Generator & Day Tank Containment Area must be Covered; Salt Storage is Outside

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comments
Flow Rates:							
1.) Input Plant Flow Minimum (mgd)	**15.00**	mgd	**0.00**	ML/d			
2.) Input Plant Flow Average (mgd)	**90.00**	mgd	**0.00**	ML/d			
3.) Input Plant Flow Maximum (mgd)	**160.00**	mgd	**567.81**	ML/d			
CHEMICAL SYSTEM DOSAGE INFORMATION:							
Percent Active Sodium Hypochlorite Generated	0.80%						Fixed
Generated Sodium Hypochlorite Specific Gravity	1.00						Fixed
Active Chemical Form for Dosage Basis	Cl2						
Active Chemical Concentration, lb/gallon	0.07						Fixed
4.) Input Chemical Doses:							
Minimum (mg/L)	**2.00**	mg/L					
Average (mg/L)	**3.00**	mg/L					
Maximum (mg/L)	**4.00**	mg/L					
5.) Input **% of Total Chlorine Dosage Applied Upstream of Rapid Mixing**	**0.00%**						
6.) Input **% of Total Chlorine Dosage Applied Upstream of Filtration**	**0.00%**						
7.) Input **% of Total Chlorine Dosage Applied Downstream of Filtration**	**50.00%**						
8.) Input **% of Total Chlorine Dosage Applied Downstream of Clearwell**	**50.00%**						
Calculate Number of Simultaneous Application Points	2.00	#					
Whole Plant Chemical Usage:							
Calculate **Minimum Sodium Hypochlorite** (lb/d)	250.36	lb/d	113.56	kg/d			
Calculate **Average Sodium Hypochlorite** (lb/d)	2,253.26	lb/d	1022.06	kg/d			
Calculate **Maximum Sodium Hypochlorite** (lb/d)	5,341.06	lb/d	2422.66	kg/d			
9.) Input **Sodium Hypochlorite Generator Capacity** (lb/d, each)	**2,000.00**	lb/d	**907.18**	kg/d			ChlorTec Standard Sizes
Calculate **Number of Sodium Hypochlorite Generators** (each)	3.00	#					
Calculate **Generator Equipment Length** (each)	3.81	ft	1160.00	mm	GL		
Calculate **Generator Equipment Width** (each)	3.81	ft	1160.00	mm	GW		
Calculate **Transformer / Rectifier Length** (ft)	5.58	ft	1700.00	mm	TL		
Calculate **Transformer / Rectifier Width** (ft)	5.58	ft	1700.00	mm	TW		
10.) Input **Clear Distance Around Electrical Equipment** (ft)	**4.00**	ft	**1,219.20**	mm	CDEE		
Calculate **Minimum Salt** (lb/d)	876.27	lb/d	397.47	kg/d			
Calculate **Average Salt** (lb/d)	7,886.40	lb/d	3577.21	kg/d			
Calculate **Maximum Salt** (lb/d)	18,693.70	lb/d	8479.32	kg/d			
Calculate Annual Salt Use (Max Flow and Avg Dose) (tons/year)	731.06	tons/yr					
30% Brine Flow from Salt Saturator to Generator Feed Proportioning Pumping							
Calculate **Maximum 30% Brine Flow for Batch Production to Each Generator** (gpm)	1.94	gpm	0.12	L/s			
Calculate **Total 30% Brine Flow for Batch Production** (gpm)	5.82	gpm	0.37	L/s			
Softened Potable Water Flow from Flow Proportioning Pumping to Generators							
Calculate **Maximum Softened Potable Water Flow for Batch Production** (gpm each generator)	19.42	gpm	1.22	L/s			
Calculate **Total Softened Potable Water Flow for Batch Production** (gpm)	58.25	gpm	3.67	L/s			
3% Brine Flow to Generators							
Calculate **Maximum 3% Brine Flow For Batch Production to Each Generator** (gpm)	21.36	gpm	1.35	L/s			
Calculate **Total 3% Brine Flow for Batch Production** (gpm)	64.07	gpm	4.04	L/s			
Chemical Metering Rates:							
Upstream of Rapid Mixing							
Calculate **Minimum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Chemical Metering Pump Flow Turndown**	0.00	#					Should be < 20, If > = 20, proceed with caution
Upstream of Filtration							
Calculate **Minimum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	0.00	gph	0.00	L/h			

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Calculate **Chemical Metering Pump Flow Turndown**	0.00	#					Should be < 20, If > = 20, proceed with caution
Downstream of Filtration							
Calculate **Minimum Sodium Hypochlorite** (gph)	78.13	gph	295.74	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	703.13	gph	2661.62	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	1,666.67	gph	6309.02	L/h			
Calculate **Chemical Metering Pump Flow Turndown**	21.33	#				**ERROR!! 'Should be less than 20. If greater than or equal to 20 proceed with caution**	Should be < 20, If > = 20, proceed with caution
Downstream of Clearwell							
Calculate **Minimum Sodium Hypochlorite** (gph)	78.13	gph	295.74	L/h			
Calculate **Average Sodium Hypochlorite** (gph)	703.13	gph	2661.62	L/h			
Calculate **Maximum Sodium Hypochlorite** (gph)	1,666.67	gph	6309.02	L/h			
Calculate **Chemical Metering Pump Flow Turndown**	21.33	#				**ERROR!! 'Should be less than 20. If greater than or equal to 20 proceed with caution**	Should be < 20, If > = 20, proceed with caution
Note to Designer: Review pump selection to accommodate Pump Discharge Back Pressure (psi)							
11.) Input Number of Days of Salt Storage at Average Flow/Dose (days)	**30.00**	days					
Calculate **Salt Storage Volume @ Avg. Flow/Dose** (gallons)	25,799.29	gal	97.66	m3			Assumes density of brine solution to be 70 lb/cf.
Calculate **Bulk Delivery Volume * 1.5** (gallons)	7,213.36	gal	27.31	m3			Assumes density of brine solution to be 70 lb/cf.
Maximum of Above 2 Volumes (gallons)	25,799.29	gal	97.66	m3			
SALT STORAGE/BRINE TANKS:							
12.) Input **Salt Storage/Brine Tank Volume** (gallons, each)	**11,300.00**	gal	42.78	m3			Bryneer Standard Sizes
Calculate **Number of Salt Storage/Brine Tanks** (each)	3.00	#					Typically, 2 minimum
Calculate **Height of Tanks** (ft)	22.83	ft	6958.58	mm			
Calculate **Diameter of Tanks** (ft)	12.00	ft	3657.60	mm	STD		
13.) Input **Clear Distance Around Brine Tanks, Generators, and Day Tanks** (ft)	**4.00**	ft	**1,219.20**	mm	CDT		
SODIUM HYPOCHLORITE DAY TANKS:							
Upstream of Rapid Mixing							
Calculate **Day Tank Volume** (per each, gallons)	0.00	gal	0.00	m3			
Convert **Day Tank Volume** (per each, cf)	0.00	cf	0.00	m3			
Calculate **Day Tank Diameter** (per each, ft)	0.00	ft	0.00	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	0.00	ft	0.00	mm			Assumption: H = 2 * D
Upstream of Filtration							
Calculate **Day Tank Volume** (per each, gallons)	0.00	gal	0.00	m3			
Convert **Day Tank Volume** (per each, cf)	0.00	cf	0.00	m3			
Calculate **Day Tank Diameter** (per each, ft)	0.00	ft	0.00	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	0.00	ft	0.00	mm			Assumption: H = 2 * D
Downstream of Filtration							
Calculate **Day Tank Volume** (per each, gallons)	40,000.00	gal	151.42	m3			
Convert **Day Tank Volume** (per each, cf)	5,347.22	cf	151.42	m3			
Calculate **Day Tank Diameter** (per each, ft)	15.04	ft	4585.12	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	30.09	ft	9170.25	mm			Assumption: H = 2 * D
Downstream of Clearwell							
Calculate **Day Tank Volume** (per each, gallons)	40,000.00	gal	151.42	m3			
Convert **Day Tank Volume** (per each, cf)	5,347.22	cf	151.42	m3			
Calculate **Day Tank Diameter** (per each, ft)	15.04	ft	4585.12	mm	DTD		
Calculate **Day Tank Height** (per each, ft)	30.09	ft	9170.25	mm			Assumption: H = 2 * D
BRINE TRANSFER & METERING PUMPS:							
Calculate **Number of Brine Transfer Pumps** (each)	4	#					
Calculate **Number of Active Metering Pumps** (each)	2	#					Rule: One active metering pump per each application point.
14.) Input **Number of Standby Metering Pumps** (each)	**2**	#					
Calculate **Total Number of Metering Pumps** (each)	4	#					
15.) Input **Clear Distance Around Transfer and Metering Pumps**	**4.00**	ft	**1,219.20**	mm	CDP		
Length of Transfer and Metering Pumps (ft, Fixed)	3.00	ft	914.40	mm	LP		Fixed. Conservatively assumes Pulsafeeder metering pump type.
SODIUM HYPOCHLORITE CONTAINMENT AREA:							
Width of Stair Access (ft, fixed)	4.00	ft	1219.20	mm	WS		Fixed
Calculate **Containment Area Length** (ft)	80.55	ft	24550.57	mm	CAL		
Calculate **Containment Area Width** (ft)	34.04	ft	10376.32	mm	CAW		
Calculate **Fire Sprinkler Water Volume** (gal) (0.2 gpm/sf for 20 min.)	10,968.20	gal	41.52	m3			

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Calculate **120% of One Storage Tank Volume** (gal)	48,000.00	gal	181.70	m3			
Calculate **30% of All Tank Volume** (gal)	24,000.00	gal	90.85	m3			
Maximum of Above 2 Volumes (gal)	48,000.00	gal	181.70	m3			
Calculate **Maximum Volume + Fire Flow Volume** (gal)	58,968.20	gal	223.22	m3			
Calculate **Maximum Volume + Fire Flow Volume** (cf)	7,882.90	cf	223.22	m3			
Calculate **Containment Wall Height (including 6" Freeboard)** (ft)	3.37	ft	1028.65	mm	CWH		120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
SALT STORAGE AREA:							
Calculate **Salt Storage Area Length** (ft)	52.00	ft	15849.60	mm	SAL		
Calculate **Salt Storage Area Width** (ft)	20.00	ft	6096.00	mm	SAW		
Calculate **Salt Storage Area** (sf)	1,040.00	sf	96.62	m2			
GENERATOR RECTIFIER AREA:							
16.) Input Clear Distance Around Generator Rectifiers (ft)	**4.00**	ft	**1,219.20**	mm	CDR		
Calculate **Generator Rectifier Area Length** (ft)	32.73	ft	9976.80	mm	RRL		
Calculate **Generator Rectifier Area Width** (ft)	11.81	ft	3598.40	mm	RRW		
Calculate **Generator Rectifier Area** (sf)	386.43	sf	35.90	m2			

COST TABLE FOR TANKS AND PUMPS	**Unit Cost**
Tanks (Installed Cost per Gallon)	
FRP	
Polyethylene (PE)	***$ 2.50***
Phenolic Lined Steel (PLS)	***$ 6.77***
Chemical Feed Pumps (Cost per Each)	***$ 8,527.12***

Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
Building:							
Length	80.55	ft	24550.57	mm	CAL		
Width	34.04	ft	10376.32	mm	CAW		
Area	2742.05	sf	254.74	m2			
Slab on Grade Length	84.55	ft	25769.77	mm			
Slab on Grade Width	38.04	ft	11595.52	mm			
Containment Wall Height	3.37	ft	1028.65	mm	CWH		
Slab on Grade Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Slab on Grade Thickness	1.00	ft	304.80	mm			
Containment Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Containment Wall Thickness	1.00	ft	304.80	mm			
Generator / Rectifier Area:							
Length	32.73	ft	9976.80	mm	RRL		
Width	11.81	ft	3598.40	mm	RRW		
Area	386.43	sf	35.90	m2			
Slab on Grade Length	34.73	ft	10586.40	mm			
Slab on Grade Width	15.81	ft	4817.60	mm			
Slab on Grade Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Slab on Grade Thickness	1.00	ft	304.80	mm			
Salt Storage Slab:							
Length	52.00	ft	15849.60	mm	SAL		
Width	20.00	ft	6096.00	mm	SAW		
Slab on Grade Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Slab on Grade Thickness	1.00	ft	304.80	mm			
Overall Dimensions:							
Building:							
Excavation Length	88.55	ft	26988.97	mm			
Excavation Width	42.04	ft	12814.72	mm			
Excavation Depth	5.37	ft	1638.25	mm			
Generator / Rectifier Area:							
Excavation Length	38.73	ft	11805.60	mm			
Excavation Width	19.81	ft	6036.80	mm			
Excavation Depth	2.00	ft	609.60	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Building:							
Excavation	986.50	CY	754.24	m3	***$6.72***	$6,632	
Imported Structural Backfill	137.88	CY	105.42	m3	***$50.94***	$7,024	
Native Backfill	139.72	CY	106.83	m3	***$8.27***	$1,155	
Haul Excess	846.78	CY	647.41	m3	***$8.27***	$6,999	
Generator / Rectifier Room:							
Excavation	73.36	CY	56.08	m3	***$6.72***	$493	

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Imported Structural Backfill	28.41	CY	21.72	m3	***$50.94***	$1,447	
Native Backfill	8.67	CY	6.63	m3	***$8.27***	$72	
Haul Excess	64.68	CY	49.45	m3	***$8.27***	$535	
Allowance for Misc Items	5%				$24,356.73	$1,218	
Subtotal						$25,575	
CONCRETE:							
Building Slab on Grade	119.13	CY	91.08	m3	***$490.62***	$58,445	
Generator / Rectifier Room	20.33	CY	15.55	m3	***$490.62***	$9,975	
Containment Walls	28.65	CY	21.90	m3	***$880.79***	$25,231	
Salt Storage Slab on Grade	38.52	CY	29.45	m3	***$490.62***	$18,898	
Allowance for Misc Items	5%				$112,549.47	$5,627	
Subtotal						$118,177	
MASONRY:	**High**						
CMU Building	3128.48	SF	290.65	m2	***$198.37***	$620,587	
Subtotal						$620,587	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Sodium Hypochlorite Generators (2000 lb/day each)	3	EA			***$998,844.80***	$2,996,534	
Metering Pump	4	EA			***$10,658.90***	$42,636	
Day Tanks:							
Upstream of Rapid Mixing (0 gallons each)	0	EA			***$0.00***	$0	
Upstream of Filtration (0 gallons each)	0	EA			***$0.00***	$0	
Downstream of Filtration (40000 gallons each)	1	EA			***$76,391.01***	$76,391	
Downstream of Clearwell (40000 gallons each)	1	EA			***$76,391.01***	$76,391	
Allowance for Misc Items	10%				$3,191,952.00	$319,195	
Subtotal						$3,511,147	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$4,275,485	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$5,481,391	$109,628			
I&C Allowance	5.00%		$5,481,391	$274,070			
Mechanical Allowance	10.00%		$5,481,391	$548,139			
Electrical Allowance	5.00%		$5,481,391	$274,070			
Facility Cost	**5,341**	**PPD**	**$1,026.27**	**$5,481,391**			
Facility Cost with Standard Additional Project Costs Added	**5,341**	**PPD**	**$1,246.99**	**$6,660,266**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**5,341**	**PPD**	**$2,162.99**	**$11,552,640**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**5,341**	**PPD**	**$1,780.14**	**$9,507,809**			
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**5,341**	**PPD**	**$2,162.99**	**$11,552,640**			

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Liquid Chemical Storage & Feed - (Aluminum Sulfate (Alum))
Located in Stand Alone Chemical Building

Is This Facility Included in My Project? Yes

Is the Facility Storage Only (no metering pumps)?	**No**	Y/N Overwrite Value					
Select Chemical	**Aluminum Sulfate (Alum)**		Select "Other" from the drop down list if using a different chemical.				
Percent Active Chemical, % w/w	48.50%		This is the intended feed strength to the process. Inputting a value in the yellow cell overwrites the cell in column "C".				For Fluoride systems, concentration must include the Available Fluoride Ion (AFI) concentration. Typically 79.2% AFI for 23% as HFA. (e.g., 23% as HFA x 79.2% AFI = 18.22% as F)
Active Chemical Form for Dosage Basis	Al2(SO4)3-14H2O		Inputting a value in the yellow cell overwrites the cell in column "C".				
Bulk Chemical Specific Gravity	1.34		Inputting a value in the yellow cell overwrites the cell in column "C".				
Active lb/gal solution	5.42	lb/gal	649.90	kg/m3			
Process User Inputs:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
FLOW AND CHEMICAL ADDITION							
Application #1							
1.) Minimum flow to application point	**15.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
2.) Average flow to application point	**90.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to.
3.) Maximum flow to applicatoin point	**160.00**	mgd	**567.81**	ML/d			Input the flow that the selected dose will be applied to.
4.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
5.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
6.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
7.) Input Number of Equal Simultaneous Application Points	**1**	#					
8.) Hours of addition per day	**24.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #2							
9.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
10.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
11.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
12.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
13.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
14.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
15.) Input Number of Equal Simultaneous Application Points	**0**	#					
16.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
Application #3							
17.) Minimum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
18.) Average flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
19.) Maximum flow to application point	**0.00**	mgd	**0.00**	ML/d			Input the flow that the selected dose will be applied to. Enter 0 if Unit Process is not Included.
20.) Minimum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
21.) Average chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
22.) Maximum chemical addition	**0.00**	mg/L					Input the dose that corresponds to the flow input above.
23.) Input Number of Equal Simultaneous Application Points	**0**	#					
24.) Hours of addition per day	**0.00**	hr					Input the total number of hours that the chemical is fed during the day.
CHEMICAL QUANTITIES AND FLOW							
Application Point #1 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	#DIV/0!	:1				**#DIV/0!**	Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #2 Chemical Usage:							
Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Application Point #3 Chemical Usage:							

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Minimum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Average as "dry" chemical	0.00	lb/d	0.00	kg/d			
Maximum as "dry" chemical	0.00	lb/d	0.00	kg/d			
Chemical Metering Rates per Simultaneously Operating Pump:							
Minimum at feed concentration	0.00	gph	0.00	L/h			
Average at feed concentration	0.00	gph	0.00	L/h			
Maximum at feed concentration	0.00	gph	0.00	L/h			
Calculate Chemical Metering Pump Flow Turndown	0.00	:1					Should be < 20:1, If ≥ 20:1, proceed with caution.
Whole Plant Chemical Usage for Storage Calcs:							
Minimum	0.00	lb/d	0.00	kg/d			
Average	0.00	lb/d	0.00	kg/d			
Maximum	0.00	lb/d	0.00	kg/d			
Max Flow Average Dose Daily Usage	0.00	lb/d					
Whole Plant # of Days of Storage							
Maximum Flow and Average Dose	#DIV/0!	days					
CHEMICAL STORAGE INPUTS							
25.) Flow used to calculate storage requirements	**Maximum**	Type					
26.) Chemcial application used to calculate storage requirements	**Average**	Type					
27.) Input Minimum Number of Days of Storage	**30.00**	days					
Minimum Storage Volume	0.00	gal	0.00	m3			
28.) Choose Chemical Delivery Method	**Tank Truck**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums)	4,024.02	gal	15.23	m3			Assumes 45,000 lb per Tank Truck.
Optional: Input Bulk Delivery Volume for Selected Delivery Method (overwrites above calculation)		gal		m3			Not typically used. Use with caution.
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	6,036.04	gal	22.85	m3			
Maximum of Above Delivery and Storage Volumes	806.90	cf	22.85	m3			
BULK TANKS:							
29.) Input Number of Tanks	**1**	#					
30.) Input Tank Diameter	**12.00**	ft	**3,657.60**	mm	BTD		Greater than 14' tank diameter will require on-site tank fabrication. Maximum diameter allowed for this model is 14'.
Calculate Liquid Height of Tanks	7.13	ft	2174.62	mm			
Use this Tank Height (Liquid Height * 1.2)	9.00	ft	2743.20	mm			Verify tank height within the facility. If indoors, typically 4' lower than the roof framing structure. Assumes extra 20% volume needed for each tank for head space and outlet connection elevation.
Calculate Usable Volume of Each Bulk Tank	6,345.20	gal	24.02	m3			Assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
Calculate Volume of Each Bulk Tank	7,614.24	gal	28.82	m3			
31.) Input Number of Rows of Tanks	**1**	#					
Calculate Number of Tanks per Row	1	#					
32.) Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	**FRP**	Type					Typically FRP
33.) Input Clear Distance Around BulkTanks, Day Tanks, Totes or Drums	**4.00**	ft	**1,219.20**	mm	CDT		Typically ≥ 3 ft
Calculate Actual Number of Days of Storage	#DIV/0!	days					For bulk tanks, assumes 20% of the volume of each tank is not usable (needed for head space and outlet connection elevation).
TOTES & DRUMS:							
Calculate Number of Totes or Drums	0	#					
34.) Input Number of Rows of Totes or Drums	**1**	#					
Calculate Number of Totes or Drums per Row	0	#					
Length of Each Tote	0.00	ft	0.00	mm			Fixed
Width of Each Tote	0.00	ft	0.00	mm			Fixed
Diameter of Each Drum	0.00	ft	0.00	mm			Fixed
DAY TANKS:							
35.) Are Day Tanks Required?	**No**	Y/N					Rule: Day Tanks are only available when the Delivery Method = "Tank Truck".
36.) Input Number of Day Tanks	**2**	#					Suggest 2 Day Tanks
Calculate Day Tank Volume based on Max. Flow/Dose (per tank)	0.00	gal	0.00	m3			
Convert Day Tank Volume (per each)	0.00	cf	0.00	m3			
Calculate Day Tank Diameter (per each)	0.00	ft	0.00	mm	DTD		
Calculate Day Tank Height (per each)	0.00	ft	0.00	mm			Assumption: H = 2 * D
TRANSFER & METERING PUMPS:							
Number of Transfer Pumps	0	#					Fixed
37.) Input Time to Fill Day Tank	**20.00**	min					Typically fill all day tanks in 20 min
Calculate Number of Active Metering Pumps	1	#					Rule: One active metering pump per each application point.
Calculate Number of Standby Metering Pumps	1	#					Rule: One standby metering pump per each application
38.) Input Number of Additional Standby Metering Pumps	**0**	#					
Calculate Total Number of Metering Pumps	2	#					
39.) Input Clear Distance Around Transfer and Metering Pumps	**4.00**	ft	**1,828.80**	mm	CDP		Typically ≥ 4 ft
Length of Transfer and Metering Pumps	3.00	ft	914.40	mm			Fixed. Conservatively assumes Pulsafeeder metering pump type.
FACILITY SIZING:							
40.) Is this Chemical Room Part of a Multiple Chemical Facility?	**No**	Y/N					
41.) Is this Chemical Room Considered the "Start Point" for this Chemical Facility?	**No**	Y/N					There should only be one "start point" per chemical facility. Recommend choosing the facility with the greatest width as the "start point"
42.) If this is Part of a Multiple Chemical Facility and is the "Start Point", Input the Summation of Total Number of Pumps from the Other Chemical Rooms Here		#					Total number of pumps is listed in row 114 of the liquid chemical facility, rows 140, 151, and 162 of the dry chemical facility, and row 122 of the potassium permanganate facility

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43.) Input Common Chemical Access Corridor Width	8.00	ft	2,438.40	mm			Input zero if a corridor is not required. Assumes Chem facilities are in series. If Chem facilities are in parallel, input 1/2 total corridor width.
44.) Is Corridor Covered?	Yes	Y/N					
45.) Select Chemical Facility Covering	Building						
46.) Select Chemical Area for this Chemical	None						Only used to help CPES user organize chemicals when multiple chemical buildings are used. Has no impact on sizing calculations or cost.
CONTAINMENT AREA:							
Are Stairs Required into Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Is Grating Required in Containment Area?	Yes	Y/N					Typically not needed for tote and drum storage areas.
Width of Stair Access	4.00	ft	1219.20	mm	WS		Fixed
Calculate Containment Area Length	20.00	ft	6096.00	mm			
Calculate Containment Area Width	35.00	ft	10668.00	mm			
47.) Optional: User Overwrite of Containment Area Width	35.00	ft	10,668.00	mm			
Calculate Fire Sprinkler Water Volume	2,800.00	gal	10.60	m3			Assumes 0.2 gpm/sf for 20 min if chemical installed inside a building. If chemical is outside or under a canopy, assume no fire sprinkler water volume.
Calculate 120% of One Storage Tank Volume	9,137.09	gal	34.59	m3			
Calculate 30% of All Tank Volume	2,284.27	gal	8.65	m3			
Calculate Maximum Volume + Fire Flow Volume	11,937.09	gal	45.19	m3			
Tank Pads Volume	339.29	cf	9.61	m3			
Tank Pads Volume	2,538.08	gal	9.61	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	14,475.17	gal	54.79	m3			
Calculate Maximum Volume + Fire Flow Volume + Tank Pad Volume	1,935.05	cf	54.79	m3			
Calculate Containment Wall Height (including freeboard)	2.25	ft	685.80	mm			120% of 1 tank volume or 30% of all tank volume whichever is greater + fire flow volume + 6" freeboard. Should be ≤ 4.5'.
48.) Optional: User Overwrite of Containment Wall Height	2.25	ft	2,438.40	mm			
49.) Input Depth of Burial	1.75	ft	0.00	mm	DB		
50.) Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
51.) Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		
Mechanical Sizing Requirements:							
Pipe Name	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Nominal Pipe Size**
Chemical Transfer Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Transfer Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Chemical Metering Pump Suction Header Piping	2.00	fps	0.61	m/s	1.00	in	25.00
Chemical Metering Pump Discharge Header Piping	6.00	fps	1.83	m/s	1.00	in	25.00
Mechanical Material Requirements:							
Pipe Name	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Length**	**# Elbows**
Chemical Transfer Pump Suction Header Piping	CTSH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Transfer Pump Discharge Header Piping	CTDH	Exposed	PVC	NA	NA	0.00	0.00
Chemical Metering Pump Suction Header Piping	LCSH	Exposed	PVC	NA	NA	55.00	8.00
Chemical Metering Pump Discharge Header Piping	LCDH	Exposed	PVC	NA	NA	55.00	8.00
						L+W	#MP*4
Electrical User Inputs and Sizing Requirements:							
52.) Is this a "Critical" Facility (requiring standby power)?	No	Y/N					
53.) Is there SWGR?	No						
Electrical Equipment Lengths:							**MCC**
Item	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
Metering Pumps	2.00	0.50	No	4.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**1.00**		**4.00**	**0.00**	**0.00**	**4.00**
Electrical Equipment Widths:							
Equipment	**Depth (ft)**						
MCC	1.67						
Small AFD's	0.00						
Large AFD's	0.00						
Switchgear	0.00						
Maximum Depth	1.67						
Clear Distances:							
Clear Distance	**Width**	**Length**	**Comment**				
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet			
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot			
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero			
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero			
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero			
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)				
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet			
Contingency Length		0.00	Contingency length	Typically Zero			
Electric Room Length (ft):							
CD1	3.00						
MCC	8.33						

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CD2	1.00						
Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Length	12.33						
Electric Room Width (ft):							
CD6	0.00	If there is no switchgear, this distance will be Zero.					
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Width	4.67						
COST TABLE FOR TANKS & PUMPS:	**Unit Cost**						
Tanks (Installed Cost per Gallon)							
FRP	***$2.50***						
Polyethylene (PE)	$ 2.25						
Phenolic Lined Steel (PLS)	***$6.41***						
Chemical Feed Pumps (Cost per Each)	***$10,658.90***						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Logic Tests ("1" = Yes, "0" = No):							
Is this Chemical Feed System Included?	1						
Is the Method of Delivery "Tank Truck"?	1						
Is Day Tank Required? (1 = Yes, 0 = No)	0						
Tank Truck without Day Tank (True or False)	TRUE						
Tank Truck with Day Tank (True or False)	FALSE						
Tank Truck without Day Tank (1 = Yes, 0 = No)	1					Tank Truck without Day Tank	
Tank Truck with Day Tank (1 = Yes, 0 = No)	0					Tank Truck without Day Tank	
Is the Method of Delivery "Tote"?	0					Tote	
Is the Method of Delivery "Drum"?	0					Drum	
Length of Module (Tank Truck)	20.00	ft	6096.00	mm			
Length of Module (Tote)	0.00	ft	0.00	mm			
Length of Module (Drum)	0.00	ft	0.00	mm			
Width of Module (Tank Truck without Transfer Pump and Day Tank)	35.00	ft	10668.00	mm			
Width of Module (Tank Truck with Transfer Pump and Day Tank)	0.00	ft	0.00	mm			
Width of Module (Tote)	0.00	ft	0.00	mm			
Width of Module (Drum)	0.00	ft	0.00	mm			
Area of Module	0.00	sf	0.00	m2			
Number of Bulk Tanks (each)	1	#					
Diameter of Bulk Tank	12.00	ft	3657.60	mm			
Volume of Each Bulk Tank	7614.24	gal	28.82	m3			
Bulk Tank Material	FRP	Type					
Number of Day Tanks (each)	0	#					
Diameter of Day Tank	0.00	ft					
Volume of Each Day Tank	0.00	gal	0.00	m3			
Number of Transfer Pumps	0	#					
Transfer Pump Capacity (each)	0.00	gpm	0.00	l/min		Assume fill each tank in 20 min	
Number of Metering Pumps	2	#					
Module Covered? ("1" = YES, "0" = NO)	0						
If Module Exists, Is it Covered? ("1" = Yes, "0" = No)	0						
Containment Wall Height	2.25	ft	685.80	mm			
Slab on Grade Thickness	**9.00**	in	**228.60**	mm		Model based on 9"	
Slab on Grade Thickness	0.75	ft	228.60	mm			
Containment Wall Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Containment Wall Thickness	0.67	ft	203.20	mm			
Tank Pad / Metering Pump Pad Height	**3.00**	ft	**914.40**	mm	EPH		
Corridor							
Length	20.00	ft	6096.00	mm			
Width	8.00	ft	2438.40	mm			
Area	160.00	sf	14.86	m2			
Corridor Covered? ("1" = YES, "0" = NO)	1						
Electrical Room:							
Slab on Grade:							
Length	13.67	ft	4165.60	mm			
Width	6.00	ft	1828.80	mm			
Concrete Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	
Concrete Thickness	1.00	ft	304.80	mm			
Walls:							
Height = FBD	10.00	ft				Fixed	
Concrete Thickness	**8.00**	in	**203.20**	mm		Model based on 8"	
Concrete Thickness	0.67	ft	203.20	mm			
Overall Dimensions							
Containment Area Length	20.00	ft	6096.00	mm			
Containment Area Width	35.00	ft	10668.00	mm			
Containment Area	700.00	sf	65.03	m2			
Corridor Area Length	20.00	ft	6096.00	mm			
Corridor Area Width	8.00	ft	2438.40	mm			
Corridor Area	160.00	sf	14.86	m2			
Electrical Area Length	13.67	ft	4165.60	mm			
Electrical Area Width	6.00	ft	1828.80	mm			
Electrical Room Area	82.00	sf	7.62	m2			
Chemical Facility Area	942.00	sf	87.51	m2			
Covered Chemical Area (Building)	942.00	sf	87.51	m2			
Covered Chemical Area (Canopy)	0.00	sf	0.00	m2			
Total Covered Area	1024.00	sf	95.13	m2			
Excavation Depth	3.50	ft	1066.80	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Excavation	168.78	CY	129.04	m3	***$6.72***	$1,135	
Imported Structural Backfill	69.78	CY	53.35	m3	***$50.94***	$3,555	
Native Backfill	28.58	CY	21.85	m3	***$8.27***	$236	
Haul Excess	140.19	CY	107.19	m3	***$8.27***	$1,159	
Allowance for Misc Items	5%				$6,084.29	$304	
Subtotal						$6,389	
CONCRETE:							
Slab on Grade	24.85	CY	19.00	m3	***$490.62***	$12,190	

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Containment Walls	6.11	CY	4.67	m3	$880.79	$5,383	
Bulk Tank Pads	22.34	CY	17.08	m3	$490.62	$10,960	
Day Tank Pads	0.00	CY	0.00	m3	$490.62	$0	
Transfer Pump Pads	0.00	CY	0.00	m3	$490.62	$0	
Metering Pump Pads	1.33	CY	1.02	m3	$490.62	$654	
Corridor							
Slab on Grade	5.56	CY	4.25	m3	$490.62	$2,726	
Electrical Room							
Slab on Grade	3.04	CY	2.32	m3	$490.62	$1,490	
Allowance for Misc Items	5%				$33,402.61	$1,670	
Subtotal						$35,073	
MASONRY:	Moderate						
Chemical Building	860.00	SF	79.90	m2	$198.37	$170,596	
Electrical Room	82.00	SF	7.62	m2	$165.31	$13,555	
Subtotal	942.00					$184,151	
METALS:							
Canopy	0.00	SF	0.00	m2	$41.80	$0	
Metal Stairway	1	EA			$8,327.28	$8,327	
Grating	1	EA			$1,998.55	$1,999	
Allowance for Misc Items	10%				$10,325.82	$1,033	
Subtotal						$11,358	
EQUIPMENT:							Budgetary Quote: (CPES will automatically add Installation Factor)
Bulk Tank	1	EA			$19,003.28	$19,003	
Day Tank	0	EA			$0.00	$0	
Transfer Pump	0	EA			$0.00	$0	
Metering Pump	2	EA			$10,658.90	$21,318	
Allowance for Misc Items	10%				$40,321.07	$4,032	
Subtotal						$44,353	
INSTRUMENTS & CONTROLS:							
Instruments							
Chemical Tank Radar Level Transmitters	1	EA			$1,043.16	$1,043	
Chemical Tank Beacons	1	EA			$1,043.16	$1,043	
Day Tank Differential Pressure Transmitter	0	EA			$1,043.16	$0	
Drum or Tote Weigh Scale	0	EA			$1,390.89	$0	
Metering Pump Discharge Pressure Switch	2	EA			$695.44	$1,391	
Magmeter	1	EA			$695.44	$695	
Sump Pump Float Switch	1	EA			$347.72	$348	
Eyewash	1	EA			$1,043.16	$1,043	
Number of Analog I/O Counts	5	EA			$264.27	$1,321	
Number of Digital I/O Counts	17	EA			$62.59	$1,064	
Number of Local Panels	1	EA			$13,074.33	$13,074	
Number of PLCs	1	EA			$13,908.86	$13,909	
I&C Conduit & Wire	140.00	LF	42.67	m	$12.06	$1,688	
Allowance for Misc Items	10%				$36,620.35	$3,662	
Subtotal						$40,282	
MECHANICAL:							
Pipe							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	$13.11	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0.00	LF	0.00	m	$13.11	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	55.00	LF	16.76	m	$13.11	$721	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	55.00	LF	16.76	m	$13.11	$721	
Elbows							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			$10.06	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			$10.06	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	8	EA			$10.06	$80	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	8	EA			$10.06	$80	
Tees							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			$10.47	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			$10.47	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			$10.47	$21	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			$10.47	$21	
End Caps							
Chemical Transfer Pump Suction Header Piping-CTSH (1-inch, Exposed, PVC)	0	EA			$5.65	$0	
Chemical Transfer Pump Discharge Header Piping-CTDH (1-inch, Exposed, PVC)	0	EA			$5.65	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC)	2	EA			$5.65	$11	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC)	2	EA			$5.65	$11	
Valves							
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			$57.14	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	0	EA			$57.14	$0	
Chemical Metering Pump Suction Header Piping-LCSH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			$57.14	$229	
Chemical Metering Pump Discharge Header Piping-LCDH (1-inch, Exposed, PVC, V-902, Diaphragm)	4	EA			$57.14	$229	
Allowance for Misc Items	10%				$2,124.73	$212	
Subtotal						$2,337	
ELECTRICAL:							
# MCC Sections	5	#			$10,730.27	$53,651	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Metering Pumps	0	EA			$8,931.12	$0	
User Defined Item #1	0	EA			$8,865.56	$0	
User Defined Item #2	0	EA			$8,865.56	$0	
User Defined Item #3	0	EA			$8,865.56	$0	
Electrical Conduit & Wire	40.00	LF	12.19	m	$12.06	$482	
Allowance for Misc Items	10%				$54,133.70	$5,413	
Subtotal						$59,547	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00				0.00	$0	
Item 2 Description	0.00				0.00	$0	

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Item 3 Description	0.00				0.00	$0	
Item 4 Description	0.00				0.00	$0	
Item 5 Description	0.00				0.00	$0	
Item 6 Description	0.00				0.00	$0	
Item 7 Description	0.00				0.00	$0	
Item 8 Description	0.00				0.00	$0	
Item 9 Description	0.00				0.00	$0	
Item 10 Description	0.00				0.00	$0	
Item 11 Description	0.00				0.00	$0	
Item 12 Description	0.00				0.00	$0	
Item 13 Description	0.00				0.00	$0	
Item 14 Description	0.00				0.00	$0	
Item 15 Description	0.00				0.00	$0	
Subtotal						$0	
Subtotal						$383,490	
ALLOWANCES:		User Override					
Finishes Allowance	2.00%		$426,100	$8,522			
I&C Allowance	2.00%		$426,100	$8,522			
Mechanical Allowance	4.00%		$426,100	$17,044			
Electrical Allowance	2.00%		$426,100	$8,522			
					Facility Cost Name		
Facility Cost	**942**	**Building SF**	**$452.34**	**$426,100**	CFLFC01		
Facility Cost with Standard Additional Project Costs Added	**942**	**Building SF**	**$549.62**	**$517,741**	CFLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**942**	**Building SF**	**$953.35**	**$898,053**	CFLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**942**	**Building SF**	**$784.60**	**$739,097**	CFLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**942**	**Building SF**	**$953.35**	**$898,053**	CFLFC06		

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Combination Wastewater Surge Basin and Floating Plate Decanter Clarification (Large System ≥ 5 MGD)

PROCESS DESIGN CRITERIA

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Is System to Handle Granular Media Filter Backwash Wastewater?	Yes	Y/N					
Is System to Handle Clarification Chemical Sludge?	Yes	Y/N					
Granular Media Filtration Backwash Wastewater:							
Input Volume of Backwash Wastewater Per Backwash	371,000.00	gal	2,468.09	m3			
Input Volume of Filter Drain Down Per Backwash	67,000.00	gal	238.48	m3			Typically either difference between operating water surface and top of wash trough for surface wash; or difference between water surface and 6-inches above top of media for air scour.
Input Volume of Filter to Waste Per Backwash	278,000.00	gal	594.31	m3			Typically 15 to 30 minutes at design filtration rate.
Input Total Number of Filters	8.00	#					
Input Backwash Turnaround Time From Off-Line to Back On-Line	60.00	min					Typically 20 to 40 minutes
Calculate Maximum Number of Backwashes Feasible Per Day	24.00	#					Assumes only backwash 1 filter at a time. This is typical.
Input Design Maximum Number of Backwashes Per Filter Per Day	1.00	#					Typically 1 to 2
Calculate Design Maximum Number of Backwashes Per Day	8.00	#					
Input Design Maximum Number of Consecutive Backwashes	2.00	#					
Calculate Maximum Design Backwash Wastewater Batch Volume	1,432,000.00	gal	5420.71	m3			
Calculate Number of Daily Backwash Wastewater Batches Per Day	4.00	#					
Input Maximum Backwash Wastewater Flow Rate	66.69	mgd	236.69	ML/d			
Clarification Chemical Sludge (Not for Softening Applications):							
Input Plant Flow Rate	0.00	mgd		ML/d			
Input Raw Water Turbidity	5.00	NTU					
Input Fraction of Turbidity to Contribute to Solids	1.50	mg/L/NTU					Typically 1 to 2
Input Raw Water Color		CU					
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Input Alum Dose	5.00	mg/L					
Input Fraction of Alum to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3.3H2O
Input Ferric Chloride Dose		mg/L					
Fraction of Ferric Chloride to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3.3H2O
Input Total Polymer Dose (coagulation, flocculation, filter aids)		mg/L					
Input Raw Water Iron		mg/L					
Input Iron Factor	2.00						Typical Value = 2
Input Raw Water Manganese		mg/L					
Input Manganese Factor	2.00						Typical Value = 2
Input PAC Dose		mg/L					
Calculate Solids Removed	9.70	mg/L					
Calculate Dry Residual Solids Produced	0.00	lb/d	0.00	kg/d			
Input % Dry Solids in Sludge Exiting Clarifier	0.25%						Typically 0.25% to 0.75%
Calculate Maximum Daily Volume of Clarification Sludge	0	gal	0.00	m3			
Input Number of Times Per Day Sludge Collection Equipment Operates	12.00	#					
Input Duration of Each Sludge Equipment Event in Minutes	60.00	min					
Calculate Clarification Sludge Volume Per Collection Event	0.00	gal	0.00	m3			
Calculate Clarification Sludge Flow Per Collection Event	0.00	gpm	0.00	m3/hr			
Calculate Combined Maximum Daily Volume of Wastewater	5,728,000.00	gal	21682.84	m3			
Calculate Combined Maximum Wastewater Episodic Batch Volume	1,432,000.00	gal	5420.71	m3			
Calculate Combined Maximum Wastewater Episodic Batch Flow Rate	46,312.50	gpm	10518.71	m3/hr			
Input Surge Basin Influent Velocity	5.00	fps	1.52	m/s			Typically 3 to 7 fps
Standard Diameter for Surge Basin Influent Pipe	66.00	in	1676.40	mm	IP		
Input Surge Basin Overflow Weir Head	1.00	ft	304.80	mm	OFH		
Calculate Surge Basin Over Flow Weir Length	30.99	ft	9444.65	mm	OFWL		
Calculate Overflow Weir Box Width	30.99	ft	9444.65	mm	OFBW		
Calculate Overflow Weir Box Length	6.00	ft	1828.80	mm	OFBL		
Floating Plate Decanter System Sizing:							
Will Backwash Equalization Basin contain Floating Decanters?	No	Y/N					
Will Backwash Equalization Basin contain Sludge Collectors?	No	Y/N					
Input Settling Time in Surge Basin Prior to Initiation of Decant Pumping	0.00	min					Typically 0 to 60 minutes
Input Plate Width	3.50	ft	304.80	mm	PW		Typically 3.5 feet
Input Plate Length	6.00	ft	304.80	mm	PL		Typically 6 feet
Plate Angle (fix @ 55 degrees)	55.00	degrees			PA		Fixed
Conversion of Plate Angle from Degrees to Radians	0.96	radians			PAR		
Effective Plate Area	95.00%				EPA		Typically 0.95
Calculate Projected Effective Plate Area (each) PEPA = PL * PW * cos PAR * EPA	11.44	sf	1.06	m2	PEPA		
Calculate Decanter Flow Rate	3,977.78	gpm	903.45	m3/hr	DFR		
Projected Plate Hydraulic Loading Rate	0.35	gpm/sf	0.75	m/h	HLR		Valid Range: < = 0.40 gpm/sf
Calculate Total Number of Plates #P = DFR / HLR / PEPA	1,000.00	#			#P		
Input Number of Decanter Units	2.00	#				Add More Decanter Units	Target 100-200 plates per decanter in next row
Calculate Number of Plates Per Decanter	500.00						Typically 100-200 plates per decanter

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Input Number of Plate Rows per Decanter	2.00	#			42.5		Either 1 or 2
Calculate Number of Plates Per Row	250.00	#					Typically 50-100 plates per row
Calculate Floating Decanter Unit Width	0.00	ft	0.00	mm			
Calculate Floating Decanter Unit Length	0.00	ft	0.00	mm			Allow 2.024" per plate
Input Floating Decanter Travel	15.00	ft	3,048.00	mm	FDT		Typically 6 to 15 feet
Decanter Equipment Profile Depth	0.00	ft	0.00	mm			Plate depth + 1 foot
Clear Depth Beneath Decanter in Low Position to Accommodate Sludge Collectors	3.00	ft	914.40	mm	CL		Fixed
Freeboard Above High Water Surface	3.00	ft	914.40	mm	FB		Typically 2 feet
Equalization Basin Sizing:							
Input Floating Decanter Distance from Back Wall of Surge Basin	12.00	ft		mm	FDBW		Typically 12 feet
Input Distance Between Floating Decanters and Surge Basin Side Walls	4.00	ft		mm	FDS		Typically 4 feet
If Floating Decanters are not included, Input Sidewater Depth in Equalization Basin	15.00	ft	4,572.00	mm			
Calculate Required Surge Basin Storage Area	12,762.04	sf	1185.63	m2			
Input Surge Basin Length to Width Ratio	2.00	:1					typically 2:1 or 3:1
Calculate Surge Basin Depth at Basin Midpoint	18.00	ft	5486.40	mm	WHMP		
Input Number of Rows of Decanter Units	2.00	#					
Calculate Number of Decanter Units Per Row	1.00	#					
Calculate Surge Basin Minimum Width for Decanter Units	0.00						
Calculate Surge Basin Minimum Length for Decanter Units	32.00						
Calculate Surge Basin Width	79.88	ft	24347.81	mm	ISBW		
Calculate Surge Basin Length	159.76	ft	48695.63	mm	ISBL		
Input Slope of Surge Basin	8.00%						Typically zero slope or 8%
Calculate Surge Basin Depth at Basin Inlet	11.61	ft	3538.57	mm	WHI		
Calculate Surge Basin Depth at Basin Outlet	24.39	ft	7434.23	mm	WHO		
Submerged Traveling Sludge Collector Sizing:							
Input Number of Sludge Collectors	3.00	#					
Calculate Sludge Collector Width	0.00	ft	0.00	mm	SCW		Acceptable range of values is 8' - 30'.
Calculate Required Sludge Collector Waste Pumping Capacity	0.00	gpm	0.00	m3/hr			Fix at 150 gpm per collector
Number of Submersible Sludge Collector Waste Pumps	2.00	#					Fix at 1 active and 1 standby
Input Sludge Collector Submersible Pump Total Dynamic Head	60.00	ft	18,288.00	mm			
Input Sludge Collector Submersible Pump Efficiency	75.00%						
Calculate Sludge Collector Submersible Pump Horsepower	0.00	hp	0.00	kW			
Equalization Basin Mixing:							
Will Submersible Mixers be included in Surge Basin without Floating Decanters & Traveling Sludge Collection?	No	Y/N					
Input Desired Mixing Intensity	50.00	sec-1					typically 50 sec-1
Input wire to water rapid mix energy input efficiency	60.00%				E		
Input Minimum Water Temperature	32.00	degrees F	0.00	degrees C			Valid Range: 0 - 40 deg C.
Dynamic (Absolute) Viscosity of Water	0.000037	lb•s/sf	0.001792	Pa•s			Reference: *Viscosity of Liquid Water in the Range -8°C to 150°C*, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978 (Eqn. 15).
Calculate Volume of Water to be Mixed	0.00	cf	0.00	m3	V		
Calculate Mixer Power	0.00	hp	0.00	kW	HP1		
Recycle Pumps							
Input Number of Decanter Submersible Duty Pumps	2.00	#					
Number of Standby Decant Submersible Pump	1.00	#					Fix at 1
Calculate Capacity of Decanter Submersible Pumps	1,988.89	gpm	451.73	m3/hr			
Input Decanter Submersible Pump Total Dynamic Head	50.00	ft	15,240.00	mm			
Input Decanter Submersible Pump Efficiency	75.00%						
Calculate Decanter Submersible Pump Horsepower	33.48	hp	24.97	kW			
Filter to Waste Basin Entry Air Gap							
Input Filter to Waste Basin Influent Air Gap Weir Head	1.00	ft	304.80	mm	H		For information the Filter Box Area (sf) is:
Input Filter to Waste Design Flow Rate	41.26	cfs	0.66	m3/s	FTWQ		
Calculate Filter to Waste Basin Influent Air Gap Weir Length	12.39	ft	3776.80	mm	WL		
Calculate Filter to Waste Influent Box Width	12.39	ft	3776.80	mm	FTWBW		
Calculate Filter to Waste Influent Box Length	6.00	ft	1828.80	mm	FTWBW		
Input Pumping Systems Pipe Support Height	3.00	ft	914.40	mm	PSH		Typically 3 Feet
Input Pumping Systems Pipe Depth of Cover	5.00	ft	1,524.00	mm	PDC		Typically 3 to 5 Feet
Are Pumping Facilities Covered?	No	Y/N					
Input Depth of Burial (as compared to the Surge Basin Depth at Basin Midpoint)	15.00	ft	4,572.00	mm	DB		Suggest choosing a depth of burial such that 3'-6" of wall remains above grade
Input Cutback Slope	1.50	:1 (ft:ft)					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Backwash Waste	7.00	fps	2.13	m/s	54.00	1350.00	
Filter to Waste	7.00	fps	2.13	m/s	36.00	900.00	
Backwash Waste Recycle Header	7.00	fps	2.13	m/s	16.00	400.00	
Backwash Waste Recycle Lateral	7.00	fps	2.13	m/s	12.00	300.00	
Backwash Waste Sludge Header	5.00	fps	1.52	m/s	0.00	#N/A	
Backwash Waste Sludge Lateral	5.00	fps	1.52	m/s	0.00	#N/A	

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Pipe Length	# Elbows
Backwash Waste	BWW	Encased	Steel	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Filter to Waste	FTW	Encased	DI	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Backwash Waste Recycle Header	BWRH	Exposed	Steel	Cement Mortar	Paint	39.94	1.00

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Backwash Waste Recycle Header	BWRH	Encased	Steel	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Backwash Waste Recycle Lateral	BWRL	Exposed	DI	Cement Mortar	Paint	69.00	6.00
Backwash Waste Sludge Header	BWSH	Exposed	Steel	Cement Mortar	Paint	39.94	1.00
Backwash Waste Sludge Header	BWSH	Encased	Steel	Cement Mortar	Fusion Bonded Epoxy	0.00	0.00
Backwash Waste Sludge Lateral	BWSL	Exposed	Steel	Cement Mortar	Paint	46.00	4.00

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	**Yes**	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	Total MCC Spaces
							MCC
Basin Mixer	0.00	0.00	**Yes**	0.00	0.00	0.00	
Sludge Pumps (Active)	1.00	0.00	**No**	2.00	0.00	0.00	
Sludge Pumps (Standby)	1.00	0.00	**No**	2.00	0.00	0.00	
Traveling Solids Removal Mechanisms	3.00	1.00	**No**	6.00	0.00	0.00	
Recycle Pumps (Active)	2.00	33.48	**No**	6.00	0.00	0.00	
Recycle Pumps (Standby)	1.00	33.48	**No**	3.00	0.00	0.00	
TOTAL		**103.45**		**19.00**	**0.00**	**0.00**	**19.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet
CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		**0.00**	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	13.33
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**17.33**

Electric Room Width (ft):

CD6	0.00	If there is no switchgear, this distance will be Zero.
Maximum Equipment Depth	1.67	
CD7	3.00	
Total Width	**4.67**	

Estimating Dimensions:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Surge Basin:							
Width	83.38	ft	25414.61	mm	W		
Length	170.01	ft	51819.83	mm	L		
Wall Height - Inlet	11.61	ft	3538.57	mm	WHI		
Wall Height - Midpoint	18.00	ft	5486.40	mm	WHMP		
Wall Height at Midpoint Above Ground	3.00	ft	914.40	mm			
Wall Height - Outlet	24.39	ft	7434.23	mm	WHO		
Influent Channel Width	5.00	ft	1524.00	mm	ICW		
Slab on Grade Width	87.38	ft	26633.81	mm			
Slab on Grade Length	174.56	ft	53204.59	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Influent Channel Wall Thickness	**21.00**	in	**533.40**	mm	TIW	Model based on 18"	
Influent Channel Wall Thickness	1.75	ft	533.40	mm			
Perimeter Wall Thickness	**21.00**	in	**533.40**	mm	TPW	Model based on 19"	
Perimeter Wall Thickness	1.75	ft	533.40	mm			
Backwash Recycle Sump:							
Width	15.00	ft	4572.00	mm			
Length	8.00	ft	2438.40	mm			
Wall Height	27.39	ft	8348.63	mm			

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Slab on Grade Width	17.00	ft	5181.60	mm			
Slab on Grade Length	12.00	ft	3657.60	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Elevated Slab Width	18.50	ft	5638.80	mm			
Elevated Slab Length	11.50	ft	3505.20	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 10"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Wall Thickness	**21.00**	in	**533.40**	mm		Model based on 18"	
Wall Thickness	1.75	ft	533.40	mm			
Backwash Sludge Sump:							
Width	0.00	ft	0.00	mm			
Length	0.00	ft	0.00	mm			
Wall Height	0.00	ft	0.00	mm			
Slab on Grade Width	2.00	ft	609.60	mm			
Slab on Grade Length	4.00	ft	1219.20	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Elevated Slab Width	3.50	ft	1066.80	mm			
Elevated Slab Length	3.50	ft	1066.80	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 10"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Wall Thickness	**21.00**	in	**533.40**	mm		Model based on 18"	
Wall Thickness	1.75	ft	533.40	mm			
Dry Pit:							
Width	0.00	ft	0.00	mm			
Length	0.00	ft	0.00	mm			
Wall Height	0.00	ft	0.00	mm			
Slab on Grade Width	2.00	ft	609.60	mm			
Slab on Grade Length	4.00	ft	1219.20	mm			
Slab on Grade Thickness	**24.00**	in	**609.60**	mm		Model based on 32"	
Slab on Grade Thickness	2.00	ft	609.60	mm			
Elevated Slab Width	3.50	ft	1066.80	mm			
Elevated Slab Length	3.50	ft	1066.80	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 10"	
Elevated Slab Thickness	1.00	ft	304.80	mm			
Wall Thickness	**21.00**	in	**533.40**	mm		Model based on 18"	
Wall Thickness	1.75	ft	533.40	mm			
Pipe Vault:							
Width	83.38	ft	25414.61	mm			
Length	14.00	ft	4267.20	mm			
Wall Height	11.00	ft	3352.80	mm			
Slab on Grade Width	84.38	ft	25719.41	mm			
Slab on Grade Length	14.00	ft	4267.20	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			
Slab on Grade Thickness	1.50	ft	457.20	mm			
Wall Thickness	**12.00**	in	**304.80**	mm			
Wall Thickness	1.00	ft	304.80	mm			
Electrical Room:							
Width	4.67	ft	1422.40	mm			
Length	17.33	ft	5283.20	mm			
Slab on Grade Width	6.67	ft	2032.00	mm			
Slab on Grade Length	21.33	ft	6502.40	mm			
Slab on Grade Thickness	**12.00**	in	**304.80**	mm		Model based on 32"	
Slab on Grade Thickness	1.00	ft	304.80	mm			
Excavation Dimensions:							
Influent Channel, Surge Basin:							
Excavation Width	91.38	ft	27853.01	mm			
Excavation Length	178.56	ft	54423.79	mm			
Excavation Depth	19.00	ft	5791.20	mm			
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well:							
Excavation Width	91.38	ft	27853.01	mm			
Excavation Length	8.00	ft	2438.40	mm			
Excavation Depth	27.39	ft	8348.63	mm			
Pipe Vault:							
Excavation Width	91.38	ft	27853.01	mm			
Excavation Length	14.00	ft	4267.20	mm			
Excavation Depth	8.50	ft	2590.80	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Excavation							
Influent Channel, Surge Basin & Decant Pump	16917.94	CY	12934.70	m3	***$6.72***	$113,741	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	1204.07	CY	920.58	m3	***$6.72***	$8,095	
Pipe Vault	719.43	CY	550.04	m3	***$6.72***	$4,837	
Imported Structural Backfill							
Influent Channel, Surge Basin & Decant Pump	1208.64	CY	924.07	m3	***$50.94***	$61,570	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	54.15	CY	41.40	m3	***$50.94***	$2,759	
Pipe Vault	94.77	CY	72.45	m3	***$50.94***	$4,828	
Native Backfill							

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Influent Channel, Surge Basin & Decant Pump	3623.22	CY	2770.15	m3	$8.27	$29,947	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	333.44	CY	254.93	m3	$8.27	$2,756	
Pipe Vault	239.59	CY	183.18	m3	$8.27	$1,980	
Haul Excess							
Influent Channel, Surge Basin & Decant Pump	13294.72	CY	10164.55	m3	$8.27	$109,885	
Dry Pit, Backwash Waste Sludge Wet Well, & Backwash Waste Recycle Wet Well	870.63	CY	665.65	m3	$8.27	$7,196	
Pipe Vault	479.84	CY	366.86	m3	$8.27	$3,966	
Allowance for Misc Items	5%				$351,558.52	$17,578	
Subtotal						$369,136	
CONCRETE:							
Surge Basin:							
Foundation	1129.84	CY	863.83	m3	$541.11	$611,365	
Perimeter Walls	381.34	CY	291.56	m3	$880.79	$335,883	
Influent Channel Wall	62.74	CY	47.97	m3	$880.79	$55,262	
Concrete Curb (8" X 8")	340.03	LF	103.64	m	$41.64	$14,157	
Backwash Recycle Sump:							
Slab on Grade	15.11	CY	11.55	m3	$490.62	$7,414	
Walls	67.46	CY	51.58	m3	$880.79	$59,420	
Elevated Slab	7.88	CY	6.02	m3	$1,333.77	$10,510	
Backwash Sludge Sump:							
Slab on Grade	0.00	CY	0.00	m3	$490.62	$0	
Walls	0.00	CY	0.00	m3	$880.79	$0	
Elevated Slab	0.00	CY	0.00	m3	$1,333.77	$0	
Dry Pit:							
Slab on Grade	0.59	CY	0.45	m3	$490.62	$291	
Walls	0.00	CY	0.00	m3	$880.79	$0	
Elevated Slab	0.45	CY	0.35	m3	$1,333.77	$605	
Pipe Vault:							
Lower Elevated Slab	65.63	CY	50.18	m3	$1,333.77	$87,535	
Upper Elevated Slab	65.63	CY	50.18	m3	$1,333.77	$87,535	
Walls	73.64	CY	56.30	m3	$880.79	$64,865	
Electrical Room Slab on Grade	5.27	CY	4.03	m3	$490.62	$2,584	
Allowance for Misc Items	5%				$1,337,426.53	$66,871	
Subtotal						$1,404,298	
MASONRY:	**Moderate**						
Pump Sumps and Pipe Vault	0.00	SF	0.00	m2	$165.31	$0	
Electrical Room	80.89	SF	7.51	m2	$165.31	$13,371	
Subtotal	80.89					$13,371	
METALS:							
Influent Channel:							
Grating	416.91	SF	38.73	m2	$90.92	$37,904	
Surge Basin:							
Grating	4.00	SF	0.37	m2	$90.92	$364	
Backwash Recycle Sump:							
Grating	4.00	SF	0.37	m2	$90.92	$364	
Backwash Sludge Sump:							
Grating	0.00	SF	0.00	m2	$90.92	$0	
Dry Pit:							
Ladder	27.39	VLF	8.35	VLM	$125.74	$3,444	
Pipe Vault:							
Grating	4.00	SF	0.37	m2	$90.92	$364	
Stairs	16.00	RISERS			$495.92	$7,935	
Allowance for Misc Items	10%				$50,374.19	$5,037	
Subtotal						$55,412	
DOORS & WINDOWS:							
Backwash Recycle Sump:							
Aluminum Access Hatch (10' x 5')	1.00	EA			$5,569.28	$5,569	
Backwash Sludge Sump:							
Aluminum Access Hatch (3' x 3')	0.00	EA			$1,389.82	$0	
Dry Pit:							
Aluminum Access Hatch (3' x 3')	0.00	EA			$1,389.82	$0	
Pipe Vault:							
Aluminum Access Hatch (3' x 3')	2.00	EA			$1,389.82	$2,780	
Allowance for Misc Items	5%				$8,348.93	$417	
Subtotal						$8,766	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Floating Decanter Plate System	0.00	SF	0.00	m2	$115.38	$0	
Traveling Solids Removal Mechanism	0.00	EA			$105,762.11	$0	
Washwater Decant Pump (Submersible Pump)	3.00	EA			$40,102.39	$120,307	
Sludge Pump (Submersible Pump)	0.00	EA			$0.00	$0	
Mixers	0.00	HP	0.00	kW	$2,499.83	$0	
Allowance for Misc Items	10%				$120,307.18	$12,031	
Subtotal						$132,338	
I&C:							
Instruments							
Backwash Waste Recycle Header Magmeter (BWRH, 16 inch)	1.00	EA			$20,596.57	$20,597	
Isolation Valve Actuators (Electric)	5.00	EA			$6,409.82	$32,049	
Level Transmitters	1.00	EA			$11,264.12	$11,264	
Number of Analog I/O Counts	6.00	EA			$264.27	$1,586	
Number of Digital I/O Counts	30.00	EA			$62.59	$1,878	
Number of Local Panels	1.00	EA			$13,074.33	$13,074	
Number of PLC's	1.00	EA			$13,908.86	$13,909	
I&C Conduit Wire	583.67	LF	177.90	m	$12.06	$7,038	
Allowance for Misc Items	5%				$101,394.75	$5,070	
Subtotal						$106,464	
MECHANICAL:							
Pipe:							
Backwash Waste (BWW, 54 inch, Steel)	0.00	LF	0.00	m	$1,248.13	$0	
Filter to Waste (FTW, 36 inch, DI)	0.00	LF	0.00	m	$312.12	$0	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	39.94	LF	12.17	m	$369.82	$14,771	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	0.00	LF	0.00	m	$369.82	$0	
Backwash Waste Recycle Lateral (BWRL, 12 inch, DI)	69.00	LF	21.03	m	$104.04	$7,179	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	39.94	LF	12.17	m	$0.00	$0	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	0.00	LF	0.00	m	$0.00	$0	
Backwash Waste Sludge Lateral (BWSL, 0 inch, Steel)	46.00	LF	14.02	m	$0.00	$0	

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Elbows:							
Backwash Waste (BWW, 54 inch, Steel)	0.00	EA			$7,516.79	$0	
Filter to Waste (FTW, 36 inch, DI)	0.00	EA			$6,550.90	$0	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	1.00	EA			$2,227.20	$2,227	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	0.00	EA			$2,227.20	$0	
Backwash Waste Recycle Lateral (BWRL, 12 inch, DI)	6.00	EA			$2,183.63	$13,102	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	1.00	EA			$0.00	$0	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	0.00	EA			$0.00	$0	
Backwash Waste Sludge Lateral (BWSL, 0 inch, Steel)	4.00	EA			$0.00	$0	
Tee:							
Backwash Waste (BWW, 54 inch, Steel)	0.00	EA			$17,126.09	$0	
Filter to Waste (FTW, 36 inch, DI)	0.00	EA			$10,877.62	$0	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	2.00	EA			$5,074.40	$10,149	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	0.00	EA			$5,074.40	$0	
Backwash Waste Recycle Lateral (BWRL, 12 inch, DI)	0.00	EA			$3,625.87	$0	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	1.00	EA			$0.00	$0	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	0.00	EA			$0.00	$0	
Backwash Waste Sludge Lateral (BWSL, 0 inch, Steel)	0.00	EA			$0.00	$0	
Valves:							
Backwash Waste (BWW, 54 inch, Steel)	0.00	EA			$54,975.93	$0	
Filter to Waste (FTW, 36 inch, DI)	0.00	EA			$31,898.29	$0	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	0.00	EA			$16,289.16	$0	
Backwash Waste Recycle Header (BWRH, 16 inch, Steel)	0.00	EA			$16,289.16	$0	
Backwash Waste Recycle Lateral (BWRL, 12 inch, DI)	3.00	EA			$10,632.76	$31,898	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	0.00	EA			$0.00	$0	
Backwash Waste Sludge Header (BWSH, 0 inch, Steel)	0.00	EA			$0.00	$0	
Backwash Waste Sludge Lateral (BWSL, 0 inch, Steel)	2.00	EA			$0.00	$0	
Allowance for Misc Items	5%				$79,325.47	$3,966	
Subtotal						$83,292	
ELECTRICAL:							
# MCC Sections	8.00	EA			$10,730.27	$85,842	
Switchgear	0.00	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Basin Mixer	0.00	EA			$8,865.56	$0	
Sludge Pumps (Active)	0.00	EA			$8,865.56	$0	
Sludge Pumps (Standby)	0.00	EA			$8,865.56	$0	
Recycle Pumps (Active)	0.00	EA			$13,256.25	$0	
Recycle Pumps (Standby)	0.00	EA			$13,256.25	$0	
Electrical Conduit & Wire	667.05	LF	203.32	m	$12.06	$8,044	
Allowance for Misc Items	5%				$93,886.09	$4,694	
Subtotal						$98,580	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$2,271,658.21	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$2,611,101	$52,222.03			
I&C Allowance	3.00%		$2,611,101.39	$78,333.04			
Mechanical Allowance	5.00%		$2,611,101.39	$130,555.07			
Electrical Allowance	3.00%		$2,611,101.39	$78,333.04			
					Facility Cost Name		
Facility Cost	**5,728,000**	**Gallons**	**$0.46**	**$2,611,101**	SDLFC01		
Facility Cost with Standard Additional Project Costs Added	**5,728,000**	**Gallons**	**$0.55**	**$3,172,667**	SDLFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**5,728,000**	**Gallons**	**$0.96**	**$5,503,185**	SDLFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**5,728,000**	**Gallons**	**$0.79**	**$4,529,115**	SDLFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**5,728,000**	**Gallons**	**$0.96**	**$5,503,185**	SDLFC06		

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Gravity Thickener

PROCESS DESIGN CRITERIA

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Solids Production:							
Input Plant Flow Rate	160.00	mgd	567.81	ML/d			
Input Raw Water Turbidity	10.00	NTU					
Input Fraction of Turbidity to Contribute to Solids	1.00	mg/L/NTU					Typically 1 to 2
Input Raw Water Color		CU					
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Input Alum Dose							
Input Fraction of Alum to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3.3H2O
Input Ferric Chloride Dose		mg/L					
Fraction of Ferric Chloride to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3.3H2O
Input Total Polymer Dose (coagulation, flocculation, filter aids)		mg/L					
Input Raw Water Iron		mg/L					
Input Iron Factor	2.00						Typical Value = 2
Input Raw Water Manganese		mg/L					
Input Manganese Factor	2.00						Typical Value = 2
Input PAC Dose		mg/L					
Input Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 2 for lime softening.
Input Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Non-Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 1 for soda ash softening.
Calculate Solids Removed	10.00	mg/L					
Calculate Dry Residual Solids Produced	13,352.64	lb/d	6056.66	kg/d			
Optional: Input Daily Dry Solids Production (overwrites above calculations) (dry)	6,487.17	lb/d	2,973.24	kg/d			
Gravity Thickener Sizing & Sludge Storage:							
Input Number of On-Line Thickeners	3	#					
Input Number of Standby Thickeners	1	#					Typically 1
Input % Dry Solids in Sludge to Thickeners	0.01%						Typically 0.25% tyo 0.75%
Calculate Total Sludge Flow Rate	5,725,070.96	gpd	21671.75	m3/d			
Calculate Sludge Flow to Each Thickener	1,908,356.99	gpd	7223.92	m3/d			
Calculate Dry Solids Flow to Each Thickener	2,162.39	lb/d	980.84	kg/d			
Input Thickener Hydraulic Loading Rate	300.00	gpd/sf	12.23	m/d			Typically 100 to 300 gpd/sf for metal salt coagulant sludges
Input Thickener Solids Loading Rate	10.00	lb/d/sf	48.82	kg/d/m2			Typically 5 to 10 lb/sf/d
Calculate Thickener Diameter, Each Based on Hydraulic Loading Rate	90.00	ft	27430.85	mm			
Calculate Thickener Diameter, Each Based on Solids Loading Rate	16.59	ft	5057.51	mm			
Calculate Thickener Diameter, Each (maximum of above)	90.00	ft	27430.85	mm			
Input Thickened Sludge % Dry Solids	0.25%						Typically 2% to 5% for metal salt coagulant sludges treated with polymer
Calculate Thickened Sludge Density	62.49	lb/cf	1000.98	kg/m3			Assumes density of dried solids of 145 lb/cf.
Input Days of Thickened Sludge Storage in Thickener	3.00	days					Typically 0 to 3 days (long weekend)
Calculate Thickened Sludge Storage Depth	6.53	ft	1989.70	mm			If Sludge Storage depth is greater than desired: 1.) Reduce days of storage or 2.) Decrease controlling thickener loading rate criteria input.
Calculate Total Thickened Sludge Storage Volume	931,890.47	gal	3527.59	m3			
Input Clear Water Depth Above Sludge Line	8.00	ft	2,438.40	mm			Typically 8 to 11 feet
Input Free Board	3.00	ft	914.40	mm			Typically 1 to 3 feet
Calculate Total Thickener Depth	17.53	ft	5342.50	mm			
Input Thickener Wall Height Above Grade	3.00	ft	914.40	mm			
Calculate Wall Burial Depth	14.53	ft	4428.10	mm	DB		
Gravity Thickener Peripheral Weir Launder Sizing:							
Calculate Total Flow Rate of all Thickeners	5.73	mgd	21671.75	m3/d	QT		
Calculate Flow Rate of Each Active Thickener	1.91	mgd	7223.92	m3/d	Q, mgd		
Convert Each Thickener Flow Rate	2.95	cfs	83.61	L/s	Q, cfs		
Input Velocity in Launder	5.00	fps	1.52	m/s	V		Typically < 5 fps
Calculate Area (Q, cfs / V)	0.59	sf	0.05	m2			
Launder Freeboard	1.00	ft	304.80	mm			Fixed
Input Launder Width	2.00	ft	609.60	mm			
Calculate Launder Height Excluding Freeboard	0.30	ft	90.00	mm			
Calculate Launder Height Including Freeboard	1.30	ft	394.80	mm			Should be ≤ 5 ft.
Thickened Sludge Pump Sizing:							
Calculate Thickened Sludge Flow from Each Thickener	103,543.39	gpd	391.95	m3/d			
Calculate Thickener Decant Flow from Each Thickener	1,804,813.60	gpd	6831.96	m3/d			
Number of Progressive Cavity Thickened Sludge Pumps per Thickener	2	#					Fixed: 1 duty and 1 standby
Calculate Number of Thickened Sludge Pumps	8	#					
Calculate Thickened Sludge Pump Capacity, Each	71.91	gpm	272.19	L/min			
Input Thickened Sludge Pump Total Dynamic Head (TDH)	60.00	ft	18,288.00	mm			

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Calculate Thickened Sludge Pump Horsepower (each)	1.45	hp	1.08	kW			
Input Distance between Thickener and Sludge Pump Pad	16.00	ft	4,876.80	mm			Minimum of 10 ft
Input Sludge Pump Length (progressive cavity)	8.50	ft	2,590.80	mm			Typically 8.5 ft
Input Sludge Pump Width (progressive cavity)	2.00	ft	609.60	mm			Typically 2.0 ft
Input Stagger Distance Between Sludge Pump Centerlines - Length	8.50	ft	2,590.80	mm			Typically equal to sludge pump length
Input Distance Between Sludge Pump Centerlines (width) and Around Pumps for Access	4.50	ft	1,371.60	mm			Typically 4.5 ft for access
Include the Cost of a Building Over Sludge Pump Station?	Yes	Y/N					
Input Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Unthickened Sludge Influent Pipe	3.00	fps	0.91	m/s	14.00	in	350.00
Decant Pipe	5.00	fps	1.52	m/s	12.00	in	300.00
Thickened Sludge Suction Pipe	3.00	fps	0.91	m/s	4.00	in	100.00
Thickened Sludge Discharge Pipe	3.00	fps	0.91	m/s	4.00	in	100.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Comments	Red Flags
Unthickened Sludge Influent Pipe	USP	Buried	DI	Cement Mortar	Tape Coating		
Unthickened Sludge Influent Pipe	USP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Unthickened Sludge Influent Pipe	USP	Submerged	DI	Cement Mortar	Fusion Bonded Epoxy		
Decant Pipe	DSP	Buried	DI	Cement Mortar	Tape Coating		
Decant Pipe	DSP	Exposed	DI	Cement Mortar	Paint		
Decant Pipe	DSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Exposed	Steel	Cement Mortar	Paint		
Thickened Sludge Discharge Pipe	TSDP	Exposed	DI	Cement Mortar	Paint		

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Thickened Sludge Pumps (Active)	4.00	1.45	Yes	0.00	12.00	8.00	
Thickened Sludge Pumps (Standby)	4.00	1.45	No	8.00	0.00	0.00	
Gravity Thickener Rake Mechanism	4.00	1.00	No	8.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**15.6**		**16.00**	**12.00**	**8.00**	**36.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	15.00
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**19.00**

Electric Room Width (ft):

CD6	0.00	If there is no switchgear, this distance will be Zero
Maximum Equipment Depth	1.67	
CD7	3.00	

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Total Width	**4.67**						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
Total Number of Thickeners	4.00	#					
Gravity Thickener (dimensions per each):							
Perimeter Wall Inside Diameter	90.00	ft	27430.85	mm			
Perimeter Wall Outside Diameter	92.00	ft	28040.45	mm			
Perimeter Wall Height	17.53	ft	5342.50	mm			
Wall Footer Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Wall Footer Thickness	1.33	ft	406.40	mm			
Slab on Grade Thickness	**6.00**	in	**152.40**	mm			Model based on 6"
Slab on Grade Thickness	0.50	ft	152.40	mm			
Center Cone Outside Diameter	6.17	ft	1879.60	mm			Fixed
Center Cone Inside Diameter	3.50	ft	1066.80	mm			Fixed
Center Cone Slab on Grade Thickness	**16.00**	in		mm			Model based on 16"
Center Cone Slab on Grade Thickness	1.33	ft	406.40	mm			
Center Cone Wall Height	**2.33**	ft	**59.18**	mm			Model based on 2.33'
Center Cone Wall Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Center Cone Wall Thickness	1.33	ft	406.40	mm			
Launder Elevated Slab Width	**2.00**	ft	**50.80**	mm			Model based on 2'
Launder Elevated Slab Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Launder Elevated Slab Thickness	1.00	ft	304.80	mm			
Launder Wall Diameter	86.00	ft	26211.65	mm			
Launder Wall Height	1.30	ft	394.80	mm			
Launder Wall Thickness	**8.00**	in	**203.20**	mm			Model based on 8"
Launder Wall Thickness	0.67	ft	203.20	mm			
Perimeter Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Perimeter Wall Thickness	1.00	ft	304.80	mm			
Floor Slope Factor	1.03						Fixed
Side Slope Depth Factor	0.23						Fixed
Side Slope Factor	4.29						Fixed
Excavation Diameter	101.00	ft	30783.65	mm			
Cone Excavation Depth	13.76	ft	4194.00	mm			
Perimeter Wall Excavation Depth (Includes Over Excavation)	16.86	ft	5139.30	mm			
Thickened Sludge Pump Slab:							
Length	26.00	ft	7924.80	mm			Fixed
Width	56.50	ft	17221.20	mm			
Slab on Grade Length	28.00	ft	8534.40	mm			
Slab on Grade Width	58.50	ft	17830.80	mm			
Slab Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Slab Thickness	1.33	ft	406.40	mm			
Excavation Length	32.00	ft	9753.60	mm			
Excavation Width	62.50	ft	19050.00	mm			
Excavation Depth	3.33	ft	1016.00	mm			
Electrical Room:							
Length	19.00	ft	5791.20	mm			
Width	4.67	ft	1422.40	mm			
Slab on Grade Length	21.00	ft	6400.80	mm			
Slab on Grade Width	6.67	ft	2032.00	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
Slab on Grade Thickness	1.50	ft	457.20	mm			
Excavation Length	25.00	ft	7620.00	mm			
Excavation Width	10.67	ft	3251.20	mm			
Excavation Depth	3.50	ft	1066.80	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Gravity Thickener:							
Excavation	39,735.64	CY	30380.08	m3	***$6.72***	$267,146	
Imported Structural Backfill	2,438.74	CY	1864.55	m3	***$50.94***	$124,233	
Native Backfill	10,022.85	CY	7663.02	m3	***$8.27***	$82,842	
Haul Excess	29,712.79	CY	22717.06	m3	***$8.27***	$245,585	
Thickened Sludge Pump Slab:							
Excavation	341.88	CY	261.38	m3	***$8.33***	$2,847	
Imported Structural Backfill	172.84	CY	132.15	m3	***$50.94***	$8,805	
Native Backfill	58.33	CY	44.60	m3	***$8.27***	$482	
Haul Excess	283.54	CY	216.78	m3	***$8.27***	$2,344	
Electrical Room:							
Excavation	65.90	CY	50.39	m3	***$8.33***	$549	
Imported Structural Backfill	24.69	CY	18.88	m3	***$50.94***	$1,258	
Native Backfill	24.27	CY	18.56	m3	***$8.27***	$201	
Haul Excess	41.63	CY	31.83	m3	***$8.27***	$344	
Allowance for Misc Items	5%				$736,633.77	$36,832	
Subtotal						$773,465	
CONCRETE:							
Gravity Thickener:							
Wall Footers	313.99	CY	240.06	m3	***$541.11***	$169,902	
Slanted Slab on Grade	484.11	CY	370.13	m3	***$541.11***	$261,954	
Slanted Floor Grout (2" thick)	26,141.88	SF	2428.66	m2	***$23.76***	$621,144	
Center Cone Slab on Grade	5.90	CY	4.51	m3	***$541.11***	$3,192	
Center Cone Walls	8.92	CY	6.82	m3	***$499.64***	$4,455	
Perimeter Walls	750.49	CY	573.79	m3	***$707.82***	$531,212	
Launder Elevated Slab	83.77	CY	64.05	m3	***$832.73***	$69,759	
Launder Wall	34.56	CY	26.42	m3	***$832.73***	$28,780	
Concrete Fill	***13.96***	CY	10.67	m3	***$374.73***	$5,232	
Thickened Sludge Pump Slab:						$0	
Slab on Grade	80.89	CY	61.84	m3	***$490.62***	$39,685	
Electrical Room:						$0	
Slab on Grade	7.78	CY	5.95	m3	***$541.11***	$4,209	
Allowance for Misc Items	5%				$1,739,525.57	$86,976	
Subtotal						$1,826,502	
METALS:							
Gravity Thickener:							

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Walkway Grating (3' wide, steel support beams supplied by mechanism mfr)	1,103.95	SF	102.56	m2	***$90.92***	$100,370	
Walkway Handrail	735.97	LF	224.32	m	***$90.92***	$66,913	
Stairway	18	Risers			***$495.92***	$8,927	
Allowance for Misc Items	10%				$176,209.03	$17,621	
Subtotal						$193,830	
MASONRY:	**High**						
Thickened Sludge Pump Building	1469.00	SF	136.47	m2	***$198.37***	$291,401	
Electrical Room	88.67	SF	8.24	m2	***$198.37***	$17,589	
Subtotal	1557.67					$308,989	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Gravity Thickener Drive Mechanism (1 hp each)	4	EA			***$307,565.41***	$1,230,262	
Thickened Sludge Pumps (Active, Progressive Cavity Pumps 1 hp each)	4	EA			***$8,793.65***	$35,175	
Thickened Sludge Pumps (Standby, Progressive Cavity Pumps 1 hp each)	4	EA			***$8,793.65***	$35,175	
Allowance for Misc Items	10%				$1,265,436.23	$126,544	
Subtotal						$1,427,154	
I&C:							
Instruments							
Thickened Sludge Discharge Pipe Magmeter (TSDP, 4 inch)	4	EA			***$8,561.98***	$34,248	
Isolation Valve Actuators (Electric)	12	EA			***$6,409.82***	$76,918	
Level Transmitters	4	EA			***$10,730.27***	$42,921	
Number of Analog I/O Counts	10	EA			***$264.27***	$2,643	
Number of Digital I/O Counts	72	EA			***$62.59***	$4,506	
Number of Local Panels	4	EA			***$13,074.33***	$52,297	
Number of PLC's	1	EA			***$13,908.86***	$13,909	
I&C Conduit Wire	4559.85	LF	1389.84	m	***$12.06***	$54,987	
Allowance for Misc Items	5%				$282,429.32	$14,121	
Subtotal						$296,551	
MECHANICAL:							
Pipe:							
Unthickened Sludge Influent Pipe (USP, Buried, 14 inch, DI)	58.11	LF	17.71	m	***$121.38***	$7,054	
Unthickened Sludge Influent Pipe (USP, Encased, 14 inch, DI)	0.00	LF	0.00	m	***$121.38***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 14 inch, DI)	191.99	LF	58.52	m	***$121.38***	$23,304	
Decant Pipe (DSP, Buried, 12 inch, DI)	20.00	LF	6.10	m	***$104.04***	$2,081	
Decant Pipe (DSP, Exposed, 12 inch, DI)	58.11	LF	17.71	m	***$104.04***	$6,046	
Decant Pipe (DSP, Encased, 12 inch, DI)	0.00	LF	0.00	m	***$104.04***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	243.99	LF	74.37	m	***$34.68***	$8,462	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	99.00	LF	30.18	m	***$92.45***	$9,153	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	96.00	LF	29.26	m	***$34.68***	$3,329	
Elbows:							
Unthickened Sludge Influent Pipe (USP, Buried, 14 inch, DI)	4	EA			***$2,547.57***	$10,190	
Unthickened Sludge Influent Pipe (USP, Encased, 14 inch, DI)	0	EA			***$2,547.57***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 14 inch, DI)	12	EA			***$2,547.57***	$30,571	
Decant Pipe (DSP, Buried, 12 inch, DI)	0	EA			***$2,183.63***	$0	
Decant Pipe (DSP, Exposed, 12 inch, DI)	4	EA			***$2,183.63***	$8,735	
Decant Pipe (DSP, Encased, 12 inch, DI)	0	EA			***$2,183.63***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	0	EA			***$727.88***	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	4	EA			***$556.80***	$2,227	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	4	EA			***$727.88***	$2,912	
End Caps:							
Unthickened Sludge Influent Pipe (USP, Buried, 14 inch, DI)	0	EA			***$632.25***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 14 inch, DI)	0	EA			***$632.25***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 14 inch, DI)	0	EA			***$632.25***	$0	
Decant Pipe (DSP, Buried, 12 inch, DI)	0	EA			***$541.93***	$0	
Decant Pipe (DSP, Exposed, 12 inch, DI)	0	EA			***$541.93***	$0	
Decant Pipe (DSP, Encased, 12 inch, DI)	0	EA			***$541.93***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	8	EA			***$180.64***	$1,445	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	0	EA			***$180.64***	$0	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	4	EA			***$180.64***	$723	
Tee:							
Unthickened Sludge Influent Pipe (USP, Buried, 14 inch, DI)	0	EA			***$4,230.18***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 14 inch, DI)	0	EA			***$4,230.18***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 14 inch, DI)	0	EA			***$4,230.18***	$0	
Decant Pipe (DSP, Buried, 12 inch, DI)	0	EA			***$3,625.87***	$0	
Decant Pipe (DSP, Exposed, 12 inch, DI)	4	EA			***$3,625.87***	$14,503	
Decant Pipe (DSP, Encased, 12 inch, DI)	0	EA			***$3,625.87***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	4	EA			***$1,208.62***	$4,834	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	4	EA			***$1,268.60***	$5,074	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	4	EA			***$1,208.62***	$4,834	
Valves:							
Unthickened Sludge Influent Pipe (USP, Buried, 14 inch, DI)	0	EA			***$12,404.89***	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 14 inch, DI)	0	EA			***$12,404.89***	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 14 inch, DI)	4	EA			***$12,404.89***	$49,620	
Decant Pipe (DSP, Buried, 12 inch, DI)	0	EA			***$10,632.76***	$0	
Decant Pipe (DSP, Exposed, 12 inch, DI)	0	EA			***$10,632.76***	$0	
Decant Pipe (DSP, Encased, 12 inch, DI)	0	EA			***$10,632.76***	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	0	EA			***$3,544.25***	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	4	EA			***$4,072.29***	$16,289	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	4	EA			***$3,544.25***	$14,177	
Allowance for Misc Items	5%				$225,562.69	$11,278	
Subtotal						$236,841	
ELECTRICAL:							
# MCC Sections	9	EA			***$10,730.27***	$96,572	
Switchgear	0	EA			***$49,359.23***	$0	
Adjustable Frequency Drives							
Thickened Sludge Pumps (Active) (1 hp each)	4	EA			***$9,056.04***	$36,224	
Thickened Sludge Pumps (Standby) (1 hp each)	0	EA			***$9,056.04***	$0	
Gravity Thickener Rake Mechanism (1 hp each)	0	EA			***$8,996.69***	$0	
Electrical Conduit & Wire	1023.97	LF	312.11	m	***$12.06***	$12,348	
Allowance for Misc Items	10%				$145,144.61	$14,514	
Subtotal						$159,659	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	

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Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$5,222,992	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$6,144,696	$122,894			
I&C Allowance	4.00%		$6,144,696	$245,788			
Mechanical Allowance	5.00%		$6,144,696	$307,235			
Electrical Allowance	4.00%		$6,144,696	$245,788			
					Facility Cost Name		
Facility Cost	**7,633,428**	**GPD**	**$0.80**	**$6,144,696**	SGTFC01		
Facility Cost with Standard Additional Project Costs Added	**7,633,428**	**GPD**	**$0.98**	**$7,466,227**	SGTFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**7,633,428**	**GPD**	**$1.70**	**$12,950,628**	SGTFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**7,633,428**	**GPD**	**$1.40**	**$10,658,352**	SGTFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**7,633,428**	**GPD**	**$1.70**	**$12,950,628**	SGTFC06		

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Gravity Thickener

PROCESS DESIGN CRITERIA

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Solids Production:							
Input Plant Flow Rate	160.00	mgd	605.67	ML/d			
Input Raw Water Turbidity	10.00	NTU					
Input Fraction of Turbidity to Contribute to Solids	1.00	mg/L/NTU					Typically 1 to 2
Input Raw Water Color		CU					
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Input Alum Dose							
Input Fraction of Alum to Contribute to Solids	0.44						Typical Value = 0.44 based on 3 waters of hydration for the most probable solid Al(OH)3.3H2O
Input Ferric Chloride Dose		mg/L					
Fraction of Ferric Chloride to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3.3H2O
Input Total Polymer Dose (coagulation, flocculation, filter aids)		mg/L					
Input Raw Water Iron		mg/L					
Input Iron Factor	2.00						Typical Value = 2
Input Raw Water Manganese		mg/L					
Input Manganese Factor	2.00						Typical Value = 2
Input PAC Dose		mg/L					
Input Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 2 for lime softening.
Input Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					
Input Non-Carbonate Hardness Factor (mg of softening solids produced per mg of hardness removed)	1.00						Typical Value: 1 for sodium hydroxide softening; 1 for soda ash softening.
Calculate Solids Removed	10.00	mg/L					
Calculate Dry Residual Solids Produced	13,352.64	lb/d	6056.66	kg/d			
Optional: Input Daily Dry Solids Production (overwrites above calculations) (dry)	21,179.93	lb/d	9,534.17	kg/d			
Gravity Thickener Sizing & Sludge Storage:							
Input Number of On-Line Thickeners	1	#					
Input Number of Standby Thickeners	1	#					Typically 1
Input % Dry Solids in Sludge to Thickeners	0.25%						Typically 0.25% tyo 0.75%
Calculate Total Sludge Flow Rate	1,015,166.71	gpd	3842.82	m3/d			
Calculate Sludge Flow to Each Thickener	1,015,166.71	gpd	3842.82	m3/d			
Calculate Dry Solids Flow to Each Thickener	21,179.93	lb/d	9607.05	kg/d			
Input Thickener Hydraulic Loading Rate	300.00	gpd/sf	44,005.50	m/d			Typically 100 to 300 gpd/sf for metal salt coagulant sludges
Input Thickener Solids Loading Rate	10.00	lb/d/sf	4.54	kg/d/m2			Typically 5 to 10 lb/sf/d
Calculate Thickener Diameter, Each Based on Hydraulic Loading Rate	65.64	ft	20006.82	mm			
Calculate Thickener Diameter, Each Based on Solids Loading Rate	51.93	ft	15828.23	mm			
Calculate Thickener Diameter, Each (maximum of above)	65.64	ft	20006.82	mm			
Input Thickened Sludge % Dry Solids	4.00%						Typically 2% to 5% for metal salt coagulant sludges treated with polymer
Calculate Thickened Sludge Density	63.86	lb/cf	1022.86	kg/m3			Assumes density of dried solids of 145 lb/cf.
Input Days of Thickened Sludge Storage in Thickener	3.00	days					Typically 0 to 3 days (long weekend)
Calculate Thickened Sludge Storage Depth	7.35	ft	2240.73	mm			If Sludge Storage depth is greater than desired: 1.) Reduce days of storage or 2.) Decrease controlling thickener loading rate criteria input.
Calculate Total Thickened Sludge Storage Volume	186,089.78	gal	704.43	m3			
Input Clear Water Depth Above Sludge Line	10.00	ft	3,048.00	mm			Typically 8 to 11 feet
Input Free Board	3.00	ft	914.40	mm			Typically 1 to 3 feet
Calculate Total Thickener Depth	20.35	ft	6203.13	mm			
Input Thickener Wall Height Above Grade	1.00	ft	304.80	mm			
Calculate Wall Burial Depth	19.35	ft	5898.33	mm	DB		
Gravity Thickener Peripheral Weir Launder Sizing:							
Calculate Total Flow Rate of all Thickeners	1.02	mgd	3842.82	m3/d	QT		
Calculate Flow Rate of Each Active Thickener	1.02	mgd	3842.82	m3/d	Q, mgd		
Convert Each Thickener Flow Rate	1.57	cfs	44.48	L/s	Q, cfs		
Input Velocity in Launder	5.00	fps	1.52	m/s	V		Typically < 5 fps
Calculate Area (Q, cfs / V)	0.31	sf	0.03	m2			
Launder Freeboard	1.00	ft	304.80	mm			Fixed
Input Launder Width	2.00	ft	609.60	mm			
Calculate Launder Height Excluding Freeboard	0.16	ft	47.87	mm			
Calculate Launder Height Including Freeboard	1.16	ft	352.67	mm			Should be ≤ 5 ft.
Thickened Sludge Pump Sizing:							
Calculate Thickened Sludge Flow from Each Thickener	62,029.93	gpd	234.81	m3/d			
Calculate Thickener Decant Flow from Each Thickener	953,136.78	gpd	3608.02	m3/d			
Number of Progressive Cavity Thickened Sludge Pumps per Thickener	2	#					Fixed: 1 duty and 1 standby
Calculate Number of Thickened Sludge Pumps	4	#					
Calculate Thickened Sludge Pump Capacity, Each	43.08	gpm	163.06	L/min			
Input Thickened Sludge Pump Total Dynamic Head (TDH)	100.00	ft	30,480.00	mm			

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Calculate Thickened Sludge Pump Horsepower (each)	1.45	hp	1.08	kW			
Input Distance between Thickener and Sludge Pump Pad	16.00	ft	4,876.80	mm			Minimum of 10 ft
Input Sludge Pump Length (progressive cavity)	8.50	ft	2,590.80	mm			Typically 8.5 ft
Input Sludge Pump Width (progressive cavity)	2.00	ft	609.60	mm			Typically 2.0 ft
Input Stagger Distance Between Sludge Pump Centerlines - Length	8.50	ft	2,590.80	mm			Typically equal to sludge pump length
Input Distance Between Sludge Pump Centerlines (width) and Around Pumps for Access	4.50	ft	1,371.60	mm			Typically 4.5 ft for access
Include the Cost of a Building Over Sludge Pump Station?	Yes	Y/N					
Input Cutback Slope	1.50	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Unthickened Sludge Influent Pipe	3.00	fps	0.91	m/s	10.00	in	250.00
Decant Pipe	5.00	fps	1.52	m/s	8.00	in	200.00
Thickened Sludge Suction Pipe	3.00	fps	0.91	m/s	4.00	in	100.00
Thickened Sludge Discharge Pipe	3.00	fps	0.91	m/s	4.00	in	100.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Comments	Red Flags
Unthickened Sludge Influent Pipe	USP	Buried	DI	Cement Mortar	Tape Coating		
Unthickened Sludge Influent Pipe	USP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Unthickened Sludge Influent Pipe	USP	Submerged	DI	Cement Mortar	Fusion Bonded Epoxy		
Decant Pipe	DSP	Buried	DI	Cement Mortar	Tape Coating		
Decant Pipe	DSP	Exposed	DI	Cement Mortar	Paint		
Decant Pipe	DSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Encased	DI	Cement Mortar	Fusion Bonded Epoxy		
Thickened Sludge Suction Pipe	TSSP	Exposed	Steel	Cement Mortar	Paint		
Thickened Sludge Discharge Pipe	TSDP	Exposed	DI	Cement Mortar	Paint		

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	No	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Thickened Sludge Pumps (Active)	2.00	1.45	Yes	0.00	6.00	4.00	
Thickened Sludge Pumps (Standby)	2.00	1.45	No	4.00	0.00	0.00	
Gravity Thickener Rake Mechanism	2.00	1.00	No	4.00	0.00	0.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**7.8**		**8.00**	**6.00**	**4.00**	**18.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	10.00
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**14.00**

Electric Room Width (ft):

CD6	0.00	If there is no switchgear, this distance will be Zero
Maximum Equipment Depth	1.67	
CD7	3.00	

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Total Width	**4.67**						
Estimating Dimensions:	**Value English**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Red Flags**	**Comment**
Total Number of Thickeners	2.00	#					
Gravity Thickener (dimensions per each):							
Perimeter Wall Inside Diameter	65.64	ft	20006.82	mm			
Perimeter Wall Outside Diameter	67.64	ft	20616.42	mm			
Perimeter Wall Height	20.35	ft	6203.13	mm			
Wall Footer Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Wall Footer Thickness	1.33	ft	406.40	mm			
Slab on Grade Thickness	**6.00**	in	**152.40**	mm			Model based on 6"
Slab on Grade Thickness	0.50	ft	152.40	mm			
Center Cone Outside Diameter	6.17	ft	1879.60	mm			Fixed
Center Cone Inside Diameter	3.50	ft	1066.80	mm			Fixed
Center Cone Slab on Grade Thickness	**16.00**	in		mm			Model based on 16"
Center Cone Slab on Grade Thickness	1.33	ft	406.40	mm			
Center Cone Wall Height	**2.33**	ft	**59.18**	mm			Model based on 2.33'
Center Cone Wall Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Center Cone Wall Thickness	1.33	ft	406.40	mm			
Launder Elevated Slab Width	**2.00**	ft	**50.80**	mm			Model based on 2'
Launder Elevated Slab Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Launder Elevated Slab Thickness	1.00	ft	304.80	mm			
Launder Wall Diameter	61.64	ft	18787.62	mm			
Launder Wall Height	1.16	ft	352.67	mm			
Launder Wall Thickness	**8.00**	in	**203.20**	mm			Model based on 8"
Launder Wall Thickness	0.67	ft	203.20	mm			
Perimeter Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Perimeter Wall Thickness	1.00	ft	304.80	mm			
Floor Slope Factor	1.03						Fixed
Side Slope Depth Factor	0.23						Fixed
Side Slope Factor	4.29						Fixed
Excavation Diameter	76.64	ft	23359.62	mm			
Cone Excavation Depth	10.92	ft	3329.56	mm			
Perimeter Wall Excavation Depth (Includes Over Excavation)	21.68	ft	6609.53	mm			
Thickened Sludge Pump Slab:							
Length	26.00	ft	7924.80	mm			Fixed
Width	30.50	ft	9296.40	mm			
Slab on Grade Length	28.00	ft	8534.40	mm			
Slab on Grade Width	32.50	ft	9906.00	mm			
Slab Thickness	**16.00**	in	**406.40**	mm			Model based on 16"
Slab Thickness	1.33	ft	406.40	mm			
Excavation Length	32.00	ft	9753.60	mm			
Excavation Width	36.50	ft	11125.20	mm			
Excavation Depth	3.33	ft	1016.00	mm			
Electrical Room:							
Length	14.00	ft	4267.20	mm			
Width	4.67	ft	1422.40	mm			
Slab on Grade Length	16.00	ft	4876.80	mm			
Slab on Grade Width	6.67	ft	2032.00	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
Slab on Grade Thickness	1.50	ft	457.20	mm			
Excavation Length	20.00	ft	6096.00	mm			
Excavation Width	10.67	ft	3251.20	mm			
Excavation Depth	3.50	ft	1066.80	mm			

COST ESTIMATE

Description	**Quantity (English)**	**Unit (English)**	**Quantity (Metric)**	**Unit (Metric)**	**$/Unit**	**Total Cost**	**User Over-Write**
SITEWORK:							
Gravity Thickener:							
Excavation	16,737.29	CY	12796.58	m3	***$6.72***	$112,526	
Imported Structural Backfill	702.14	CY	536.83	m3	***$50.94***	$35,768	
Native Backfill	6,289.84	CY	4808.93	m3	***$8.27***	$51,987	
Haul Excess	10,447.45	CY	7987.65	m3	***$8.27***	$86,351	
Thickened Sludge Pump Slab:							
Excavation	208.86	CY	159.68	m3	***$8.33***	$1,739	
Imported Structural Backfill	100.94	CY	77.17	m3	***$50.94***	$5,142	
Native Backfill	42.28	CY	32.33	m3	***$8.27***	$349	
Haul Excess	166.58	CY	127.36	m3	***$8.27***	$1,377	
Electrical Room:							
Excavation	54.35	CY	41.55	m3	***$8.33***	$453	
Imported Structural Backfill	19.75	CY	15.10	m3	***$50.94***	$1,006	
Native Backfill	20.87	CY	15.96	m3	***$8.27***	$172	
Haul Excess	33.48	CY	25.60	m3	***$8.27***	$277	
Allowance for Misc Items	5%				$297,148.31	$14,857	
Subtotal						$312,006	
CONCRETE:							
Gravity Thickener:							
Wall Footers	115.43	CY	88.25	m3	***$541.11***	$62,459	
Slanted Slab on Grade	128.76	CY	98.45	m3	***$541.11***	$69,674	
Slanted Floor Grout (2" thick)	6,953.20	SF	645.97	m2	***$23.76***	$165,211	
Center Cone Slab on Grade	2.95	CY	2.26	m3	***$541.11***	$1,596	
Center Cone Walls	4.46	CY	3.41	m3	***$499.64***	$2,227	
Perimeter Walls	320.34	CY	244.92	m3	***$707.82***	$226,742	
Launder Elevated Slab	30.55	CY	23.36	m3	***$832.73***	$25,440	
Launder Wall	11.06	CY	8.46	m3	***$832.73***	$9,214	
Concrete Fill	***5.09***	CY	3.89	m3	***$374.73***	$1,908	
Thickened Sludge Pump Slab:						$0	
Slab on Grade	44.94	CY	34.36	m3	***$490.62***	$22,047	
Electrical Room:						$0	
Slab on Grade	5.93	CY	4.53	m3	***$541.11***	$3,207	
Allowance for Misc Items	5%				$589,726.58	$29,486	
Subtotal						$619,213	
METALS:							
Gravity Thickener:							

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Walkway Grating (3' wide, steel support beams supplied by mechanism mfr)	405.84	SF	37.70	m2	$90.92	$36,898	
Walkway Handrail	270.56	LF	82.47	m	$90.92	$24,599	
Stairway	3	Risers			$495.92	$1,488	
Allowance for Misc Items	10%				$62,984.04	$6,298	
Subtotal						$69,282	
MASONRY:	Moderate						
Thickened Sludge Pump Building	793.00	SF	73.67	m2	$165.31	$131,087	
Electrical Room	65.33	SF	6.07	m2	$165.31	$10,800	
Subtotal	858.33					$141,887	
EQUIPMENT:							Budgetary Quote: (CPES will automatically add Installation Factor)
Gravity Thickener Drive Mechanism (1 hp each)	2	EA			$226,972.46	$453,945	
Thickened Sludge Pumps (Active, Progressive Cavity Pumps 1 hp each)	2	EA			$8,789.61	$17,579	
Thickened Sludge Pumps (Standby, Progressive Cavity Pumps 1 hp each)	2	EA			$8,789.61	$17,579	
Allowance for Misc Items	10%				$471,524.13	$47,152	
Subtotal						$536,256	
I&C:							
Instruments							
Thickened Sludge Discharge Pipe Magmeter (TSDP, 4 inch)	2	EA			$8,561.98	$17,124	
Isolation Valve Actuators (Electric)	6	EA			$6,409.82	$38,459	
Level Transmitters	2	EA			$10,730.27	$21,461	
Number of Analog I/O Counts	5	EA			$264.27	$1,321	
Number of Digital I/O Counts	36	EA			$62.59	$2,253	
Number of Local Panels	2	EA			$13,074.33	$26,149	
Number of PLC's	1	EA			$13,908.86	$13,909	
I&C Conduit Wire	1116.39	LF	340.28	m	$12.06	$13,463	
Allowance for Misc Items	5%				$134,138.07	$6,707	
Subtotal						$140,845	
MECHANICAL:							
Pipe:							
Unthickened Sludge Influent Pipe (USP, Buried, 10 inch, DI)	38.70	LF	11.80	m	$86.70	$3,356	
Unthickened Sludge Influent Pipe (USP, Encased, 10 inch, DI)	0.00	LF	0.00	m	$86.70	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 10 inch, DI)	67.64	LF	20.62	m	$86.70	$5,864	
Decant Pipe (DSP, Buried, 8 inch, DI)	4.67	LF	1.42	m	$69.36	$324	
Decant Pipe (DSP, Exposed, 8 inch, DI)	38.70	LF	11.80	m	$69.36	$2,684	
Decant Pipe (DSP, Encased, 8 inch, DI)	0.00	LF	0.00	m	$69.36	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	97.64	LF	29.76	m	$34.68	$3,386	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	49.50	LF	15.09	m	$92.45	$4,576	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	48.00	LF	14.63	m	$34.68	$1,665	
Elbows:							
Unthickened Sludge Influent Pipe (USP, Buried, 10 inch, DI)	2	EA			$1,819.70	$3,639	
Unthickened Sludge Influent Pipe (USP, Encased, 10 inch, DI)	0	EA			$1,819.70	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 10 inch, DI)	6	EA			$1,819.70	$10,918	
Decant Pipe (DSP, Buried, 8 inch, DI)	0	EA			$1,455.76	$0	
Decant Pipe (DSP, Exposed, 8 inch, DI)	2	EA			$1,455.76	$2,912	
Decant Pipe (DSP, Encased, 8 inch, DI)	0	EA			$1,455.76	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	0	EA			$727.88	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	2	EA			$556.80	$1,114	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	2	EA			$727.88	$1,456	
End Caps:							
Unthickened Sludge Influent Pipe (USP, Buried, 10 inch, DI)	0	EA			$451.61	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 10 inch, DI)	0	EA			$451.61	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 10 inch, DI)	0	EA			$451.61	$0	
Decant Pipe (DSP, Buried, 8 inch, DI)	0	EA			$361.29	$0	
Decant Pipe (DSP, Exposed, 8 inch, DI)	0	EA			$361.29	$0	
Decant Pipe (DSP, Encased, 8 inch, DI)	0	EA			$361.29	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	4	EA			$180.64	$723	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	0	EA			$180.64	$0	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	2	EA			$180.64	$361	
Tee:							
Unthickened Sludge Influent Pipe (USP, Buried, 10 inch, DI)	0	EA			$3,021.56	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 10 inch, DI)	0	EA			$3,021.56	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 10 inch, DI)	0	EA			$3,021.56	$0	
Decant Pipe (DSP, Buried, 8 inch, DI)	0	EA			$2,417.25	$0	
Decant Pipe (DSP, Exposed, 8 inch, DI)	2	EA			$2,417.25	$4,834	
Decant Pipe (DSP, Encased, 8 inch, DI)	0	EA			$2,417.25	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	2	EA			$1,208.62	$2,417	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	2	EA			$1,268.60	$2,537	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	2	EA			$1,208.62	$2,417	
Valves:							
Unthickened Sludge Influent Pipe (USP, Buried, 10 inch, DI)	0	EA			$8,860.64	$0	
Unthickened Sludge Influent Pipe (USP, Encased, 10 inch, DI)	0	EA			$8,860.64	$0	
Unthickened Sludge Influent Pipe (USP, Submerged, 10 inch, DI)	2	EA			$8,860.64	$17,721	
Decant Pipe (DSP, Buried, 8 inch, DI)	0	EA			$7,088.51	$0	
Decant Pipe (DSP, Exposed, 8 inch, DI)	0	EA			$7,088.51	$0	
Decant Pipe (DSP, Encased, 8 inch, DI)	0	EA			$7,088.51	$0	
Thickened Sludge Suction Pipe (TSSP, Encased, 4 inch, DI)	0	EA			$3,544.25	$0	
Thickened Sludge Suction Pipe (TSSP, Exposed, 4 inch, Steel)	2	EA			$4,072.29	$8,145	
Thickened Sludge Discharge Pipe (TSDP, Exposed, 4 inch, DI)	2	EA			$3,544.25	$7,089	
Allowance for Misc Items	5%				$88,137.95	$4,407	
Subtotal						$92,545	
ELECTRICAL:							
# MCC Sections	6	EA			$10,730.27	$64,382	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Thickened Sludge Pumps (Active) (1 hp each)	2	EA			$9,055.75	$18,111	
Thickened Sludge Pumps (Standby) (1 hp each)	0	EA			$9,055.75	$0	
Gravity Thickener Rake Mechanism (1 hp each)	0	EA			$8,996.69	$0	
Electrical Conduit & Wire	279.28	LF	85.12	m	$12.06	$3,368	
Allowance for Misc Items	10%				$85,860.92	$8,586	
Subtotal						$94,447	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	

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Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	
Subtotal						$2,006,481	
ALLOWANCES:		**User Override**					
Finishes Allowance	2.00%		$2,360,566	$47,211			
I&C Allowance	4.00%		$2,360,566	$94,423			
Mechanical Allowance	5.00%		$2,360,566	$118,028			
Electrical Allowance	4.00%		$2,360,566	$94,423			
					Facility Cost Name		
Facility Cost	**2,030,333**	**GPD**	**$1.16**	**$2,360,566**	SGTFC01		
Facility Cost with Standard Additional Project Costs Added	**2,030,333**	**GPD**	**$1.41**	**$2,868,250**	SGTFC02		
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**2,030,333**	**GPD**	**$2.45**	**$4,975,154**	SGTFC03		
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**2,030,333**	**GPD**	**$2.02**	**$4,094,546**	SGTFC05		
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**2,030,333**	**GPD**	**$2.45**	**$4,975,154**	SGTFC06		

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Centrifuge Solids Dewatering Facility

Is This Facility Included in My Project? Yes

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Dry Solids Production							
Input Design Plant Flow Rate	160.00	mgd	605.67	ML/d			Enter plant flow rate for which dewatering equipment/system shall be sized.
Input Average Annual Plant Flow Rate	90.00	mgd	340.69	ML/d			Enter plant flow rate for calculating average annual production of solids.
Input Design Raw Water Turbidity		NTU					Enter raw water turbidity for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Turbidity		NTU					Enter raw water turbidity for calculating average annual production of solids.
Input Fraction of Turbidity to Contribute to Solids	1.00	mg/L/NTU					Typically 1 to 2
Input Design Raw Water Color		CU					Enter raw water color for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Color		CU					Enter raw water color for calculating average annual production of solids.
Input Fraction of Color to Contribute to Solids	0.05	mg/L/CU					Typically 0.02 to 0.1
Select Coagulant Used for Raw Water	Ferric Chloride	Type					
Input Design Coagulant Dose		mg/L					Enter coagulant dose for which dewatering equipment/system shall be sized.
Input Average Annual Coagulant Dose		mg/L					Enter coagulant dose for calculating average annual production of solids.
Fraction of Coagulant to Contribute to Solids	0.99						Typical Value = 0.99 based on 3 waters of hydration for the most probable solid Fe(OH)3*3H2O.
Optional: Input Fraction of Coagulant to Contribute to Solids (overwrites above calculations)							
Input Total Design Polymer Dose (coagulation, flocculation, filter aids)		mg/L					Enter polymer dose for which dewatering equipment/system shall be sized.
Input Total Average Annual Polymer Dose (coagulation, flocculation, filter aids)		mg/L					Enter polymer dose for calculating average annual production of solids.
Input Design Raw Water Iron		mg/L					Enter raw water iron for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Iron		mg/L					Enter raw water iron for calculating average annual production of solids.
Input Iron Factor that Contrinbutes to Solids	2.00						Typical Value = 2
Input Design Raw Water Manganese		mg/L					Enter raw water manganese for which dewatering equipment/system shall be sized.
Input Average Annual Raw Water Manganese		mg/L					Enter raw water manganese for calculating average annual production of solids.
Input Manganese Factor that Contrinbutes to Solids	2.00						Typical Value = 2
Input Design PAC Dose		mg/L					Enter PAC dose for which dewatering equipment/system shall be sized.
Input Average Annual PAC Dose		mg/L					Enter PAC dose for calculating average annual production of solids.
Input Design Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter carbonate hardness removed for which dewatering equipment/system shall be sized.
Input Average Annual Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter carbonate hardness removed for calculating average annual production of solids.
Input Carbonate Hardness Factor that Contributes to Solids	1.00	(mg of softening solids produced per mg of hardness removed)					Typical Value: 1 for sodium hydroxide softening; 2 for lime softening.
Input Design Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter non-carbonate hardness removed for which dewatering equipment/system shall be sized.
Input Average Annual Non-Carbonate Hardness Concentration to be Removed via Softening		mg/L as CaCO3					Enter non-carbonate hardness removed for calculating average annual production of solids.
Input Non-Carbonate Hardness Factor that Contributes to Solids	1.00	(mg of softening solids produced per mg of hardness removed)					Typical Value: 1 for sodium hydroxide softening; 1 for soda ash softening.
Calculate Design Solids Removed	0.00	mg/L					
Calculate Design Daily Dry Solids Production	19,301.34	lb/d	8754.94	kg/d			Calculated on a dry weight basis.
Optional: Input Design Daily Dry Solids Production (overwrites above calculations)	19,301.34	lb/d	8,688.53	kg/d			Overrides cell above. Calculated on a dry weight basis.
Calculate Average Annual Solids Removed	0.00	mg/L					

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Calculate Average Annual Daily Dry Solids Production	3,569.76	lb/d	1619.22	kg/d			Calculated on a dry weight basis.
Optional: Input Average Annual Daily Dry Solids Production (overwrites above calculations)	**3,569.76**	lb/d	**1,648.47**	kg/d			Overrides cell above. Calculated on a dry weight basis.
Centrifuge Dewatering Sizing							
Input % Dry Solids in Sludge to Centrifuges	**2.00%**						Typically from Gravity Thickener at 2% to 5%
Input Number of Days per Week Centrifuges Will Be Operated	**5.00**	days					1 to 7, often 5 days
Input Number of Hours per Day Centrifuges Will Be Operated	**8.00**	hours					1 to 24, often 8 hours
Calculate Required Gravity Thickener Dry Solids Storage (dry)	51,470.24	lb	23346.51	kg			
Calculate Thickened Sludge Density	63.12	lb/cf	1011.07	kg/m3			Assumes density of dried solids of 145 lb/cf.
Calculate Required Gravity Thickener Sludge Storage Volume	40,772.30	cf	1154.54	m3			
Calculate Required Gravity Thickener Sludge Storage Volume	304,997.99	gal	1154.54	m3			For Information, see cell C34 in the Gravity Thickener model for the volume (in gallons) of sludge.
Calculate Required Centrifuge Dewatering Rate	333.59	gpm	75.77	m3/hr			
Input Number of Duty Centrifuges	**2**	#					Toggle number of duty centrifuges to select optimum centrifuge configuration.
Input Number of Standby Centrifuges	**1**	#					Typically 0 or 1.
Total Number of centrifuges	3	#					
Loading, hydraulic (each)	166.80	gpm	37.88	m3/hr			
Loading, dry solids (each)	1,688.87	lb/hr	766.06	kg/hr			
Centrifuge Selection							
Input Sludge Type	**Alum**						
Case No.	1.00						Number used for selection of centrifuge
Expected Feed Solids	2.5-3.5% DS						
Polymer Consumption	15-25 lb/ton DS						DS = dry solids
Cake Solids	18-23% DS						DS = dry solids
Capture Efficiency	95.00%	`					
Centrifuge Selection	5.00						Number used for selection of centrifuge
Model No. (Andritz)	D6						The service numbers for each model have a level of conservativism already in them.
Capacity	105	gpm	23.85	m3/hr			Contact Andritz for actual model selection. There are several versions of each model that changes the capacity ranges for each.
Bowl Diameter	23.23	in	590.04	mm			
Length	208.00	in	5283.20	mm			
Width	63.00	in	1600.20	mm			
Height	69.00	in	1752.60	mm			
Power, Main Drive	200.00	hp	149.14	kW			
Power, Back Drive	30.00	hp	22.37	kW			
Weight	22,050.00	lb	10001.71	kg			Be sure to provide access to the centrifuges on the second floor
Chemical Storage and Feed							
Input Chemical Name	**Liquid Polymer**	Type					Typically Liquid Polymer, but if Dry Polymer is used, use the Dry Polymer Model
Is this Chemical System to be Included?	**Yes**	Y/N					
Input Percent Active Chemical	**40.00%**						If Liquid Polymer, typically 30% to 50%
Input Bulk Chemical Specific Gravity	**1.10**	#					If Liquid Polymer, typically 1.1
Active Chemical Concentration, lb/gallon	3.67	lb/gal	440.00	kg/m3			
Choose Chemical Delivery Method	**Tote**	Type					
Bulk Delivery Volume (Tank Truck, Totes, Drums), gallons	300.00	gal	1.14	m3			
Input Number of Simultaneous Application Points	**1**	#					
CHEMICAL DOSES:							
Input Minimum Dose (per ton of dry solids)	**15.00**	lb/t	**7.50**	kg/t			Typically 5 to 15 lb dry polymer per ton of dry solids (2.5 to 7.5 kg/t).
Input Average Dose (per ton of dry solids)	**20.00**	lb/t	**10.00**	kg/t			Typically 10 to 20 lb dry polymer per ton of dry solids (5.0 to 10.0 kg/t).
Input Maximum Dose (per ton of dry solids)	**25.00**	lb/t	**12.50**	kg/t			Typically 15 to 25 lb dry polymer per ton of dry solids (7.5 to 12.5 kg/t).
Minimum Chemical Usage	202.66	lb/d	91.93	kg/d			Usage rate on operating days.
Average Chemical Usage	270.22	lb/d	122.57	kg/d			Usage rate on operating days.
Maximum Chemical Usage	337.77	lb/d	153.21	kg/d			Usage rate on operating days.
Chemical Metering Rates per Simultaneous Operating Pump:							
Minimum Rate	6.90	gph	26.12	L/h			Usage rate when operating.
Average Rate	9.20	gph	34.82	L/h			Usage rate when operating.
Maximum Rate	11.50	gph	43.53	L/h			Usage rate when operating.
Calculate Chemical Metering Pump Flow Turndown (should be < 20, if > 20, proceed with caution)	1.67	:1					Should be < 20, If ≥ 20, proceed with caution.
Input Number of Days of Storage at Avg. Flow/Dose for Chemical	**30.00**	days					Includes non-operating days.
Calculate Number of Operating Days of Storage	21.43	days					Includes only operating days.
Calculate Storage Volume for Pretreatment @ Avg. Flow/Dose	1,576.92	gal	5.97	m3			
Calculate Bulk Delivery Volume * 1.5 (for Truck Delivery Only)	0.00	gal	0.00	m3			
Maximum of Above Two Volumes	1,576.92	gal	5.97	m3			
Maximum Volume in	210.80	cf	5.97	m3			
BULK TANKS:							
Input Number of Tanks	**1**	#					
Input Tank Diameter	**10.00**	ft	**3,048.00**	mm			
Calculate Height of Tanks	0.00	ft	0.00	mm			
Use this Tank Height (Liquid Height * 1.2)	0.00	ft	0.00	mm			
Input Number of Rows of Tanks	**1**	#					

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Calculate Number of Tanks per Row	0	#					
Input Tank Material (FRP, PE (Polyethylene), PLS (Phenolic Lined Steel))	FRP	Type					
Input Clear Distance Around BulkTanks, Totes or Drums	4.00	ft	1,219.20	mm	CDT		
TOTES & DRUMS:							
Calculate Number of Totes or Drums	6	each					
Will Totes or Drums be Stored by Stacking on Top of Each Other?	No	Y/N					
Input Number of Rows of Totes or Drum Pallets	1	#					
Calculate Number of Totes or Drum Pallets on Floor per Row	6.00	#					
Length of Each Tote	4.00	ft	1219.20	mm			Fixed
Width of Each Tote	4.00	ft	1219.20	mm			Fixed
Length and Width of Each Drum Pallet	5.00	ft	1524.00	mm			Fixed
CHEMICAL FEED SYSTEMS:							
Select Chemical Feed Method	Polymer Blend Unit	Type					If using polymer, a Polymer Blend Unit is recommended
Calculate Number of Active Chemical Feed Systems	1	#					
Input Number of Standby Chemical Feed Systems	1	#					
Calculate Total Number of Chemical Feed Systems	2	#					
Input Clear Distance Around Chemical Feed Systems	4.00	ft	1,219.20	mm			
Length of Chemical Feed Systems	2.50	ft	762.00	mm			
Width of Chemical Feed Systems	3.33	ft	1015.90	mm			
Width of Stair Access	3.50	ft	1066.80	mm			Fixed
CONTAINMENT AREA:							
Calculate Containment Area Internal Length	52.00	ft	15849.60	mm			
Calculate Containment Area Internal Width	26.00	ft	7924.80	mm			
Calculate Fire Sprinkler Water Volume (0.2 gpm/sf for 20 min.)	5,408.00	gal	20.47	m3			
Calculate 120% of One Storage Tank Volume	360.00	gal	1.36	m3			
Calculate 30% of All Tank Volume	90.00	gal	0.34	m3			
Maximum of Above Two Volumes	360.00	gal	1.36	m3			
Calculate Maximum Volume + Fire Flow Volume	5,768.00	gal	21.83	m3			
Calculate Maximum Volume + Fire Flow Volume	771.07	cf	21.83	m3			
Calculate Containment Wall Height (including 6" Freeboard)	1.07	ft	326.23	mm			
Dewatering Building							
Truck Lane Length	68.00	ft	20,726.40	mm	DWB-TLL		Typically 68 ft for full container truck or roll-off.
Truck Lane Width	20.00	ft	6,096.00	mm	DWB-TLW		Typically ≥ 16 ft for full container truck or roll-off.
First Floor Height	24.00	ft	7,315.20	mm	DWB-FFH		Typically ≥ 22 ft
Number of Truck Lanes	2.00	#					Typically 2.
Offset Between Centrifuges	5.00	ft	1,524.00	mm	CN-OS		Typically ≥ 4 ft for access.
Centrifuge Offset from Wall (width direction in relationship to the centrifuges)	5.00	ft	1,524.00	mm	CN-OEW		Typically ≥ 4 ft for access.
Centrifuge Offset from Wall (length direction in relationship to centrifuges)	17.00	ft	5,181.60	mm	CN-ONW		Typically = 17 ft for proper alignment over truck bays.
Input Stair Tread Width	3.50	ft	1,066.80	mm			Typically ≥ 3.5 ft.
Calculate Stairwell Width	8.00	ft	2438.40	mm	DWB-SW		
Calculate Stairwell Length	25.50	ft	7772.40	mm	DWB-SL		
Dewatering Building Width	76.75	ft	23393.40	mm	DWB-W		
Dewatering Building Length	89.17	ft	27178.00	mm	DWB-L		
Conveyor Equipment							
Centrifuge Conveyor Length	53.13	ft	16192.50	mm	CON-CNL		
Centrifuge Conveyor Width or Diameter	10.00	in	254.00	mm	CON-CNW		Verify with conveyor vendor
Conveyor Truck Lane Length	40.00	ft	12,192.00	mm	CON-TLL		Typically 40 ft
Calculate Conveyor Truck Lane Width	10.00	in	254.00	mm	CON-TLW		
% Dry Solids Capture by Centrifuge	95.00%						
Optional: Input % Dry Solids Capture by Centrifuge (overwrites above calculations)							Typically 90 to 98%.
% Dry Solids in Centrifuge Cake	18.00%						
Optional: Input % Dry Solids in Centrifuge Cake (overwrites above calculations)							Typically 15 to 25%.
Calculate the Centrifuge Dry Solids Production Rate (dry)	3,208.85	lb/hr	1455.51	kg/hr			
Calculate the Cake Density	69.53	lb/cf	1113.75	kg/m3			Assumes density of dried solids of 145 lb/cf.
Calculate the Centrifuge Cake Solids Production Rate	17,826.93	lb/hr	8086.16	kg/hr			
Calculate Truck Loads	0.37	per hour					
Calculate the Centrifuge Cake Volume Production Rate	256.39	cf/hr	7.26	m3/hr			
Calculate Total Yearly Wet Mass of Sludge (per year)	18,590.94	tons	16865419.34	kg			
Calculate Total Design Yearly Wet Sludge Volume	19,806.11	cy	15142.86	m3			
Calculate Average Annual Wet Sludge Volume	3,663.12	cy	2800.65	m3			
Calculate Number of Gates per Truck Conveyor	6	#					Assumes 6 ft on center
Input Depth of Burial		ft	0.00	mm	DB		
Input Cutback Slope	1.00	:1					Cutback slope should be 1:1 for depth of burial ≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.
Input Over Excavation Depth	1.00	ft	0.00	mm	OEXD		

Mechanical Sizing Requirements:

Pipe Name	Input Velocity	Unit (English)	Input Velocity	Unit (Metric)	Standard Pipe Size	Unit (English)	Nominal Pipe Size
Centrifuge Feed Header	5.00	fps	1.52	m/s	6.00	in	150.00
Centrifuge Feed Lateral	5.00	fps	1.52	m/s	4.00	in	100.00
Centrifuge Drain Lateral/Header	5.00	fps	1.52	m/s	4.00	in	100.00
Centrifuge Decant Header	5.00	fps	1.52	m/s	6.00	in	150.00
Centrifuge Decant Lateral	5.00	fps	1.52	m/s	4.00	in	100.00

Mechanical Material Requirements:

Pipe Name	Pipe ID	Installation Type	Pipe Material	Pipe Lining Material	Pipe Coating Material	Comments	Red Flags
Centrifuge Feed Header	CFH	Exposed	DI	Cement Mortar	Tape Coating		
Centrifuge Feed Lateral	CFL	Exposed	Steel	Cement Mortar	Paint		
Centrifuge Drain Lateral/Header	CD	Exposed	Steel	Cement Mortar	Paint		

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Centrifuge Decant Header	CDH	Exposed	Steel	Cement Mortar	Paint		
Centrifuge Decant Lateral	CDL	Exposed	Steel	Cement Mortar	Paint		

Electrical User Inputs and Sizing Requirements:

Is this a "Critical" Facility (requiring standby power)?	Yes	Y/N
Is there SWGR?	No	

Electrical Equipment Lengths:

Item	Quantity	HP per Each	AFD's Required?	MCC Spaces for Motor Starters	MCC Spaces for AFD's less than 50hp)	MCC Spaces for Breakers	MCC Total MCC Spaces
Centrifuges (Active)	2	200.00	No	12.00	0.00	0.00	
Centrifuges (Standby)	1	200.00	No	6.00	0.00	0.00	
Centrifuge Conveyor Belt	1	3.00	No	2.00	0.00	0.00	
Truck Conveyor Belt	2	3.00	No	4.00	0.00	0.00	
User Defined Item #1	0	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0	0.00	No	0.00	0.00	0.00	
TOTAL		**609.0**		**24.00**	**0.00**	**0.00**	**24.00**

Electrical Equipment Widths:

Equipment	Depth (ft)
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	Width	Length	Comment	
CD1		**3.00**	Clear Distance between wall and MCC	Typically 3 feet
CD2		**1.00**	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		**0.00**	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		**0.00**	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		**0.00**	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	**4.00**		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	**3.00**		Clear Distance in front of Equipment	Tyipcally 3 feet
Contingency Length		**0.00**	Contingency length	Typically Zero

Electric Room Length (ft):

CD1	3.00
MCC	13.33
CD2	1.00
Small AFD's	0.00
CD3	0.00
Large AFD's	0.00
CD4	0.00
Swithgear	0.00
CD5	0.00
Contingency	0.00
Total Length	**17.33**

Electric Room Width (ft):

CD6	0.00	If there is no switchgear, this distance will be Zero.
Maximum Equipment Depth	1.67	
CD7	3.00	
Total Width	**4.67**	

Estimating Dimensions:	Value English	Unit (English)	Value (Metric)	Unit (Metric)	Name	Red Flags	Comment
Centrifuge Building							
Building Length	89.17	ft	27178.00	mm			
Building Width	76.75	ft	23393.40	mm			
Slab on Grade Length	93.17	ft	28397.20	mm			
Slab on Grade Width	80.75	ft	24612.60	mm			
Excavation Length	97.17	ft	29616.40	mm			
Excavation Width	84.75	ft	25831.80	mm			
Excavation Depth	3.50	ft	1066.80	mm			
Stair Height	24.00	ft	7315.20	mm			
Slab on Grade Thickness	**18.00**	in	**457.20**	mm			Model based on 18"
Slab on Grade Thickness	1.50	ft	457.20	mm			
Wall Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Wall Thickness	1.00	ft	304.80	mm			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm			Model based on 12"
Elevated Slab Thickness	1.00	ft	304.80	mm			
Chemical Containment Wall Thickness	**8.00**	in	**203.20**	mm			
Chemical Containment Wall Thickness	0.67	ft	203.20	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Excavation	1288.02	CY	984.76	m3	***$6.72***	$8,659	
Imported Structural Backfill	609.99	CY	466.37	m3	***$50.94***	$31,074	

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Native Backfill	82.54	CY	63.10	m3	$8.27	$682	
Haul Excess	1205.49	CY	921.66	m3	$8.27	$9,964	
Allowance for Misc Items	5%				$50,379.26	$2,519	
Subtotal						$52,898	
CONCRETE:							
Centrifuge Building Slab on Grade	417.96	CY	319.55	m3	$490.62	$205,056	
Elevated Slab	265.90	CY	203.30	m3	$1,333.77	$354,652	
Equipment Pads	12.73	CY	9.73	m3	$490.62	$6,246	
Allowance for Misc Items	5%				$565,954.44	$28,298	
Subtotal						$594,252	
MASONRY:	Moderate						
CMU Building	13687.08	SF	1271.57	m2	$165.31	$2,262,553	
Subtotal						$2,262,553	
METALS:							
Stairway	72	Risers			$495.92	$35,706	
Guardrail	356.67	LF	108.71	m	$27.82	$9,922	
Allowance for Misc Items	10%				$45,627.69	$4,563	
Subtotal						$50,190	
EQUIPMENT:							Budgetary Quote: (CPES will automatically add Installation Factor)
Centrifuges	3	EA			$939,649.32	$2,818,948	
Liquid Polymer Feed System	2	EA			$11,347.52	$22,695	
Shaftless Screw Conveyer	133.13	ft	40.58	m	$2,884.42	$383,989	
Allowance for Misc Items	10%				$3,225,631.55	$322,563	
Subtotal						$3,548,195	Total Horsepower >>>>
							Percent On-Line Factor >>>>
I&C:							Effective On-Line Horsepower >>>>
Instruments							
Centrifuge Feed Header Magmeter (CFH, 6 inch)	1	EA			$5,118.41	$5,118	
Isolation Valve Actuators (Electric)	9	EA			$6,409.82	$57,688	
Slide Gate Actuators	14	EA			$2,781.77	$38,945	
Number of Analog I/O Counts	2	EA			$264.27	$529	
Number of Digital I/O Counts	138	EA			$62.59	$8,637	
Number of Local Panels	3	EA			$13,074.33	$39,223	
Number of PLC's	1	EA			$13,908.86	$13,909	
I&C Conduit Wire	2716.00	LF	827.84	m	$12.06	$32,752	
Allowance for Misc Items	5%				$196,801.59	$9,840	
Subtotal						$206,642	
							Percent On-Line Factor >>>>
CONVEYING SYSTEMS:							Effective On-Line Horsepower >>>>
Bridge Crane (8 Ton)	1	EA			$70,027.47	$70,027	
Bridge Crane Rail	178.33	LF	54.36	m	$36.37	$6,486	
Allowance for Misc Items	10%				$76,513.89	$7,651	
Subtotal						$84,165	
MECHANICAL:							
Pipe:							
Centrifuge Feed Header (CFH, DI, 6 inch, Exposed)	99.33	LF	30.28	m	$52.02	$5,167	
Centrifuge Feed Lateral (CFL, Steel, 4 inch, Exposed)	17.25	LF	5.26	m	$92.45	$1,595	
Centrifuge Drain Lateral/Header (CD, Steel, 4 inch, Exposed)	116.58	LF	35.53	m	$92.45	$10,779	
Centrifuge Decant Header (CDH, Steel, 6 inch, Exposed)	99.33	LF	30.28	m	$138.68	$13,776	
Centrifuge Decant Lateral (CDL, Steel, 4 inch, Exposed)	17.25	LF	5.26	m	$92.45	$1,595	
Elbows:							
Centrifuge Feed Header (CFH, DI, 6 inch)	3	EA			$1,091.82	$3,275	
Centrifuge Feed Lateral (CFL, Steel, 4 inch)	3	EA			$556.80	$1,670	
Centrifuge Drain Lateral/Header (CD, Steel, 4 inch)	3	EA			$556.80	$1,670	
Centrifuge Decant Header (CDH, Steel, 6 inch)	6	EA			$835.20	$5,011	
Centrifuge Decant Lateral (CDL, Steel, 4 inch)	3	EA			$556.80	$1,670	
End Caps:							
Centrifuge Feed Header (CFH, DI, 6 inch)	0	EA			$270.96	$0	
Centrifuge Feed Lateral (CFL, Steel, 4 inch)	0	EA			$180.64	$0	
Centrifuge Drain Lateral/Header (CD, Steel, 4 inch)	0	EA			$180.64	$0	
Centrifuge Decant Header (CDH, Steel, 6 inch)	0	EA			$270.96	$0	
Centrifuge Decant Lateral (CDL, Steel, 4 inch)	0	EA			$180.64	$0	
Tee:							
Centrifuge Feed Header (CFH, DI, 6 inch)	2	EA			$1,812.94	$3,626	
Centrifuge Feed Lateral (CFL, Steel, 4 inch)	0	EA			$1,268.60	$0	
Centrifuge Drain Lateral/Header (CD, Steel, 4 inch)	2	EA			$1,268.60	$2,537	
Centrifuge Decant Header (CDH, Steel, 6 inch)	2	EA			$1,902.90	$3,806	
Centrifuge Decant Lateral (CDL, Steel, 4 inch)	0	EA			$1,268.60	$0	
Valves:							
Centrifuge Feed Header (CFH, DI, 6 inch)	0	EA			$5,316.38	$0	
Centrifuge Feed Lateral (CFL, Steel, 4 inch)	3	EA			$4,072.29	$12,217	
Centrifuge Drain Lateral/Header (CD, Steel, 4 inch)	3	EA			$4,072.29	$12,217	
Centrifuge Decant Header (CDH, Steel, 6 inch)	0	EA			$6,108.44	$0	
Centrifuge Decant Lateral (CDL, Steel, 4 inch)	3	EA			$4,072.29	$12,217	
Slide Gates:							
Centrifuge Conveyor Solids Gates (10 in)	2	EA			$985.05	$1,970	
Truck Conveyor Solids Gates (10 in)	12	EA			$985.05	$11,821	
Allowance for Misc Items	5%				$106,619.21	$5,331	
Subtotal						$111,950	
ELECTRICAL:							
# MCC Sections	8	EA			$10,730.27	$85,842	
Switchgear	0	EA			$49,359.23	$0	
Adjustable Frequency Drives							
Centrifuges (Active) (200 hp each)	0	EA			$35,092.00	$0	
Centrifuges (Standby) (200 hp each)	0	EA			$35,092.00	$0	
Centrifuge Conveyor Belt (3 hp each)	0	EA			$9,258.95	$0	
Truck Conveyor Belt (3 hp each)	0	EA			$9,258.95	$0	
Electrical Conduit & Wire	679.00	LF	206.96	m	$12.06	$8,188	
Allowance for Misc Items	10%				$94,030.19	$9,403	
Subtotal						$103,433	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	

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Item 2 Description	0.00		0.00		0.00	$0
Item 3 Description	0.00		0.00		0.00	$0
Item 4 Description	0.00		0.00		0.00	$0
Item 5 Description	0.00		0.00		0.00	$0
Item 6 Description	0.00		0.00		0.00	$0
Item 7 Description	0.00		0.00		0.00	$0
Item 8 Description	0.00		0.00		0.00	$0
Item 9 Description	0.00		0.00		0.00	$0
Item 10 Description	0.00		0.00		0.00	$0
Item 11 Description	0.00		0.00		0.00	$0
Item 12 Description	0.00		0.00		0.00	$0
Item 13 Description	0.00		0.00		0.00	$0
Item 14 Description	0.00		0.00		0.00	$0
Item 15 Description	0.00		0.00		0.00	$0
Subtotal						$0
Subtotal						$7,014,279
ALLOWANCES:		**User Override**				
Finishes Allowance	2.00%		$7,707,999	$154,160		
I&C Allowance	2.00%		$7,707,999	$154,160		
Mechanical Allowance	3.00%		$7,707,999	$231,240		
Electrical Allowance	2.00%		$7,707,999	$154,160		
					Facility Cost Name	
Facility Cost	**19,301**	**Dry Pounds per Day**	**$399.35**	**$7,707,999**	SCEFC01	
Facility Cost with Standard Additional Project Costs Added	**19,301**	**Dry Pounds per Day**	**$485.24**	**$9,365,747**	SCEFC02	
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**19,301**	**Dry Pounds per Day**	**$841.68**	**$16,245,462**	SCEFC03	
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**19,301**	**Dry Pounds per Day**	**$692.70**	**$13,369,996**	SCEFC05	
Facility Cost with Standard Additional Project Costs, Contractor Markups, and Location Adjustment Factor Added	**19,301**	**Dry Pounds per Day**	**$841.68**	**$16,245,462**	SCEFC06	

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Wet Pit Submersible Pump Station

Is This Facility Included in My Project? Yes

Notes to Designer:

This Model is designed around the ITT Flygt Large Submersible Pump Design Recommendations with a maximum pump cycling of 5 starts per hour

For applications with a discharge pressure over 250 feet, use the Vertical Turbine PS Model. Submersible pumps are used in applications with smaller heads

If this is a Seawater Desalination Application, the materials in contact with seawater need to be corrosion resistant.

Process User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Comment	Red Flags
Is this Facility Included in a Seawater Treatment Train?	No	Y/N					
Input Design Pump Station Inflow	3.91	mgd	20.19	ML/d			
Conversion of Design P.S. Flow from MGD to CFS	6.05	cfs	0.17	m3/s			
Input Average Pump Station Flow	2.85	mgd	15.84	ML/d			
Conversion of Average P.S. Flow from MGD to CFS	4.42	cfs	0.13	m3/s			
Input Maximum Water Temperature	50.00	degrees F	10.00	degrees C			
Calculate Maximum Vapor Pressure	0.40	ft	122.73	mm			
Input Pump Station Site Elevation	750.00	ft	228.60	m			
Calculate Atmospheric Pressure	33.02						
Mechanical Design Inputs:							
Pipe Name	**Input Velocity**	**Unit (English)**	**Input Velocity**	**Unit (Metric)**	**Standard Pipe Size**	**Unit (English)**	**Standard Pipe Size**
Discharge Lateral Pipe	5.00	fps	1.52	m/s	10.00	in	250.00
Discharge Header Pipe	5.00	fps	1.52	m/s	16.00	in	400.00
Pipe Name	**Pipe ID**	**Installation Type**	**Pipe Material**	**Pipe Lining Material**	**Pipe Coating Material**	**Pipe Diameter**	**Pipe Length**
Discharge Lateral Pipe	DIS	Exposed	Steel	Cement Mortar	Paint	10.00	64.00
Discharge Header Pipe	DIS	Exposed/Buried	Steel	Cement Mortar	Paint	16.00	31.11
Select Type of Pump Isolation Valve	Butterfly Valve	Type					
Select Type of Pump Control Valve	Check Valve	Type					
Calculate Pump Discharge Lateral Pipe Length	16.00	ft	4876.80	mm	DLPL		
Calculate Pump Discharge Lateral Pipe Headloss	1.34	ft	407.13	mm	DLPH	Assumes minor loss K value for Tee, Valve, Control Valve, Elbow, and Reducer	
Is Pump Station Discharge Pressure Known?	Yes	Y/N					
Input Actual Design Discharge Pressure	50.00	ft	15,240.00	mm			
Input Design Discharge WSEL		ft		mm	MaxDL		
Input Length of Pump Station Discharge Header and Pipeline		ft		mm	LPSDP	Confirm with Hydraulic Analysis	
Input Total Friction Coefficient, K for Discharge Header Minor Losses		ft		mm	MPSDF	Friction K values should be obtained from D.S. Miller Internal Flow System.	
Input Hazen Williams Friction Coefficient	130.00	C			HWFC	Consult Conveyance GTL, for appropriate C value	
Calculate Design Discharge Header & Pipeline Dynamic Headloss	0.03	ft	8.13	mm	maxDPDH		
Calculate Total Dynamic Head at Design Flow	50.00	ft	15240.00	mm	maxTDH		
Pump Selection Design Inputs:							
Input Number of Active Pumps	3	#			NAP	Should be 1,2,3,5, or 7 if there is a standby pump	
Include a Standby Pump?	Yes	Y/N					
Pump Efficiency	75.00%					Fixed	
Motor Efficiency	95.00%					Fixed	
AFD Efficiency	95.00%					Fixed	
Safety Margin Allocated in Pump Design Brake Horsepower	1.15					Fixed	
Input Pump Information	**Capacity (MGD)**	**AFD? (Yes or No)**	**Actual Individual Pump Sizing Flow (GPM)**	**Calculated Individual Pump BHP**	**Actual Individual Pump BHP**	**Pump?? ("1"= Yes, "0" = No)**	**Weir Pump Model Number**
Active Pump # 1	1.30	Yes	1000	18.44999955	25	1.00	F1000_HP25_C3201.180_MT
Active Pump # 2	1.30	Yes	1000	18.44999955	25	1.00	F1000_HP25_C3201.180_MT
Active Pump # 3	1.30	Yes	1000	18.44999955	25	1.00	F1000_HP25_C3201.180_MT
Active Pump # 4	0.00	No	0	0	-	0.00	#N/A
Active Pump # 5	0.00	No	0	0	-	0.00	#N/A
Active Pump # 6	0.00	No	0	0	-	0.00	#N/A
Active Pump # 7	0.00	No	0	0	-	0.00	#N/A
Calculate Standby Pump Capacity = Max Pump	1.30	Yes	1000	18.44999955	25	1.00	F1000_HP25_C3201.180_MT
Calculate Total Active Pump Capacity	3.91	4.00	3000	55.34999864	75	User Override Pump Criteria (Pump 1)	
Calculate Total P.S. Capacity	5.21	mgd	4000	73.79999818	100	User Override Pump Criteria (Pump 2)	
Calculate Total Number of Pumps (Active & Standby)	4.00	#			TNP	should be 2,3,4,6, or 8	
Recommended NPSHR Margin	1.50	#				Fixed - Verify Margin with Pump Manufacturer	
Calculate Minimum Submergence based on NPSHR Margin or HI Standards	1.34	ft	408.77	mm	mSUB	Calculated - Verify with Pump Manufacturer	
Calculate Pump Elevation based on Minimum Submergence Requirements	742.21	ft	226225.90	mm		Calculated	
Wet Well Design Calculations:							
Calculate Number of Wet Wells	1.00	#			NW		
Calculate Number of Pumps per Wet Well	4.00	#			PPW		

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Calculate Conceptual Minimum Wet Well Volume	16,296.00	gal	61.69	m3	MWWV	Vreq=T*2*Q/4; T=12	
Calculate Distance From Wall to Baffles	50.68	in	1287.16	mm	WTB		
Calculate Conceptual Distance From Wall to Pump Center	87.20	in	2214.95	mm	PWFW	Greater than or equal to this value	
Calculate Distance Between Pump Shells	37.45	in	951.29	mm	DBPS		
Calculate Length From Wall to Pump Center	18.16	in	461.15	mm	PLFW	Less than or equal to this value	
Calculate Operational Wet Well Width	12.12	ft	3694.50	mm			
Calculate Operational Wet Well Length	19.70	ft	6005.03	mm	WWL		
Calculate Operational Wet Well Surface Area	238.80	sf	22.19	m2			
Calculate Minimum Operational Wet Well Depth	9.12	ft	2780.50	mm	OWWD		
Input Additional Storage Volume Requirements	0.00	gal		m3			
Input Wet Well Freeboard	2.00	ft		mm	WWFB	Typically 2 to 3 feet	
Calculate Required Wet Well Width	12.12	ft	3694.50	mm	WWW		
Calculate Total Required Wet Well Depth	15.12	ft	4609.30	mm	WWD		
Calculate Total Wet Well Volume	3,611.28	cf					
Calculate Total Wet Well Volume	27,014.26	gal			WWV		
Calculate Minimum Wet Well Low Operating Level Required	746.21	ft	227445.10	mm			
Calculate Maximum Wet Well High Operating Level Required	755.33	ft	230225.60	mm			
Does Wet Well Have a Liner?	No	Y/N					
Calculate Wet Well Liner Surface Area	0.00	sf	0.00	m2			

Pump Station Design User Inputs:	Value (English)	Unit (English)	Value (Metric)	Unit (Metric)	Name	Comment	Red Flags
Input Lateral Pipe Distance from Wall to Valve	1.00	ft	100.00	mm	PDWV	Typically 1 foot	
Input Lateral Distance from Valve to Header	4.00	ft		mm	VTHD	Minimum 2 feet	
Input Clear Distance Width From Discharge Header to Wall	6.00	ft		mm	HTW	Minimum 6 feet	
Input Discharge Pipe Distance from Wet Well Ceiling	4.00	ft		mm	PDTC	Typically 4 feet	
Input Discharge Pipe Height From Operating Room Floor	1.00	ft		mm	HHTF	Typically 1-2 feet	
Input Clear Distance Length Discharge Header to Wall	3.00	ft		mm	CDHW	Typically 3-4 feet	
Calculate Vertical Lateral Pipe Length	8.62	ft			VLPL		
Is the Surge Protection Area Covered?	No	Y/N					
Input Cutback Slope	1.50	:1				Cutback slope should be 1:1 for depth of burial≤ 5 ft, and at least 1.5:1 for depth of burial > 5 ft.	
Input Over Excavation Depth	1.00	ft	609.60	mm			
Electrical User Inputs and Sizing Requirements:							
Is this a "Critical" Facility (requiring standby power)?	No	Y/N					
Is there SWGR?	No						

							MCC
Item	**Quantity**	**HP per Each**	**AFD's Required?**	**MCC Spaces for Motor Starters**	**MCC Spaces for AFD's less than 50hp)**	**MCC Spaces for Breakers**	**Total MCC Spaces**
Active Pump # 1	1.00	26.32	Yes	0.00	6.00	2.00	
Active Pump # 2	1.00	26.32	Yes	0.00	6.00	2.00	
Active Pump # 3	1.00	26.32	Yes	0.00	6.00	2.00	
Active Pump # 4	0.00	0.00	No	0.00	0.00	0.00	
Active Pump # 5	0.00	0.00	No	0.00	0.00	0.00	
Active Pump # 6	0.00	0.00	No	0.00	0.00	0.00	
Active Pump # 7	0.00	0.00	No	0.00	0.00	0.00	
Standby	1.00	26.32	Yes	0.00	6.00	2.00	
User Defined Item #1	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #2	0.00	0.00	No	0.00	0.00	0.00	
User Defined Item #3	0.00	0.00	No	0.00	0.00	0.00	
TOTAL		**105.26**		**0.00**	**24.00**	**8.00**	**32.00**

Electrical Equipment Lengths:

Equipment	**Depth (ft)**
MCC	1.67
Small AFD's	0.00
Large AFD's	0.00
Switchgear	0.00
Maximum Depth	**1.67**

Clear Distances:

Clear Distance	**Width**	**Length**	**Comment**	
CD1		3.00	Clear Distance between wall and MCC	Typically 3 feet
CD2		1.00	Clear Distance between MCC and Small AFD	Typically 1 foot
CD3		0.00	Clear Distance between Small AFD and Large AFD	Typically Zero
CD4		0.00	Clear Distance between Large AFD and Switchgear	Typically Zero
CD5		0.00	Clear Distance between Switchgear and Contingency Space	Typically Zero
CD6	4.00		Clear Distance behind Switchgear (If there is no Switchgear, this distance will be Zero)	
CD7	3.00		Clear Distance in front of Equipment	Typically 3 feet
Contingency Length		0.00	Contingency length	Typically Zero

Electric Room Width (ft):

CD1	3.00
MCC	11.67
CD2	1.00

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Small AFD's	0.00						
CD3	0.00						
Large AFD's	0.00						
CD4	0.00						
Swithgear	0.00						
CD5	0.00						
Contingency	0.00						
Total Width	**15.67**				ERL		
Electric Room Length (ft):							
CD6	0.00					If there is no switchgear, this distance will be Zero.	
Maximum Equipment Depth	1.67						
CD7	3.00						
Total Length	**4.67**				ERW		
Stair Dimensions:							
Operating Room Floor Elevation	751.00	ft			OREL		
Hatch Access Elevation	758.33	ft			HAEL		
Total Stair Height	88.00	in			TSH		
Individual Step Height	**7.00**	in		Between 6 and 8 inches	ISTH		
Number of Steps	13.00				NS		
Last Step Height	4.00	in			LSH		
Step Width	**12.00**	in		Typically 12 inches	SW		
Step Length	4.00	ft		Fixed	SL		
Handrail Length	13.00	ft			HRL		
Handrail Height	4.00	ft		Fixed	HRH		
Hatch Access Dimensions:							
Is Hatch Access Area Covered?	**Yes**	Y/N					
Double Door Width	**5.00**	ft		Typically at least 5 feet	DDW		
Clear Distance From Doors to Steps	**2.00**	ft		Between 2 and 4 feet	DTSW		
Landing Platform Width	**6.00**	ft		At least 6 feet	LPW		
Landing Platform Length	**4.00**	ft		Typically 4 feet	LPL		
Total Area Required	396.27	sf					
Hatch Access Area Without Wet Well Ceiling	53.00	ft					
Hatch Length	3.44	ft			HL		
Hatch Width	4.85	ft			HW		
Access Hatch Length	2.00	ft		Fixed	AHL		
Access Hatch Width	1.50	ft		Fixed	AHW		
Influent Pipe and Baffle Dimensions:							
Inlet Pipe Diameter	**24.00**	in			IPD		
Influent Pipe Height From Floor	4.00	ft		measured from top of pipe	IPHF		
Influent Pipe Offset Distance	11.64	in			IPOD		
Baffle Clearance Height	29.54	in			BCH		
Baffle Length	2.00	ft		Fixed	BL		
Baffle Height	4.00	ft		Same as IPHF	BH		
Baffle Thickness	6.00	in		Fixed	BT		
Inlet Slope Width	69.84	in			ISW		
Inlet Slope Height	11.64	in			ISH		
Estimating Dimensions:	**Value (English)**	**Unit (English)**	**Value (Metric)**	**Unit (Metric)**	**Name**	**Comment**	**Red Flags**
Mechanical Fitting Dimensions:							
Discharge Lateral Increaser Length	0.67	ft	203.20	mm	DLIL		
Pump Control Valve Length	2.42	ft	736.60	mm	PCVL		
Discharge Lateral Butterfly Valve Length	0.67	ft	203.20	mm	BFVL		
Discharge Lateral to Header Increaser Length	2.00	ft	609.60	mm	LHIL		
Magmeter Length	2.00	ft	609.60	mm	MML		
Operating Room Area:							
Slab On Grade							
Operating Room Floor Width	16.42	ft	5003.80	mm	ORFW		
Operating Room Floor Length	40.71	ft	12408.23	mm	ORFL		
Concrete Thickness	**12.00**	in	**457.20**	mm		Model based on 24"	
Concrete Thickness	1.00	ft	304.80	mm	ORFST		
Surge Protection Area:							
Slab on Grade							
Overall Surge Area Width	16.42	ft	5003.80	mm	SSOGW		
Overall Surge Area Length	10.18	ft	3102.06	mm	SSOGL		
Concrete Thickness	**12.00**	in	**609.60**	mm		Model based on 24"	
Concrete Thickness	1.00	ft	304.80	mm	SSOGT		
Electrical Room Area:							
Slab on Grade							
Electrical Room Width	17.67	ft	5384.80	mm	ESOGW		
Electrical Room Length	6.67	ft	2032.00	mm	ESOGL		
Concrete Thickness	**12.00**	in	**609.60**	mm		Model based on 24"	
Concrete Thickness	1.00	ft	304.80	mm	ESOGT		
Pump Station Wet Well:							
Floor Slab							
Wet Well Floor Slab Area	343.27	sf	31.89	m2			
Wet Well Floor Slab Thickness	**24.00**	in	**609.60**	mm		Model based on 24"	
Wet Well Floor Slab Thickness	2.00	ft	609.60	mm	WWFST		
Wet Well Walls							
Wet Well Width	12.12	ft	3694.50	mm	WWW		
Wet Well Length	19.70	ft	6005.03	mm	WWL		
Wet Well Depth	15.12	ft	4609.30	mm	WWD		
Wall Thickness	**18.00**	in	**304.80**	mm		Model based on 12"	
Wall Thickness	1.50	ft	457.20	mm	WWWT		
Elevated Ceiling Slab							
Wet Well Ceiling Area	343.27	sf	31.89	m2			
Elevated Slab Thickness	**12.00**	in	**304.80**	mm		Model based on 12"	

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Elevated Slab Thickness	1.00	ft	304.80	mm	WWCT		
Hatch Access Room Area:							
Elevated Floor Slab							
Overall Hatch Access Area	396.27	sf	36.81	m2			
Overall Hatch Access Area New Concrete Required	53.00	sf	4.92	m2			
Concrete Thickness	**12.00**	in	**457.20**	mm			
Concrete Thickness	1.00	ft	304.80	mm	SOGT		
Overall Facility Dimensions:							
Operating Room Slab Length	40.71	ft	12408.23	mm			
Operating Room Slab WIdth	16.42	ft	5003.80	mm			
Operating Room Excavation Length	44.71	ft	13627.43	mm			
Operating Room Excavation Width	20.42	ft	6223.00	mm			
Operating Room Excavation Depth	1.00	ft	304.80	mm			
Wet Well Area	343.27	sf	31.89	m2			
Wet Well Excavation Length	26.70	ft	8138.63	mm			
Wet Well Excavation Width	19.12	ft	5828.10	mm			
Wet Well Excavation Depth	18.12	ft	5523.70	mm			
Surge Protection SOG Area	167.08	sf	15.52	m2			
Surge Protection Excavation Area	289.45	sf	26.89	m2			
Surge Protection Excavation Depth	2.00	ft	609.60	mm			
Electrical Room SOG Area	117.78	sf	10.94	m2			
Electrical Room Excavation Area	231.11	sf	21.47	m2			
Electrical Room Excavation Depth	2.00	ft	609.60	mm			
Hatch Access SOG Area	53.00	sf	4.92	m2			
Hatch Access Excavation Area	58.00	sf	5.39	m2			
Hatch Access Excavation Depth	2.00	ft	609.60	mm			

COST ESTIMATE

Description	Quantity (English)	Unit (English)	Quantity (Metric)	Unit (Metric)	$/Unit	Total Cost	User Over-Write
SITEWORK:							
Operating Room:							
Excavation	41.92	CY	32.05	m3	***$6.72***	$282	
Imported Structural Backfill	67.62	CY	51.70	m3	***$50.94***	$3,444	
Native Backfill	3.62	CY	2.77	m3	***$8.27***	$30	
Haul Excess	38.30	CY	29.28	m3	***$8.27***	$317	
Wet Well:							
Excavation	1047.38	CY	800.78	m3	***$6.72***	$7,042	
Imported Structural Backfill	37.82	CY	28.92	m3	***$50.94***	$1,927	
Native Backfill	592.47	CY	452.97	m3	***$8.27***	$4,897	
Haul Excess	454.91	CY	347.80	m3	***$8.27***	$3,760	
Surge Protection:							
Excavation	32.48	CY	24.83	m3	***$6.72***	$218	
Imported Structural Backfill	21.44	CY	16.39	m3	***$50.94***	$1,092	
Native Backfill	7.56	CY	5.78	m3	***$8.27***	$62	
Haul Excess	24.92	CY	19.05	m3	***$8.27***	$206	
Hatch Access Room:							
Excavation	7.66	CY	5.85	m3	***$6.72***	$51	
Imported Structural Backfill	4.30	CY	3.28	m3	***$50.94***	$219	
Native Backfill	2.54	CY	1.94	m3	***$8.27***	$21	
Haul Excess	5.12	CY	3.91	m3	***$8.27***	$42	
Electrical Room:							
Excavation	26.74	CY	20.45	m3	***$6.72***	$180	
Imported Structural Backfill	17.12	CY	13.09	m3	***$50.94***	$872	
Native Backfill	6.76	CY	5.17	m3	***$8.27***	$56	
Haul Excess	19.98	CY	15.28	m3	***$8.27***	$165	
Allowance for Misc Items	5%				$24,883.36	$1,244	
Subtotal						$26,128	
CONCRETE:							
Operating Room							
Foundation	31.35	CY	23.97	m3	***$541.11***	$16,962	
Pipe Supports	0.58	CY	0.44	m3	***$490.62***	$283	
Electrical Room							
Foundation	4.36	CY	3.34	m3	***$541.11***	$2,360	
Surge Protection							
Foundation	6.19	CY	4.73	m3	***$541.11***	$3,348	
Pump Station Wet Well							
Floor Slab	25.43	CY	19.44	m3	***$490.62***	$12,475	
Wet Well Walls	58.51	CY	44.74	m3	***$880.79***	$51,536	
Ceiling Slab	12.71	CY	9.72	m3	***$1,333.77***	$16,957	
Pump Baffling	6.65	CY	5.09	m3	***$880.79***	$5,858	
Inlet Slope	2.06	CY	1.57	m3	***$490.62***	$1,011	
Pipe Support Fitting	8.60	CY	6.57	m3	***$490.62***	$4,218	
Hatch Access Room							
Foundation	1.96	CY	1.50	m3	***$198.37***	$389	
Allowance for Misc Items	5%				$115,397.65	$5,770	
Subtotal						$121,168	
MASONRY:	**Moderate**						
Operating Room	866.78	SF	80.53	m2	***$165.31***	$143,283	
Hatch Access Room	396.27	SF	36.81	m2	***$165.31***	$65,506	
Surge Building	0.00	SF	0.00	m2	***$165.31***	$0	
Electrical Room	117.78	SF	10.94	m2	***$165.31***	$19,469	
Subtotal	1380.83					$228,259	
METALS:							
Pump Removal Hatches	69.74	SF	6.48	m2	***$160.25***	$11,176	
Stairs	20.00	Risers			***$495.92***	$9,918	
Access Hatch Ladder	15.12	VLF	4.61	VLM	***$141.02***	$2,132	
Allowance for Misc Items	10%				$23,227.14	$2,323	
Subtotal						$25,550	

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THERMAL & MOISTURE PROTECTION:							
Wet Well Liner	0.00	SF	0.00	m2	**$16.00**	$0	
Allowance for Misc Items	10%				$0.00	$0	
Subtotal						$0	
EQUIPMENT:							**Budgetary Quote: (CPES will automatically add Installation Factor)**
Pumps							
Active Pump # 1	1.00	EA			***$32,263.02***	$32,263	
Active Pump # 2	1.00	EA			***$32,263.02***	$32,263	
Active Pump # 3	1.00	EA			***$32,263.02***	$32,263	
Active Pump # 4	0.00	EA			***$0.00***	$0	
Active Pump # 5	0.00	EA			***$0.00***	$0	
Active Pump # 6	0.00	EA			***$0.00***	$0	
Active Pump # 7	0.00	EA			***$0.00***	$0	
Standby Pump	1.00	EA			***$32,263.02***	$32,263	
Allowance for Misc Items	10%				$129,052.08	$12,905	
Subtotal						$141,957	
INSTRUMENTATION & CONTROLS:							
Instruments							
Isolation Valve Actuators	5.00	EA			***$6,409.82***	$32,049	
Control Valve Actuators	4.00	EA			***$6,409.82***	$25,639	
Level Indicator Transmitters	2.00	EA			***$10,700.91***	$21,402	
Level Swithces	0.00	EA			***$11,264.12***	$0	
Pressure Indicator Transmitters	1.00	EA			***$11,264.12***	$11,264	
Pressure Switches	4.00	EA			***$11,264.12***	$45,056	
Number of Analog I/O Counts	21.60	EA			***$264.27***	$5,708	
Number of Digital I/O Counts	58.80	EA			***$62.59***	$3,680	
Number of PLC's	1.00	EA			***$13,074.33***	$13,074	
I&C Conduit & Wire	651.35	LF	198.53	m	***$12.06***	$7,855	
Allowance for Misc Items	10%				$165,728	$16,573	
Subtotal						$182,301	
MECHANICAL:							
Pipe:							
Discharge Lateral Pipe (10-inch,DIS, Exposed, Steel, Cement Mortar, Paint)	64.00	LF	19.51	m	***$301.76***	$19,313	
Discharge Header Pipe (16-inch,DIS, Exposed/Buried, Steel, Cement Mortar, Paint)	31.11	LF	9.48	m	***$493.82***	$15,364	
Elbows:							
Pump Discharge (6-inch)	4.00	EA			***$460.10***	$1,840	
Discharge Lateral Pipe (10-inch)	4.00	EA			***$980.74***	$3,923	
Discharge Header Pipe (16-inch)	2.00	EA			***$1,761.70***	$3,523	
Tees:							
Discharge Header Pipe (16-inch)	4.00	EA			***$3,386.13***	$13,545	
Valves:							
Discharge Lateral Isolation Valve (10-inch - Butterfly Valve)	4.00	EA			***$1,302.01***	$5,208	
Pump Control Valve (10-inch, Check Valve)	4.00	EA			***$6,214.71***	$24,859	
Discharge Header Isolation Valve (16-inch, BFV)	1.00	EA			***$4,514.81***	$4,515	
Air Release Vacuum Valves	1.00	EA			***$1,922.95***	$1,923	
Increasers:							
Pump Discharge to Discharge Lateral (6-inch to 10-inch)	4.00	EA			***$980.74***	$3,923	
Discharge Lateral to Discharge Header (10-inch to 16-inch)	4.00	EA			***$1,761.70***	$7,047	
Allowance for Misc Items	10%				$104,982.35	$10,498	
Subtotal						$115,481	
ELECTRICAL:							
MCC's							
Sections	7.00	EA			***$10,730.27***	$75,112	
AFD's							
Active Pump # 1	25.00	hp	18.64	kW	***$485.75***	$12,144	
Active Pump # 2	25.00	hp	18.64	kW	***$485.75***	$12,144	
Active Pump # 3	25.00	hp	18.64	kW	***$485.75***	$12,144	
Active Pump # 4	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 5	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 6	0.00	hp	0.00	kW	***$0.00***	$0	
Active Pump # 7	0.00	hp	0.00	kW	***$0.00***	$0	
Standby Pump	25.00	hp	18.64	kW	***$485.75***	$12,144	
Switchgear							
Units	0.00	EA			***$49,359.23***	$0	
Electrical Conduit & Wire	162.84	LF	49.63	m	***$12.06***	$1,964	
Allowance for Misc Items	5%				$125,651	$6,283	
Subtotal						$131,934	
USER DEFINED ESTIMATE ITEMS:	**QUANT (ENGLISH)**	**UNIT (ENGLISH)**	**QUANT (METRIC)**	**UNIT (METRIC)**	**$/UNIT**	**TOTAL COST**	
Item 1 Description	0.00		0.00		0.00	$0	
Item 2 Description	0.00		0.00		0.00	$0	
Item 3 Description	0.00		0.00		0.00	$0	
Item 4 Description	0.00		0.00		0.00	$0	
Item 5 Description	0.00		0.00		0.00	$0	
Item 6 Description	0.00		0.00		0.00	$0	
Item 7 Description	0.00		0.00		0.00	$0	
Item 8 Description	0.00		0.00		0.00	$0	
Item 9 Description	0.00		0.00		0.00	$0	
Item 10 Description	0.00		0.00		0.00	$0	
Item 11 Description	0.00		0.00		0.00	$0	
Item 12 Description	0.00		0.00		0.00	$0	
Item 13 Description	0.00		0.00		0.00	$0	
Item 14 Description	0.00		0.00		0.00	$0	
Item 15 Description	0.00		0.00		0.00	$0	
Subtotal						$0	

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Subtotal						$972,776	
ALLOWANCES:		**User Override**					
Finishes Allowance	5.00%		$1,247,149	$62,357			
I&C Allowance	2.00%		$1,247,149	$24,943			
Surge Allowance	5.00%		$1,247,149	$62,357			
Mechanical Allowance	5.00%		$1,247,149	$62,357			
Electrical Allowance	5.00%		$1,247,149	$62,357			
Facility Cost	**100**	**Total Pump HP**	**$12,471.49**	**$1,247,149**			
Facility Cost with Standard Additional Project Costs Added	**100**	**Total Pump HP**	**$15,153.71**	**$1,515,371**			
Facility Cost with Standard Additional Project Costs and Contractor Markups Added	**100**	**Total Pump HP**	**$26,285.04**	**$2,628,504**			
Facility Cost, Contractor Markups, and Location Adjustment Factor Added (excluding ALL Additional Project Costs)	**100**	**Total Pump HP**	**$21,632.56**	**$2,163,256**			
Facility Cost with Standard Additional Project Costs, Contractor Markups and Location Adjustment Factor Added	**100**	**Total Pump HP**	**$26,285.04**	**$2,628,504**			

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CH2M Parametric Engineering System (CPES)

FACILITIES LIFE CYCLE COST ANALYSIS MODULE

File Version: 9/21/2017

Linked to CPES Facilities File: C:\Users\lodell\Documents\PWB\Filtration\160mgdfiles\PWB Membrane Filtration CPES Facilities_160MGD.xlsm

Project Name:	***PWB Filtration Decision***	***Life Cycle Analysis:***	
Project Number:	***699275***	***i =***	***5.00%***
Project Manager:	***Kelly Irving***	***n =***	***25 years***
Estimator:	***Enoch Nicholson/Lee Odell***	***Annual Inflation:***	***3.00%***
Project Description:	***PWB Membrane Filtration***		
Project Location (City):	***Portland OR***		
Project Location (State):	***OREGON***		
Project Location (Country):	***USA***		
Cost Basis (Month/Year):	***April/2018***		

Item	Include? (Yes or No)	SCOPE OF PROJECT	Construction Cost	Annual O&M Cost (Year 1)	Life Cycle Cost (NPV)
	Yes	Flocculation: RapMix	$3,062,000	$208,000	$7,020,000
	Yes	Flocculation: Floc	$14,319,000	$131,000	$16,817,000
	No	DAF: DAF	$0	$0	$0
	No	Ozone Serpentine: Ozone	$0	$0	$0
	No	Filters: Filt	$0	$0	$0
	Yes	Concrete Clearwell: Clearwell	$50,789,000	$22,000	$51,196,000
	Yes	Liquid Chemical: Alum	$2,004,000	$710,000	$15,538,000
	Yes	Liquid Chemical: FAP	$503,000	$93,000	$2,263,000
	Yes	Liquid Chemical: CAP	$997,000	$668,000	$13,729,000
	Yes	Liquid Chemical: Hypo	$1,819,000	$421,000	$9,846,000
	Yes	On-Site Sodium Hypo: OSHG	$8,829,000	$662,000	$21,454,000
	Yes	Liquid Chemical: Caustic	$687,000	$6,000	$789,000
	Yes	Surge Basin-Decanter: BWSurge	$4,206,000	$36,000	$4,875,000
	Yes	Gravity Thickener: BWClar	$9,898,000	$116,000	$12,109,000
	Yes	Gravity Thickener: GravThick	$3,803,000	$45,000	$4,650,000
	Yes	WTP Centrifuge: Centrifuge	$12,416,000	$913,000	$29,826,000
	Yes	WPSPS: RecPS	$2,009,000	$41,000	$2,785,000
	Yes	Pall - Large: Membrane	$200,512,000	$12,612,000	$441,205,000
		Additional Project Costs:			
		Biosolids Disposal	$0	$0	$0
		Standard Items	$67,955,000	$2,321,000	$112,244,000
		User Defined Items	$0	$0	$0
		Plant O&M Labor		$972,000	$18,532,000
TOTAL - Life Cycle Analysis *(Red Flag Items and Market Adjustment Factor are EXCLUDED)*			$383,808,000	$19,977,000	$764,878,000
Construction Cost per GPD (based on Maximum Daily Flow Rate)			$3.49 / GPD		
Annual O&M Cost per 1,000 Gallons (based on Average Annual Daily Flow Rate)				$ 0.730 / Thousand Gallons	

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C H2M P arametric E ngineering S ystem (CPES)

WTP LIFE CYCLE COST ANALYSIS
Summary of Annual O&M Costs (Year 1)

Project Name:	PWB Filtration Decision	Life Cycle Analysis:	
Project Number:	699275	i =	5.00%
Project Manager:	Kelly Irving	n =	25 years
Estimator:	Enoch Nicholson/Lee Odell	Annual Inflation:	3.00%
Project Description:	PWB Membrane Filtration		
Project Location (City):	Portland OR		
Project Location (State):	OREGON		
Project Location (Country):	USA		
Cost Basis (Month/Year):	April/2018		

Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Labor	Equipment Power	Building Electrical	Chemicals	Sludge Disposal	Specialty Items	Repair & Maintenance	Replacement	Other	User Defined	Total
5	Yes	Flocculation	$0	$99,489	$173	$0	$0	$0	$68,139	$0	$33,560	$0	$201,360
5	Yes	Flocculation	$0	$25,096	$20,093	$0	$0	$0	$60,708	$0	$21,180	$0	$127,077
11	No	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
16	No	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
12	No	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
22	Yes	Concrete Tank 1	$0	$0	$0	$0	$0	$0	$17,243	$0	$3,449	$0	$20,691
24	Yes	Liquid Chemical	$0	$2,689	$3,340	$553,717	$0	$0	$14,004	$0	$114,750	$0	$688,499
24	Yes	Liquid Chemical	$0	$896	$960	$70,675	$0	$0	$2,099	$0	$14,926	$0	$89,557
24	Yes	Liquid Chemical	$0	$1,793	$1,974	$530,065	$0	$0	$5,930	$0	$107,952	$0	$647,714
24	Yes	Liquid Chemical	$0	$2,988	$3,620	$321,848	$0	$0	$11,831	$0	$68,057	$0	$408,344
20	Yes	On-Site Sodium Hypochlorite Generation	$0	$243,792	$3,676	$91,433	$0	$0	$196,311	$0	$107,042	$0	$642,254
24	Yes	Liquid Chemical	$0	$598	$1,107	$0	$0	$0	$2,647	$0	$870	$0	$5,222
27	Yes	Combination Wastewater Surge Basin & Floating Tube Decanter Clarification (Large System >= 5MGD)	$0	$20,017	$95	$0	$0	$0	$8,246	$0	$5,672	$0	$34,030
30	Yes	Gravity Thickener	$0	$2,988	$1,831	$0	$0	$0	$88,928	$0	$18,749	$0	$112,496
30	Yes	Gravity Thickener	$0	$1,494	$1,008	$0	$0	$0	$33,415	$0	$7,183	$0	$43,100
31	Yes	Centrifuge Solids Dewatering	$0	$33,462	$16,086	$102,162	$365,252	$0	$221,092	$0	$147,611	$0	$885,664
4	Yes	Wet Pit Submersible Pump Station	$0	$22,407	$1,623	$0	$0	$0	$8,846	$0	$6,575	$0	$39,451
34	Yes	Pall Micro Filtration - Small Systems: .5 - 5 mgd	$0	$2,502,457	$110,294	$748,485	$0	$2,352,997	$4,489,302	$0	$2,040,707	$0	$12,244,241
		Totals	$0	$2,960,165	$165,881	$2,418,384	$365,252	$2,352,997	$5,228,739	$0	$2,698,284	$0	$16,189,701
		Additional Project Costs:											
		Biosolids Disposal					$0					$0	$0
		Standard Items							$1,877,529	$0	$375,506	$0	$2,253,035
		User Defined Items		$0	$0	$0		$0	$0	$0	$0	$0	$0
		Plant O&M Labor	$942,720										$942,720
		TOTAL - O&M Cost	$942,720	$2,960,165	$165,881	$2,418,384	$365,252	$2,352,997	$7,106,268	$0	$3,073,789	$0	$19,385,456
		Percent of TOTAL Cost	4.9%	15.3%	0.9%	12.5%	1.9%	12.1%	36.7%	0.0%	15.9%	0.0%	100.0%

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Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Labor	Equipment Power	Building Electrical	Chemicals	Sludge Disposal	Specialty Items	Repair & Maintenance	Replacement	Other	User Defined	Total

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Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Labor	Equipment Power	Building Electrical	Chemicals	Sludge Disposal	Specialty Items	Repair & Maintenance	Replacement	Other	User Defined	Total

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Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)

Construction Cost:	**$3,061,676**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	333	68%	8,760	$ 0.06	$ 82,907	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	147	2.00	8,760	$ 0.06	$ 144	

Chemicals:	$ -

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		$ 56,782
Replacement Cost	-	$ -

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 139,833	20.0%	$ 27,967	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	$ -
Item 2	$ -
Item 3	$ -
Item 4	$ -
Item 5	$ -
Item 6	$ -
Item 7	$ -
Item 8	$ -
Item 9	$ -
Item 10	$ -
Item 11	$ -
Item 12	$ -
Item 13	$ -
Item 14	$ -
Item 15	$ -

Subtotal Annual O&M Cost		$ 167,800
Contingency	20%	$ 33,560
Total Annual O&M Cost		$ 201,360

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$3,061,676		$3,061,676	
1	$207,401		$207,401	
2	$213,623		$213,623	
3	$220,032		$220,032	
4	$226,633		$226,633	
5	$233,432		$233,432	
6	$240,435		$240,435	
7	$247,648		$247,648	

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8	$255,077		$255,077				
9	$262,729		$262,729				
10	$270,611		$270,611				
11	$278,730		$278,730				
12	$287,092		$287,092				
13	$295,704		$295,704				
14	$304,575		$304,575				
15	$313,713		$313,713				
16	$323,124		$323,124				
17	$332,818		$332,818				
18	$342,802		$342,802				
19	$353,086		$353,086				
20	$363,679		$363,679				
21	$374,589		$374,589				
22	$385,827		$385,827				
23	$397,402		$397,402				
24	$409,324		$409,324				
25	$421,604		$421,604				
26							
27							
28							
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49							
50							
NPV			$7,019,940	$207,401			

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Flocculation (Horizontal Paddle Wheel Flocculation for Downstream Sedimentation)

Construction Cost:	**$14,318,845**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	84	68%	8,760	$ 0.06	$ 20,914	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	17,097	2.00	8,760	$ 0.06	$ 16,744	

Chemicals:	$ -

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		$ 50,590
Replacement Cost	-	$ -

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 88,248	20.0%	$ 17,650	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	$ -
Item 2	$ -
Item 3	$ -
Item 4	$ -
Item 5	$ -
Item 6	$ -
Item 7	$ -
Item 8	$ -
Item 9	$ -
Item 10	$ -
Item 11	$ -
Item 12	$ -
Item 13	$ -
Item 14	$ -
Item 15	$ -

Subtotal Annual O&M Cost		$ 105,898
Contingency	20%	$ 21,180
Total Annual O&M Cost		$ 127,077

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	**Default Cost**	**User Over-Ride**	**Cost Used in NPV Calculation**	**Adjusted Annual O&M Cost**
0	**$14,318,845**		**$14,318,845**	
1	**$130,890**		**$130,890**	
2	**$134,816**		**$134,816**	
3	**$138,861**		**$138,861**	
4	**$143,027**		**$143,027**	
5	**$147,317**		**$147,317**	
6	**$151,737**		**$151,737**	
7	**$156,289**		**$156,289**	

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8	$160,978		$160,978				
9	$165,807		$165,807				
10	$170,781		$170,781				
11	$175,905		$175,905				
12	$181,182		$181,182				
13	$186,617		$186,617				
14	$192,216		$192,216				
15	$197,982		$197,982				
16	$203,922		$203,922				
17	$210,039		$210,039				
18	$216,340		$216,340				
19	$222,831		$222,831				
20	$229,516		$229,516				
21	$236,401		$236,401				
22	$243,493		$243,493				
23	$250,798		$250,798				
24	$258,322		$258,322				
25	$266,071		$266,071				
26							
27							
28							
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30							
31							
32							
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50							
NPV			$16,816,882	$130,890			

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DAF

Construction Cost:						$32,727,111	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		684	68%	8,760	$ 0.06	$ 170,296	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		-	2.00	8,760	$ 0.06	$ -	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 565,135	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 735,431	20.0%	$ 147,086	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 882,517	
Contingency					20%	$ 176,503	
Total Annual O&M Cost						$ 1,059,020	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$32,727,111		$32,727,111	
1	$1,090,791		$1,090,791	
2	$1,123,515		$1,123,515	
3	$1,157,220		$1,157,220	
4	$1,191,937		$1,191,937	
5	$1,227,695		$1,227,695	
6	$1,264,526		$1,264,526	
7	$1,302,462		$1,302,462	

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8	$1,341,535		$1,341,535				
9	$1,381,781		$1,381,781				
10	$1,423,235		$1,423,235				
11	$1,465,932		$1,465,932				
12	$1,509,910		$1,509,910				
13	$1,555,207		$1,555,207				
14	$1,601,863		$1,601,863				
15	$1,649,919		$1,649,919				
16	$1,699,417		$1,699,417				
17	$1,750,399		$1,750,399				
18	$1,802,911		$1,802,911				
19	$1,856,999		$1,856,999				
20	$1,912,709		$1,912,709				
21	$1,970,090		$1,970,090				
22	$2,029,193		$2,029,193				
23	$2,090,068		$2,090,068				
24	$2,152,770		$2,152,770				
25	$2,217,354		$2,217,354				
26							
27							
28							
29							
30							
31							
32							
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NPV			$53,544,944	$1,090,791			

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Ozone - Serpentine

Construction Cost:						**$40,175,553**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		1,362	68%	8,760	$ 0.06	**$ 339,098**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		4,400	2.00	8,760	$ 0.06	**$ 4,309**	
Liquid Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**	
Liquid Oxygen		100%	68%	7,311	$ 126.22	**$ 629,152**	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 849,911**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 1,822,471	20.0%	**$ 364,494**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 2,186,965**	
Contingency					**20%**	**$ 437,393**	
Total Annual O&M Cost						**$ 2,624,359**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$40,175,553		$40,175,553	
1	$2,703,089		$2,703,089	

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2	$2,784,182		$2,784,182				
3	$2,867,707		$2,867,707				
4	$2,953,739		$2,953,739				
5	$3,042,351		$3,042,351				
6	$3,133,621		$3,133,621				
7	$3,227,630		$3,227,630				
8	$3,324,459		$3,324,459				
9	$3,424,193		$3,424,193				
10	$3,526,918		$3,526,918				
11	$3,632,726		$3,632,726				
12	$3,741,708		$3,741,708				
13	$3,853,959		$3,853,959				
14	$3,969,578		$3,969,578				
15	$4,088,665		$4,088,665				
16	$4,211,325		$4,211,325				
17	$4,337,665		$4,337,665				
18	$4,467,795		$4,467,795				
19	$4,601,829		$4,601,829				
20	$4,739,884		$4,739,884				
21	$4,882,080		$4,882,080				
22	$5,028,542		$5,028,542				
23	$5,179,399		$5,179,399				
24	$5,334,781		$5,334,781				
25	$5,494,824		$5,494,824				
26							
27							
28							
29							
30							
31							
32							
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50							
NPV			$91,764,225	$2,703,089			

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Filters

Construction Cost:						**$44,760,891**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		-	68%	8,760	$ 0.06	$ -	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		1,015	2.00	8,760	$ 0.06	$ 994	
Chemicals:			**Annual Usage (tons)**	**Annual Facility Usage (% of year)**	**$/ton**	**Chemical Cost**	
GAC			-	100%	$ 3,251.28	$ -	
Total Chemical Cost						$ -	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						$ 506,544	
Replacement Cost					-	$ -	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 507,538	20.0%	$ 101,508	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 609,046	
Contingency					20%	$ 121,809	
Total Annual O&M Cost						$ 730,855	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$44,760,891		$44,760,891	
1	$752,781		$752,781	
2	$775,365		$775,365	
3	$798,625		$798,625	
4	$822,584		$822,584	
5	$847,262		$847,262	
6	$872,680		$872,680	
7	$898,860		$898,860	

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8	$925,826		$925,826				
9	$953,601		$953,601				
10	$982,209		$982,209				
11	$1,011,675		$1,011,675				
12	$1,042,025		$1,042,025				
13	$1,073,286		$1,073,286				
14	$1,105,484		$1,105,484				
15	$1,138,649		$1,138,649				
16	$1,172,808		$1,172,808				
17	$1,207,993		$1,207,993				
18	$1,244,232		$1,244,232				
19	$1,281,559		$1,281,559				
20	$1,320,006		$1,320,006				
21	$1,359,606		$1,359,606				
22	$1,400,395		$1,400,395				
23	$1,442,406		$1,442,406				
24	$1,485,679		$1,485,679				
25	$1,530,249		$1,530,249				
26							
27							
28							
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31							
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NPV			$59,127,777	$752,781			

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Concrete Tank

Construction Cost:						**$50,788,316**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		-	68%	8,760	$ 0.06	$ -	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		-	2.00	8,760	$ 0.06	$ -	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						$ 14,369	
Replacement Cost					-	$ -	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 14,369	20.0%	$ 2,874	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 17,243	
Contingency					20%	$ 3,449	
Total Annual O&M Cost						$ 20,691	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$50,788,316		$50,788,316	
1	$21,312		$21,312	
2	$21,951		$21,951	
3	$22,610		$22,610	
4	$23,288		$23,288	
5	$23,987		$23,987	
6	$24,706		$24,706	
7	$25,448		$25,448	
8	$26,211		$26,211	
9	$26,997		$26,997	
10	$27,807		$27,807	
11	$28,642		$28,642	

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12	$29,501		$29,501				
13	$30,386		$30,386				
14	$31,297		$31,297				
15	$32,236		$32,236				
16	$33,203		$33,203				
17	$34,199		$34,199				
18	$35,225		$35,225				
19	$36,282		$36,282				
20	$37,371		$37,371				
21	$38,492		$38,492				
22	$39,647		$39,647				
23	$40,836		$40,836				
24	$42,061		$42,061				
25	$43,323		$43,323				
26							
27							
28							
29							
30							
31							
32							
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NPV			$51,195,057	$21,312			

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Liquid Chemical Storage & Feed

Construction Cost:	**$2,003,670**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	9	68%	8,760	$ 0.06	**$ 2,241**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	2,842	2.00	8,760	$ 0.06	**$ 2,783**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	68%	1,218	$ 555.44	$ 461,431
Aqueous Ammonia	100%	68%	-	$ 1,208.65	$ -
Citric Acid	100%	68%	-	$ 3,204.91	$ -
Ferric Chloride	100%	68%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	68%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	68%	-	$ 2,223.22	$ -
Liquid Polymer	100%	68%	-	$ 3,544.77	$ -
Sodium Bisulfite	100%	68%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	68%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	68%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	68%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	68%	-	$ 379.51	$ -
Other Chemical	100%	68%	-	$ -	$ -
Total Chemical Cost					**$ 461,431**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 11,670**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 478,125	20.0%	**$ 95,625**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 573,749**
Contingency	**20%**	**$ 114,750**
Total Annual O&M Cost		**$ 688,499**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$2,003,670		$2,003,670				
1	$709,154		$709,154				
2	$730,429		$730,429				
3	$752,342		$752,342				
4	$774,912		$774,912				
5	$798,159		$798,159				
6	$822,104		$822,104				
7	$846,767		$846,767				
8	$872,170		$872,170				
9	$898,335		$898,335				
10	$925,286		$925,286				
11	$953,044		$953,044				
12	$981,635		$981,635				
13	$1,011,084		$1,011,084				
14	$1,041,417		$1,041,417				
15	$1,072,659		$1,072,659				
16	$1,104,839		$1,104,839				
17	$1,137,984		$1,137,984				
18	$1,172,124		$1,172,124				
19	$1,207,288		$1,207,288				
20	$1,243,506		$1,243,506				
21	$1,280,812		$1,280,812				
22	$1,319,236		$1,319,236				
23	$1,358,813		$1,358,813				
24	$1,399,577		$1,399,577				
25	$1,441,565		$1,441,565				
26							
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NPV			$15,537,935	$709,154			

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Liquid Chemical Storage & Feed

Construction Cost:	**$502,018**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	3	68%	8,760	$ 0.06	**$ 747**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	817	2.00	8,760	$ 0.06	**$ 800**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	68%	-	$ 555.44	$ -
Aqueous Ammonia	100%	68%	-	$ 1,208.65	$ -
Citric Acid	100%	68%	-	$ 3,204.91	$ -
Ferric Chloride	100%	68%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	68%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	68%	-	$ 2,223.22	$ -
Liquid Polymer	100%	68%	24	$ 3,544.77	$ 58,896
Sodium Bisulfite	100%	68%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	68%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	68%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	68%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	68%	-	$ 379.51	$ -
Other Chemical	100%	68%	-	$ -	$ -
Total Chemical Cost					**$ 58,896**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 1,749**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 62,192	20.0%	**$ 12,438**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 74,631**
Contingency	**20%**	**$ 14,926**
Total Annual O&M Cost		**$ 89,557**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$502,018		$502,018				
1	$92,244		$92,244				
2	$95,011		$95,011				
3	$97,861		$97,861				
4	$100,797		$100,797				
5	$103,821		$103,821				
6	$106,936		$106,936				
7	$110,144		$110,144				
8	$113,448		$113,448				
9	$116,852		$116,852				
10	$120,357		$120,357				
11	$123,968		$123,968				
12	$127,687		$127,687				
13	$131,517		$131,517				
14	$135,463		$135,463				
15	$139,527		$139,527				
16	$143,713		$143,713				
17	$148,024		$148,024				
18	$152,465		$152,465				
19	$157,039		$157,039				
20	$161,750		$161,750				
21	$166,602		$166,602				
22	$171,600		$171,600				
23	$176,748		$176,748				
24	$182,051		$182,051				
25	$187,512		$187,512				
26							
27							
28							
29							
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NPV			$2,262,496	$92,244			

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Liquid Chemical Storage & Feed

Construction Cost:	**$996,135**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	6	68%	8,760	$ 0.06	**$ 1,494**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	1,680	2.00	8,760	$ 0.06	**$ 1,645**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	68%	-	$ 555.44	$ -
Aqueous Ammonia	100%	68%	-	$ 1,208.65	$ -
Citric Acid	100%	68%	-	$ 3,204.91	$ -
Ferric Chloride	100%	68%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	68%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	68%	-	$ 2,223.22	$ -
Liquid Polymer	100%	68%	183	$ 3,544.77	$ 441,720
Sodium Bisulfite	100%	68%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	68%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	68%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	68%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	68%	-	$ 379.51	$ -
Other Chemical	100%	68%	-	$ -	$ -
Total Chemical Cost					**$ 441,720**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 4,941**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 449,801	20.0%	**$ 89,960**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 539,761**
Contingency	**20%**	**$ 107,952**
Total Annual O&M Cost		**$ 647,714**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$996,135		$996,135				
1	$667,145		$667,145				
2	$687,159		$687,159				
3	$707,774		$707,774				
4	$729,007		$729,007				
5	$750,878		$750,878				
6	$773,404		$773,404				
7	$796,606		$796,606				
8	$820,504		$820,504				
9	$845,119		$845,119				
10	$870,473		$870,473				
11	$896,587		$896,587				
12	$923,485		$923,485				
13	$951,189		$951,189				
14	$979,725		$979,725				
15	$1,009,117		$1,009,117				
16	$1,039,390		$1,039,390				
17	$1,070,572		$1,070,572				
18	$1,102,689		$1,102,689				
19	$1,135,770		$1,135,770				
20	$1,169,843		$1,169,843				
21	$1,204,938		$1,204,938				
22	$1,241,086		$1,241,086				
23	$1,278,319		$1,278,319				
24	$1,316,668		$1,316,668				
25	$1,356,168		$1,356,168				
26							
27							
28							
29							
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48							
49							
50							
NPV			$13,728,651	$667,145			

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Liquid Chemical Storage & Feed

Construction Cost:	**$1,818,813**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	10	68%	8,760	$ 0.06	**$ 2,490**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	3,080	2.00	8,760	$ 0.06	**$ 3,016**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	68%	708	$ 555.44	$ 268,207
Aqueous Ammonia	100%	68%	-	$ 1,208.65	$ -
Citric Acid	100%	68%	-	$ 3,204.91	$ -
Ferric Chloride	100%	68%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	68%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	68%	-	$ 2,223.22	$ -
Liquid Polymer	100%	68%	-	$ 3,544.77	$ -
Sodium Bisulfite	100%	68%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	68%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	68%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	68%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	68%	-	$ 379.51	$ -
Other Chemical	100%	68%	-	$ -	$ -
Total Chemical Cost					**$ 268,207**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 9,859**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 283,572	20.0%	**$ 56,714**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 340,287**
Contingency	**20%**	**$ 68,057**
Total Annual O&M Cost		**$ 408,344**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$1,818,813		$1,818,813				
1	$420,594		$420,594				
2	$433,212		$433,212				
3	$446,208		$446,208				
4	$459,595		$459,595				
5	$473,382		$473,382				
6	$487,584		$487,584				
7	$502,211		$502,211				
8	$517,278		$517,278				
9	$532,796		$532,796				
10	$548,780		$548,780				
11	$565,243		$565,243				
12	$582,201		$582,201				
13	$599,667		$599,667				
14	$617,657		$617,657				
15	$636,186		$636,186				
16	$655,272		$655,272				
17	$674,930		$674,930				
18	$695,178		$695,178				
19	$716,033		$716,033				
20	$737,514		$737,514				
21	$759,640		$759,640				
22	$782,429		$782,429				
23	$805,902		$805,902				
24	$830,079		$830,079				
25	$854,981		$854,981				
26							
27							
28							
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NPV			$9,845,885	$420,594			

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Sodium Hypochlorite

Construction Cost:						**$8,828,729**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		816	68%	8,760	$ 0.06	**$ 203,160**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		3,128	2.00	8,760	$ 0.06	**$ 3,063**	
Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (tons)**	**Cost ($/ton)**	**Chemical Cost**	
Salt		100%	68%	731	$ 152.86	$ 76,194	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 163,592**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 446,010	20.0%	**$ 89,202**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 535,212**	
Contingency					**20%**	**$ 107,042**	
Total Annual O&M Cost						**$ 642,254**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$8,828,729		$8,828,729	
1	$661,522		$661,522	
2	$681,368		$681,368	
3	$701,809		$701,809	
4	$722,863		$722,863	
5	$744,549		$744,549	
6	$766,885		$766,885	

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7	$789,892		$789,892				
8	$813,589		$813,589				
9	$837,996		$837,996				
10	$863,136		$863,136				
11	$889,030		$889,030				
12	$915,701		$915,701				
13	$943,172		$943,172				
14	$971,467		$971,467				
15	$1,000,611		$1,000,611				
16	$1,030,630		$1,030,630				
17	$1,061,549		$1,061,549				
18	$1,093,395		$1,093,395				
19	$1,126,197		$1,126,197				
20	$1,159,983		$1,159,983				
21	$1,194,782		$1,194,782				
22	$1,230,626		$1,230,626				
23	$1,267,545		$1,267,545				
24	$1,305,571		$1,305,571				
25	$1,344,738		$1,344,738				
26							
27							
28							
29							
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50							
NPV			$21,453,928	$661,522			

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Liquid Chemical Storage & Feed

Construction Cost:	**$686,308**

Annual O&M Cost:

Power:	**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power	2	68%	8,760	$ 0.06	**$ 498**	

Other Electrical:	**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical	942	2.00	8,760	$ 0.06	**$ 923**	

Liquid Chemicals:	**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**
Aluminum Sulfate (Alum)	100%	68%	-	$ 555.44	$ -
Aqueous Ammonia	100%	68%	-	$ 1,208.65	$ -
Citric Acid	100%	68%	-	$ 3,204.91	$ -
Ferric Chloride	100%	68%	-	$ 1,003.69	$ -
Hydrofluorosilicic Acid	100%	68%	-	$ 500.72	$ -
Hyrogen Peroxide (35%)	100%	68%	-	$ 2,223.22	$ -
Liquid Polymer	100%	68%	-	$ 3,544.77	$ -
Sodium Bisulfite	100%	68%	-	$ 1,336.98	$ -
Sodium Hydroxide (25%)	100%	68%	-	$ 1,043.24	$ -
Sodium Hydroxide (50%)	100%	68%	-	$ 1,222.48	$ -
Sodium Hypochlorite (12.5%)	100%	68%	-	$ 2,205.88	$ -
Sulfuric Acid	100%	68%	-	$ 379.51	$ -
Other Chemical	100%	68%	-	$ -	$ -
Total Chemical Cost					**$ -**

Repair and Maintenance, and Replacement:	**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**
Maintenance & Repair Cost		**$ 2,206**
Replacement Cost	-	**$ -**

Other:	**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost	$ 3,626	20.0%	**$ 725**	

User Defined Annual O&M Items:	**Annual Cost**
Item 1	**$ -**
Item 2	**$ -**
Item 3	**$ -**
Item 4	**$ -**
Item 5	**$ -**
Item 6	**$ -**
Item 7	**$ -**
Item 8	**$ -**
Item 9	**$ -**
Item 10	**$ -**
Item 11	**$ -**
Item 12	**$ -**
Item 13	**$ -**
Item 14	**$ -**
Item 15	**$ -**

Subtotal Annual O&M Cost		**$ 4,351**
Contingency	**20%**	**$ 870**
Total Annual O&M Cost		**$ 5,222**

Net Present Value (NPV) Calculation:

i = 5.00%

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n =	25						
Annual Inflation % =	3.00%						
Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$686,308		$686,308				
1	$5,378		$5,378				
2	$5,540		$5,540				
3	$5,706		$5,706				
4	$5,877		$5,877				
5	$6,053		$6,053				
6	$6,235		$6,235				
7	$6,422		$6,422				
8	$6,615		$6,615				
9	$6,813		$6,813				
10	$7,018		$7,018				
11	$7,228		$7,228				
12	$7,445		$7,445				
13	$7,668		$7,668				
14	$7,898		$7,898				
15	$8,135		$8,135				
16	$8,379		$8,379				
17	$8,631		$8,631				
18	$8,890		$8,890				
19	$9,156		$9,156				
20	$9,431		$9,431				
21	$9,714		$9,714				
22	$10,005		$10,005				
23	$10,305		$10,305				
24	$10,615		$10,615				
25	$10,933		$10,933				
26							
27							
28							
29							
30							
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NPV			$788,954	$5,378			

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Large System Combination Wastewater Surge Basin and Floating Tube Decanter Clarification (>= 5 MGD)

Construction Cost:						$4,205,630	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		67	68%	8,760	$ 0.06	$ 16,681	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		81	2.00	8,760	$ 0.06	$ 79	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 6,872	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 23,632	20.0%	$ 4,726	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 28,359	
Contingency					20%	$ 5,672	
Total Annual O&M Cost						$ 34,030	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$4,205,630		$4,205,630	
1	$35,051		$35,051	
2	$36,103		$36,103	
3	$37,186		$37,186	
4	$38,301		$38,301	
5	$39,450		$39,450	
6	$40,634		$40,634	
7	$41,853		$41,853	
8	$43,109		$43,109	
9	$44,402		$44,402	
10	$45,734		$45,734	
11	$47,106		$47,106	
12	$48,519		$48,519	

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13	$49,975		$49,975				
14	$51,474		$51,474				
15	$53,018		$53,018				
16	$54,609		$54,609				
17	$56,247		$56,247				
18	$57,934		$57,934				
19	$59,672		$59,672				
20	$61,463		$61,463				
21	$63,306		$63,306				
22	$65,206		$65,206				
23	$67,162		$67,162				
24	$69,177		$69,177				
25	$71,252		$71,252				
26							
27							
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NPV			$4,874,585.60	$35,051			

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Gravity Thickener

Construction Cost:						**$9,897,096**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		10	68%	8,760	$ 0.06	**$ 2,490**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		1,558	2.00	8,760	$ 0.06	**$ 1,526**	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 74,106**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 78,122	20.0%	**$ 15,624**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 93,746**	
Contingency					**20%**	**$ 18,749**	
Total Annual O&M Cost						**$ 112,496**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$9,897,096		$9,897,096	
1	$115,871		$115,871	
2	$119,347		$119,347	
3	$122,927		$122,927	
4	$126,615		$126,615	
5	$130,413		$130,413	
6	$134,326		$134,326	
7	$138,355		$138,355	

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8	$142,506		$142,506				
9	$146,781		$146,781				
10	$151,185		$151,185				
11	$155,720		$155,720				
12	$160,392		$160,392				
13	$165,204		$165,204				
14	$170,160		$170,160				
15	$175,265		$175,265				
16	$180,523		$180,523				
17	$185,938		$185,938				
18	$191,516		$191,516				
19	$197,262		$197,262				
20	$203,180		$203,180				
21	$209,275		$209,275				
22	$215,553		$215,553				
23	$222,020		$222,020				
24	$228,681		$228,681				
25	$235,541		$235,541				
26							
27							
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NPV			$12,108,494	$115,871			

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Gravity Thickener

Construction Cost:						$3,802,100	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		5	68%	8,760	$ 0.06	$ 1,245	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		858	2.00	8,760	$ 0.06	$ 840	
Chemicals:						$ -	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 27,846	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 29,931	20.0%	$ 5,986	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 35,917	
Contingency					20%	$ 7,183	
Total Annual O&M Cost						$ 43,100	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$3,802,100		$3,802,100	
1	$44,393		$44,393	
2	$45,725		$45,725	
3	$47,097		$47,097	
4	$48,510		$48,510	
5	$49,965		$49,965	
6	$51,464		$51,464	
7	$53,008		$53,008	

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8	$54,598		$54,598				
9	$56,236		$56,236				
10	$57,923		$57,923				
11	$59,661		$59,661				
12	$61,451		$61,451				
13	$63,294		$63,294				
14	$65,193		$65,193				
15	$67,149		$67,149				
16	$69,163		$69,163				
17	$71,238		$71,238				
18	$73,375		$73,375				
19	$75,577		$75,577				
20	$77,844		$77,844				
21	$80,179		$80,179				
22	$82,585		$82,585				
23	$85,062		$85,062				
24	$87,614		$87,614				
25	$90,242		$90,242				
26							
27							
28							
29							
30							
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NPV			$4,649,350	$44,393			

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Centrifuge Solids Dewatering Facility

Does Your Project Include *Sludge Drying Beds* ?	**No**						
Construction Cost:						**$12,415,066**	
Annual O&M Cost:							
Power:		**Total HP**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		112	68%	8,760	$ 0.06	**$ 27,885**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		13,687	2.00	8,760	$ 0.06	**$ 13,405**	
Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Quantity (tons/year)**	**Unit Cost**	$ -	
Polymer		100%	68%	35	$ 3,544.77	**$ 85,135**	
Sludge Disposal:				**Average Annual Qty. (cy)**	**Unit Cost**	**Cost**	
Haul Sludge to Disposal Site				3,663	$ 8.09	$ 29,643	
Dumping Charge				3,663	$ 75.00	$ 274,734	
Total Disposal Cost						**$ 304,377**	
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 184,244**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				615,044	20.0%	**$ 123,009**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	

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Subtotal Annual O&M Cost						$	738,053
Contingency					20%	$	147,611
Total Annual O&M Cost						$	885,664

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$12,415,066		$12,415,066	
1	$912,234		$912,234	
2	$939,601		$939,601	
3	$967,789		$967,789	
4	$996,823		$996,823	
5	$1,026,727		$1,026,727	
6	$1,057,529		$1,057,529	
7	$1,089,255		$1,089,255	
8	$1,121,933		$1,121,933	
9	$1,155,591		$1,155,591	
10	$1,190,258		$1,190,258	
11	$1,225,966		$1,225,966	
12	$1,262,745		$1,262,745	
13	$1,300,627		$1,300,627	
14	$1,339,646		$1,339,646	
15	$1,379,836		$1,379,836	
16	$1,421,231		$1,421,231	
17	$1,463,868		$1,463,868	
18	$1,507,784		$1,507,784	
19	$1,553,017		$1,553,017	
20	$1,599,608		$1,599,608	
21	$1,647,596		$1,647,596	
22	$1,697,024		$1,697,024	
23	$1,747,934		$1,747,934	
24	$1,800,372		$1,800,372	
25	$1,854,384		$1,854,384	
26				
27				
28				
29				
30				
31				
32				
33				
34				
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37				
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49				
50				
NPV			$29,825,121	$912,234

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Wet Pit Submersible Pump Station

Construction Cost:						$2,008,749	
Annual O&M Cost:							
Power:		Total HP	Average-to-Maximum Flow Factor	Annual Usage (Hours / Year)	$/kWh	Power Cost	Annual Usage Hours / Year (Over-write)
Equipment Power		75	68%	8,760	$ 0.06	$ 18,673	
Other Electrical:		Building Area (SF)	Watts / SF	Annual Usage (Hours / Year)	$/kWh	Other Electrical Cost	Annual Usage Hours / Year (Over-write)
Building Electrical		1,381	2.00	8,760	$ 0.06	$ 1,353	
Chemicals:		Annual Usage (% of year)	Average-to-Maximum Flow Factor	Annual Usage (dry tons / year)	Cost ($/dry ton)	Chemical Cost	
Repair and Maintenance, and Replacement:					Replacement Included? (1 = "Yes", 0 = "No")	Annual Cost	
Maintenance & Repair Cost						$ 7,371	
Replacement Cost					-	$ -	
Other:				Total Annual O&M Cost	"Other" Percent	Other Cost	Other Cost Percent (Over-write)
Other Cost				$ 27,397	20.0%	$ 5,479	
User Defined Annual O&M Items:						Annual Cost	
Item 1						$ -	
Item 2						$ -	
Item 3						$ -	
Item 4						$ -	
Item 5						$ -	
Item 6						$ -	
Item 7						$ -	
Item 8						$ -	
Item 9						$ -	
Item 10						$ -	
Item 11						$ -	
Item 12						$ -	
Item 13						$ -	
Item 14						$ -	
Item 15						$ -	
Subtotal Annual O&M Cost						$ 32,876	
Contingency					20%	$ 6,575	
Total Annual O&M Cost						$ 39,451	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
0	$2,008,749		$2,008,749	
1	$40,635		$40,635	
2	$41,854		$41,854	
3	$43,109		$43,109	
4	$44,403		$44,403	
5	$45,735		$45,735	
6	$47,107		$47,107	
7	$48,520		$48,520	
8	$49,975		$49,975	
9	$51,475		$51,475	
10	$53,019		$53,019	

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11	$54,610		$54,610				
12	$56,248		$56,248				
13	$57,935		$57,935				
14	$59,673		$59,673				
15	$61,464		$61,464				
16	$63,307		$63,307				
17	$65,207		$65,207				
18	$67,163		$67,163				
19	$69,178		$69,178				
20	$71,253		$71,253				
21	$73,391		$73,391				
22	$75,592		$75,592				
23	$77,860		$77,860				
24	$80,196		$80,196				
25	$82,602		$82,602				
26							
27							
28							
29							
30							
31							
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50							
NPV			$2,784,264	$40,635			

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Pall Membrane Filtration - Large Systems: > 5 mgd

Construction Cost:						**$200,511,590**	
Annual O&M Cost:							
Power:		**Total HP (All Subsystems)**	**Average-to-Maximum Flow Factor**	**Annual Usage (Hours / Year)**	**$/kWh**	**Power Cost**	**Annual Usage Hours / Year (Over-write)**
Equipment Power		8,376	68%	8,760	$ 0.06	**$ 2,085,380**	
Other Electrical:		**Building Area (SF)**	**Watts / SF**	**Annual Usage (Hours / Year)**	**$/kWh**	**Other Electrical Cost**	**Annual Usage Hours / Year (Over-write)**
Building Electrical		93,848	2.00	8,760	$ 0.06	**$ 91,912**	
Chemicals:		**Annual Usage (% of year)**	**Average-to-Maximum Flow Factor**	**Annual Usage (dry tons / year)**	**Cost ($/dry ton)**	**Chemical Cost**	
Citric Acid		100%	68%	162.7	$ 3,204.91	$ 355,604	
Sodium Hydroxide		100%	68%	101.6	$ 1,222.48	$ 84,723	
Sodium Hypochlorite		100%	68%	115.1	$ 2,205.88	$ 173,042	
Sodium Bilsulfite		100%	68%	11.4	$ 1,336.98	$ 10,368	
Total Chemicals						**$ 623,738**	
Specialty Items:					**Number per Relacement**	**Cost**	
Membrane Elements					7,020	**$ 1,960,831**	
Input **Membrane Replacement Frequency** (yrs)	**7**	**Typically 5 to 10 years**					
Input **Membrane Module Cost**	**$ 2,500.00**						
Repair and Maintenance, and Replacement:					**Replacement Included? (1 = "Yes", 0 = "No")**	**Annual Cost**	
Maintenance & Repair Cost						**$ 3,741,085**	
Replacement Cost					-	**$ -**	
Other:				**Total Annual O&M Cost**	**"Other" Percent**	**Other Cost**	**Other Cost Percent (Over-write)**
Other Cost				$ 8,502,945	20.0%	**$ 1,700,589**	
User Defined Annual O&M Items:						**Annual Cost**	
Item 1						**$ -**	
Item 2						**$ -**	
Item 3						**$ -**	
Item 4						**$ -**	
Item 5						**$ -**	
Item 6						**$ -**	
Item 7						**$ -**	
Item 8						**$ -**	
Item 9						**$ -**	
Item 10						**$ -**	
Item 11						**$ -**	
Item 12						**$ -**	
Item 13						**$ -**	
Item 14						**$ -**	
Item 15						**$ -**	
Subtotal Annual O&M Cost						**$ 10,203,534**	
Contingency					**20%**	**$ 2,040,707**	
Total Annual O&M Cost						**$ 12,244,241**	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	25
Annual Inflation % =	3.00%

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Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost			
0	$200,511,590		$200,511,590				
1	$12,611,568		$12,611,568				
2	$12,989,916		$12,989,916				
3	$13,379,613		$13,379,613				
4	$13,781,001		$13,781,001				
5	$14,194,431		$14,194,431				
6	$14,620,264		$14,620,264				
7	$15,058,872		$15,058,872				
8	$15,510,638		$15,510,638				
9	$15,975,958		$15,975,958				
10	$16,455,236		$16,455,236				
11	$16,948,893		$16,948,893				
12	$17,457,360		$17,457,360				
13	$17,981,081		$17,981,081				
14	$18,520,513		$18,520,513				
15	$19,076,129		$19,076,129				
16	$19,648,413		$19,648,413				
17	$20,237,865		$20,237,865				
18	$20,845,001		$20,845,001				
19	$21,470,351		$21,470,351				
20	$22,114,462		$22,114,462				
21	$22,777,896		$22,777,896				
22	$23,461,232		$23,461,232				
23	$24,165,069		$24,165,069				
24	$24,890,021		$24,890,021				
25	$25,636,722		$25,636,722				
26							
27							
28							
29							
30							
31							
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50							
NPV			**$441,204,367**	**$12,611,568**			

Calculate Cost for Membrane Replacement:

Calculate **Current Cost of Membrane Replacement**	$17,550,000		**Membrane Replacement #**	**Year of Replacement**	**Cost of Membrane Replacement at Time of Replacement**	**Cost of Membrane Replacement at End of Life Cycle**	
Calculate **Number of Membrane Replacements (should be < = 10)**	3		1	7	$17,550,000	$42,236,168	
			2	14	$17,550,000	$30,016,456	
			3	21	$17,550,000	$21,332,135	
			4	0	$0	$0	
			5	0	$0	$0	
			6	0	$0	$0	
			7	0	$0	$0	
			8	0	$0	$0	
			9	0	$0	$0	
			10	0	$0	$0	
					Total	$93,584,758	
					Annualized Cost	**$1,960,831**	

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	A	B	C	D	E	F	G	H	I
1	***Global Life Cycle Data***								
2									
3									
4									
5	**Net Present Value Calculation Inputs:**								
6	Annual Discount Rate (i) :		5.00%						
7	Number of Years (n):		25	Valid Range: 1 to 50 years					
8	Annual Inflation Rate (%):		3.00%						
9									
10	**Annual O&M Cost Inputs:**								
11	Maximum Daily Plant Flow (mgd)		110.00						
12	Average Annual Daily Flow (mgd)		75.00						
13	Average-to-Maximum Flow Factor		68%						
14	**Power:**								
15	If Project in U.S., Select State Location:		OREGON		User Over-Ride				
16	Power Cost ($/kWh): (Note: "All-in" including usage, demand, TOU, and transmission charges)		$ 0.0559			Source for U.S. Power Costs	(Note: U.S. National Average is $0.0768/kW		
17	Facility Electrical (Watts/SF):		2.00						
18	**Fuel:**								
19	Natural Gas:		$ 3.50	$/MMBTU			(Note: Units are $/1,000,000 BTU)		
20	**Annual Plant Operating Usage**		Days per Year Used	Hour per Day Used	Annual Usage (hours / year)	Annual Usage (% of year)			
21	Annual Plant Operating Usage		365	24	8,760.00	100%			
22	**Maintenance, Repair, and Replacement Costs:**								
23	*Maintenance* and *Repair* Costs		Automatically Included						
24	Include *Replacement* Costs?		No						
25	**Chemical Costs:** *(Please check with your local Chemical vendor to verify the default unit costs shown CPES)*								
26	Liquid Chemicals:	Default Costs ($/dry ton)	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
27	Alum (48.5%)	$ 555.44		$ 555.44					
28	Aqueous Ammonia (29%)	$ 1,208.65		$ 1,208.65					
29	Ferric Chloride (40%)	$ 1,003.69		$ 1,003.69					
30	Hydrochloric Acid	$ 500.72		$ 500.72					
31	Hydrofluorosilicic Acid (18%)	$ 5,419.53		$ 5,419.53					
32	Hydrogen Peroxide (35%)	$ 2,223.22		$ 2,223.22					
33	Liquid Polymer	$ 3,544.77		$ 3,544.77					
34	Sodium Bilsulfite (40%)	$ 1,336.98		$ 1,336.98					
35	Sodium Hydroxide (25%)	$ 1,043.24		$ 1,043.24					
36	Sodium Hydroxide (50%)	$ 1,222.48		$ 1,222.48					
37	Sodium Hypochlorite (12.5%)	$ 2,205.88		$ 2,205.88					
38	Sulfuric Acid (93%)	$ 379.51		$ 379.51					
39	Other 1			$ -					
40	Other 2			$ -					
41	Other 3			$ -					
42	Other 4			$ -					
43	Liquid Chlorine	$ 128.20		$ 128.20					
44	Purate	$ 923.01		$ 923.01	Purate cost ranges from $150/ton for bulk delivery to $720/ton for totes.				
45	CO2	$ 165.21		$ 165.21					
46									
47	Dry Chemicals:	Default Costs ($/dry ton)	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
48	Powdered Activated Carbon	$ 1,441.81		$ 1,441.81					
49	Calcium Hydroxide	$ 345.23		$ 345.23					
50	Sodium Bicarbonate	$ 777.73		$ 777.73					
51	Sodium Carbonate	$ 364.09		$ 364.09					
52	Polymer	$ 5,478.26		$ 5,478.26					
53	Potassium Permanganate	$ 5,419.17		$ 5,419.17					
54	Ammonium Sulfate	$ 2,574.66		$ 2,574.66					
55	Bayoxide (SORB33)	$ 287.40		$ 287.40					
56	Other 1			$ -					
57	Other 2			$ -					
58									
59	Specialty Chemicals:	Default Costs ($/dry ton)	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
60	Liquid Oxygen	$ 126.22		$ 126.22					
61	GAC	$ 3,251.28		$ 3,251.28					
62	Sand	$ 181.61		$ 181.61					
63	IX TEA	$ 5,451.98		$ 5,451.98					
64	IX TPA	$ 8,505.08		$ 8,505.08					
65	IX Bifunctional	$ 54,519.77		$ 54,519.77					
66	Citric Acid	$ 3,204.91		$ 3,204.91					
67	Trisodium Phosphate	$ 3,461.31		$ 3,461.31					
68	Scale Inhibitor	$ 5,640.65		$ 5,640.65					
69	Sodium Tripolyphosphate	$ 3,974.09		$ 3,974.09					
70	Sodium EDTA	$ 1,752.52		$ 1,752.52					
71	Salt	$ 152.86		$ 152.86					
72	Resin ($/Gal for MIEX model)	$ 60.39		$ 60.39					
73									
74	Specialty Chemicals:	Default Costs	User Over-Ride	Cost Used in Life Cycle Cost Analysis					
75	GFH ($/ton)	$ 25,014.11		$ 25,014.11					

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	A	B	C	D
76	Sybron Chemicals Inc., IONAC A-554 Strongly Basin Anion Ion Exchange Resin ($/cf)	$ 302.25		$ 302.25
77	**Membranes:**	**Default Cost ($/ea)**	**User Over-Ride**	**Cost Used in Life Cycle Cost Analysis**
78	**Pressure:**			
79	Memcor CP - L10	$ 1,276.60		$ 1,276.60
80	Memcor CP - L20	$ 1,276.60		$ 1,276.60
81	Norit	$ 2,102.64		$ 2,102.64
82	Pall - 48 Module Rack	$ 1,538.36		$ 1,538.36
83	Pall - 80 Module Rack	$ 1,538.36		$ 1,538.36
84	**Submerged:**			
85	Memcor CS	$ 938.68		$ 938.68
86	Zenon 1000	$ 1,089.67		$ 1,089.67
87	Zenon 500	$ 1,353.20		$ 1,353.20
88	**SWRO & BWRO:**			
89	Process Cartridge Filter Replacements	$ 16.52		$ 16.52
90	CIP Filter Replacements	$ 16.52		$ 16.52
91				
92	**Solids:**			
93	**Biosolids:**			
94	Biosolids Reuse or Disposal Technology	End-Use Technology Code		
95	1 = Class A - Composting (static pile, invessel, air dry)	1		
96	2 = Class A - Alkaline Stabilization			
97	3 = Class A - ATAD, TPAAD Advanced Digestion			
98	4 = Class A - Thermal Drying			
99	5 = Class B - Land Application (digested)			
100	6 = Class B - Land Application (alkaline stabilized)			
101	7 = Class B - Land Reclamation (alkaline stabilized)			
102	8 = Disposal - Landfill or Monofill			
103	9 = Disposal - Incineration			
104	Biosolids Unit Cost ($/US Dry Ton)	$ 250.00		
105	Percent Solids	80%		
106	Biosolids *CALCULATED* Unit Cost ($/WT)	$ 200.00		
107	Biosolids *USER OVER-RIDE* Unit Cost ($/WT)			
108	Biosolids Unit Cost Used in CPES ($/WT)	$ 200.00	1 = Class A - Composting (static pile, invessel, air dry)	
109	Haul Distance from Plant (Miles, Round Trip)	20		
110	Haulage *USER OVER-RIDE* Unit Cost ($/WT/mile)			
111	Haulage Cost ($/WT)	$ 2.40	Default haulage cost is $0.12/US wet tonne/mile	
112	**Trash Disposal:**			
113	Haul Distance from Plant (Miles, Round Trip)		20	
114	Disposal Cost ($/cy)		$ 75.00	Typical Range: $50 - $175 / CY
115	Haul Cost ($/cy)		$ 8.09	
116	**Other Costs:**			
117	O&M Other Costs: Percent for Misc Annual Costs:		20.0%	Includes vehicles, lab tests, office equipment other required misc expenses, default of 20% from OM
118	**O&M Cost Contingency:**			
119	O&M Cost Contingency		20.0%	
120				
121	**Overall Plant Labor:**			
122	Labor Calculation Method	User Defined		
123				
124				
125				
126				
127				
128				
129				
130	**Overall Plant Labor:**			

131	Supervisory Staff	Work Shift Scheme	User Defined Number of Personnel	User Defined Hours / Week	User Defined Weeks/Year	Hours / Year	Hourly Rate (Including Fringe Benefits)	Yearly Cost
132	Superintendent	1 8 hr shift 5 days per week		40	52	2,080	$ 50.00	$ 104,000
133	Assistant Superintendent	User Defined	0	40	52	-	$ 40.00	$ -
134	Plant Operator 1	2 Operators onsite at all times	0	40	52	17,520	$ 30.00	$ 525,600
135	Plant Operator 2	User Defined	0	40	52	-	$ 30.00	$ -
136	Plant Operator 3	User Defined	0	40	52	-	$ 30.00	$ -
137	Plant Maintenance Worker 1	1 8 hr shift 5 days per week	0	40	52	2,080	$ 25.00	$ 52,000
138	Plant Maintenance Worker 2	User Defined	0	40	52	-	$ 25.00	$ -
139	Plant Maintenance Worker 3	User Defined	0	40	52	-	$ 25.00	$ -
140	Clerical Worker	1 8 hr shift 5 days per week	0	40	52	2,080	$ 25.00	$ 52,000
141	Lab Technician	1 8 hr shift 5 days per week	0	40	52	2,080	$ 25.00	$ 52,000
142	Other		0	40	52	-	$ 25.00	$ -
143	Other		0	40	52	-	$ 25.00	$ -
144	Staff	User Defined	0	40	52	-	$ 25.00	$ -
145	Subtotal - Annual Labor Cost					25,840		$ 785,600
146	Contingency						20%	$ 157,120
147	TOTAL - Annual Labor Cost					25,840	$ 36.48	$ 942,720
148								
149	**LABOR Net Present Value (NPV) Calculation:**							
150								
151	i =	5%						
152	n =	25						
153	**Annual Inflation % =**	3.00%						
154								

155	Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O&M Cost
156	0	$0		$0	
157	1	$971,002		$971,002	
158	2	$1,000,132		$1,000,132	
159	3	$1,030,136		$1,030,136	
160	4	$1,061,040		$1,061,040	
161	5	$1,092,871		$1,092,871	

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	A	B	C	D	E	F	G	H	I
162	6	$1,125,657		$1,125,657					
163	7	$1,159,427		$1,159,427					
164	8	$1,194,209		$1,194,209					
165	9	$1,230,036		$1,230,036					
166	10	$1,266,937		$1,266,937					
167	11	$1,304,945		$1,304,945					
168	12	$1,344,093		$1,344,093					
169	13	$1,384,416		$1,384,416					
170	14	$1,425,949		$1,425,949					
171	15	$1,468,727		$1,468,727					
172	16	$1,512,789		$1,512,789					
173	17	$1,558,173		$1,558,173					
174	18	$1,604,918		$1,604,918					
175	19	$1,653,065		$1,653,065					
176	20	$1,702,657		$1,702,657					
177	21	$1,753,737		$1,753,737					
178	22	$1,806,349		$1,806,349					
179	23	$1,860,539		$1,860,539					
180	24	$1,916,356		$1,916,356					
181	25	$1,973,846		$1,973,846					
182	26								
183	27								
184	28								
185	29								
186	30								
187	31								
188	32								
189	33								
190	34								
191	35								
192	36								
193	37								
194	38								
195	39								
196	40								
197	41								
198	42								
199	43								
200	44								
201	45								
202	46								
203	47								
204	48								
205	49								
206	50								
207	NPV			$18,531,642	$971,002				

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ENVIRONMENTAL IMPACT CALCULATOR

Does your project span multiple U.S. states?	No	
	eGrid Region	Select state applicable to your project State
Select eGrid Region or State Where Electricity is Purchased	NWPP	OREGON
Region Name	WECC Northwest	Override
CO2 Emissions (lbs/MWh)[1]	842.58	
N2O Emissions (lbs/MWh)[1]	0.02	
CH4 Emissions (lbs/MWh)[1]	0.01	

Power Summary

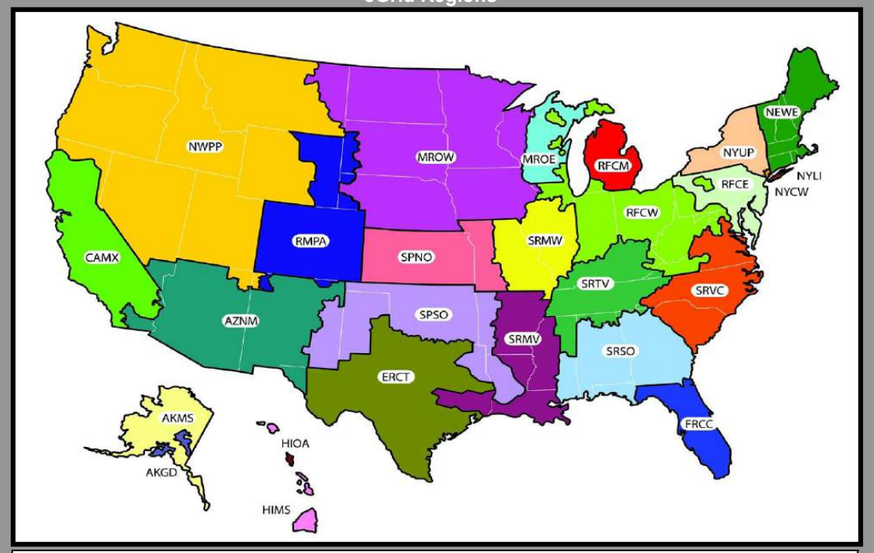
		Override
Total Horsepower (hp)	9,832.75	
Total Area of All Buildings (sf)	139,766.50	
Average to Maximum Flow Factor (%)	0.68	
Annual Plant Operating Hours (hr)	8,760.00	
Calculate Total Electricity Consumption (MWh/yr)	46,945.44	
Calculate Annual Emissions from Electricity Consumption (tons CO2/yr)	19,777.65	
Calculate Annual Emissions from Electricity Consumption (tons N20/yr)	0.38	
Convert N2O Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	112.27	
Calculate Annual Emissions from Electricity Consumption (tons CH4/yr)	0.31	
Convert CH4 Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	10.43	
Calculate Annual Emissions From Electrical Usage (tons CO2e/yr)	19,900.34	

1. U.S. Environmental Protection Agency. eGrid Ninth ed. 2010 data. Released 2/24/2014.Available: http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

Energy Price Summary

		Override
State Where Electricity is Purchased	OREGON	Override Options
Average Electrical Price (USD/kWh)[2]	$ 0.0559	0
Estimated Electrical Cost per Day (USD $)	$ 7,185	

eGrid Regions



2. U.S Energy Information Administration, Average Retail Price of Electricity to Ultimate Customers By End-Use, State, and Provider 2012. Released 11/8/2013. Available: http://www.eia.gov/electricity/data.cfm#sales

File Version: 9/21/2017

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Chemical Summary

If using either of these chemicals, input additional information in cells bx10 and by10

	Sodium Hypochlorite	Alum	Ferric Chloride	Sulfuric Acid	Hydrofluorosilicic Acid	Sodium Hydroxide	Aqueous Ammonia	Liquid Polymer	Hydrogen Peroxide	Sodium Bisulfite	Powdered Activated Carbon	Calcium Hydroxide	Sodium Bicarbonate	Sodium Carbonate	Potassium Permanganate	Ammonium Sulfate	Other 1	Other 2	Liquid Oxygen	GAC	Sand	Citric Acid	Trisodium Phosphate	Sodium Tripolyphosphate	Sodium EDTA	Salt	Purafa	GFH / Resin Replacements (cf/yr)	CO2	Scale Inhibitor	Hydrochloric Acid	Other Liquid CIP Chem1	Other Liquid CIP Chem2	Other Dry Chem CIP 1	Other Pretreat Chem 1	Other Pretreat Chem 2
Total Chemical Usage (dry tons/yr)	115.05	1,926.64	0.00	0.00	0.00	101.65	0.00	242.36	0.00	11.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	162.74	0.00	0.00	0.00	731.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calculate Annual Emissions from Chemical Production (tons CO2)	122.53	531.75				139.86		504.59		11.37												162.74				16.16										
Chemical Delivery Vehicle Type	Tanker	Tanker				Tanker		Tanker		Tanker												Tanker				Tanker										
Size of Chemical Delivery (lbs/load)	40,000.00	40,000.00				40,000.00		40,000.00		40,000.00												40,000.00				40,000.00										
If Using Totes, Drums, or Supersacks, Input Number Per Delivery																																				
Calculate Number of Deliveries per year	46.00	199.00				10.00		12.00		1.00												1.00				37.00										
Transportation Distance for Delivery (Miles/Delivery)	50.0	50.0				50.0		50.0		50.0												50.0				50.0										
Calculate Total Miles Traveled by Delivery Vehicles	4,600.00	19,900.00				1,000.00		1,200.00		100.00												100.00				3,700.00										
Delivery Vehicle Fuel Economy (mpg)	8.90	8.90				8.90		8.90		8.90												8.90				8.90										
Emissions for Transportation (tons CO2/gal)	0.01	0.01				0.01		0.01		0.01												0.01				0.01										
Calculate Annual Emissions for Transportation (tons CO2/yr)	5.67	24.55				1.23		1.48		0.12												0.12				4.56										
Emissions for Transportation (tons N2O/mile)	0.00	0.00				0.00		0.00		0.00												0.00				0.00										
Emissions for Transportation (tons CH4/mile)	0.00	0.00				0.00		0.00		0.00												0.00				0.00										
Convert N2O Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	0.09	0.41				0.02		0.02		0.00												0.00				0.08										
Convert CH4 Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	0.01	0.02				0.00		0.00		0.00												0.00				0.00										
Calculate Annual Emissions from Chemical Transportation (tons CO2)	5.67	24.55				1.23		1.48		0.12												0.12				4.56										
Calculate Total Annual Emissions from Chemical Usage (tons CO2)	128.21	556.30				141.10		506.07		11.50												162.86				20.72										

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	Sodium Hypochlorite	Alum	Ferric Chloride	Sulfuric Acid	Hydrofluorosilicic Acid	Sodium Hydroxide	Aqueous Ammonia	Liquid Polymer	Hydrogen Peroxide	Sodium Bisulfite	Powdered Activated Carbon	Calcium Hydroxide	Sodium Bicarbonate	Sodium Carbonate	Potassium Permanganate	Ammonium Sulfate	Other 1	Other 2	Liquid Oxygen	GAC	Sand	Citric Acid	Trisodium Phosphate	Sodium Tripolyphosphate	Sodium EDTA	Number of Membrane Elements	Cartridge Replacements	Sludge (cy/year)	Liquid Chlorine Cylinders	Salt	Purate	Lamps	Ballasts	Sleeves	Intensity Sensors	SFPT Resin Replacements	CO2	Membrane Type	Scale Inhibitor	CIP Cartridge	Hydrochloric Acid	Other Liquid CIP Chem1	Other Liquid CIP Chem2	Other Dry Chem CIP 1	Other Pretreat Chem 1	Other Pretreat Chem 2
Wet Density (lbs/gal)	10.0914	11.1756	11.9262	15.2622	10.0914	12.8436	7.7562	9.174	9.4242	10.842												13.8444									11.43						6.43		9.17		3.67					
% Active Chemical	0.125	0.485	0.4	0.93	0.18	0.5	0.19	1	0.35	0.4									1												1						1		1		0.37					
Dry Density (lbs/cf)											35	30	60	65	100	60				28	99		60	60	54					80																

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Construction Summary

	Concrete (cy)	Excavation (cy)	Structural Backfill (cy)	Native Backfill (cy)	Haul Excess (cy)	Steel Process Piping (lbs)	Iron Process Piping (lbs)
Total Quantity Used	42,701.61	232,540.85	26,948.14	51,720.29	180,820.57	735,381.81	97,892.97
Input Load Factor		Low	Low	Low			
Calculate Gallons of Diesel Consumed based on Quantity Used (gal)		5,038.81	583.93	1,120.70			
Calculate CO2 Emissions based on Consumption (tons CO2)		55.80	6.47	12.41			
Calculate CH4 Emissions based on Consumption (tons CH4)		0.01	0.00	0.00			
Calculate N2O Emissions based on Consumption (tons N2O)		0.00	0.00	0.00			
Convert CH4 Into CO2 Equivalents for Emissions (tons CO2e)		0.16	0.02	0.04			
Convert N2O Into CO2 Equivalents for Emissions (tons CO2e)		0.17	0.02	0.04			
Calculate Emissions from Construction Quantities (tons CO2e)	1,601.31	56.14	6.51	12.49		1,904.64	94.47
Select Vehicle Capacity (cy)	7.85	10.00	10.00	10.00	10.00	40,000.00	40,000.00
Calculate Number of Vehicle Trips per year	5,442.00	23,255.00	2,695.00	5,173.00	18,083.00	19.00	3.00
Input Transportation Distance for Delivery (Miles/Delivery)	50.00	20.00	20.00	20.00	20.00	20.00	20.00
Calculate Total Miles Traveled by Construction Vehicles	272,100.00	465,100.00	53,900.00	103,460.00	361,660.00	380.00	60.00
Vehicle Fuel Economy (mpg)	8.90	8.90	8.90	8.90	8.90	8.90	8.90
Emissions for Transportation (tons CO2/gal)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Calculate Emissions for Transportation (tons CO2)	335.66	573.75	66.49	127.63	446.14	0.47	0.07
Emissions for Transportation (tons N2O/mile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions for Transportation (tons CH4/mile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Convert N2O Into CO2 Equivalents for Emissions (tons CO2e)	5.58	9.53	1.10	2.12	7.41	0.01	0.00
Convert CH4 Into CO2 Equivalents for Emissions (tons CO2e)	0.31	0.54	0.06	0.12	0.42	0.00	0.00
Calculate Total Emissions from Transportation (tons CO2e)	341.55	583.81	67.66	129.87	453.97	0.48	0.08
Calculate Total Emissions from Construction Quantities (tons CO2e)	1,942.86	639.95	74.16	142.35	453.97	1,905.12	94.54

Load factor guide for excavation and backfill:

High - Most pipeline applications in hard rocky material. Digging 90-95% of the daily work schedule

Medium - Most residential sewer applications in natural bed clay. Digging 60-85% of the daily work schedule. Most log loading applications.

Low - Most utility, urban applications in sandy loam. Digging less than 50% of daily work schedule. Scrap handling applications.

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WTP Solids Summary

Solids Handling Emissions from WTP sludge

	Sludge (cy/year)	
Are the Solids Produced in a WTP or WWTP?	**WTP**	
Quantity of Sludge Produced Annually (cy/yr)	3,663.12	
Input % Dry Solids in Dewatered Sludge	**20.00%**	***Typically 15 to 25%.***
Weight of Sludge (lbs/cy)	1,901.43	***Assumption:*** Density of dried solids of 145 lb/cf.
Vehicle Hauling Capacity (cy)	**10.00**	
Calculate Number of Hauls per year	366.31	
Transportation Distance for Hauling (Miles/Delivery)	**20.00**	
Calculate Total Miles Traveled by Hauling Vehicles	14,652.47	
Hauling Vehicle Fuel Economy (mpg)	8.90	
Emissions for Transportation (tons CO2/ gal)	0.01	
Calculate Annual Emissions for Transportation (tons CO2/yr)	18.08	
Emissions for Transportation (tons N2O/ mile)	0.00	
Emissions for Transportation (tons CH4/ mile)	0.00	
Convert N2O Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	0.30	
Convert CH4 Into CO2 Equivalents for Annual Emissions (tons CO2e/yr)	0.02	
Calculate Annual Emissions from Solids Transportation (tons CO2)	18.39	

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Supporting Documents

Preliminary Geotechnical Study
The purpose of this study was to assist with the site evaluation and suitability of Carpenter Lane for future development by performing a preliminary geotechnical evaluation of the site. This report summarizes RhinoOne Geotechnical's field exploration, laboratory testing, preliminary geotechnical engineering analysis and design criteria recommended to be used during development of the proposed project.

Carpenter lane Site Evaluation
The purpose of this study was to provide a multi-disciplinary site assessment of the Carpenter Lane site and to identify the feasibility of redeveloping it. The objectives of this site evaluation were to research, identify, and document the existing site conditions and perform a general site investigation, cultural resource assessment, and environmental investigations of the site. This included on-site and desktop review for Phase I environmental site assessment, endangered species assessment, and wetland delineation for the purpose of identifying environmental permits that may be required to develop the site and estimated permitting schedule.

Preliminary Geotechnical Study

Preliminary Geotechnical Study

Portland Water Bureau – Filtration Plant Design Support
Site at SE Carpenter Lane and SE Dodge Park Boulevard
Gresham, Oregon

Prepared for:
HDR, Inc.
Attn: Mr. Andy McCaskill, PE
Oregon Water Business Group Manager
1001 SW 5th Avenue, Suite 1800
Portland, Oregon 97204

July 19, 2018
Project No. HDR-2018-008

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Appendix A – Figures

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Figure 2 Site Exploration Plan
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Appendix B – Summary Logs

Summary Boring Logs and Test Pit Logs
Results of Laboratory Testing

1.0 INTRODUCTION

The City of Portland Water Bureau (PWB) is in the process of planning significant upgrades to its water supply system. This includes the implementation of a filtration treatment plant. One of the more suitable sites the Filtration Plant may be located is an approximately 93.5 acre site at the eastern dead-end of SE Carpenter Lane near SE Dodge Park Boulevard outside Gresham, Oregon. This report presents the results of Rhino One Geotechnical's (ROG) preliminary geotechnical engineering study for the Carpenter Lane site and supports the site selection process for the proposed PWB Bull Run Filtration project. A Site Plan is provided on Figure 1 of Appendix A.

The purpose of this study is to assist with the site selection and suitability of this site for future development. This report provides a summary of our field exploration, laboratory testing, preliminary geotechnical engineering analysis and design criteria to be used during the development of the proposed project.

2.0 SITE CONDITIONS

Site geology and subsurface conditions for the site were evaluated based on a review of geologic and hazard mapping reports, site reconnaissance, previous subsurface explorations, and explorations conducted for this study. Geologic mapping of the site was evaluated by an Oregon Certified Engineering Geologist (CEG). Figure 2 of Appendix A, Site Exploration Plan, shows the project site with the approximate location of our borings and test pits completed for this study.

Geologic Mapping

The site is located just west of the Sandy River drainage near the foothills of the Cascade Mountains. The site is located on Ancient River Rock deposits between Boring Lava basalt flows to the west and the foothills of the Cascade Mountain Range to the east. The site is approximately 600 feet above the Sandy River. An ancient river terrace is located roughly 300 feet down the steep valley walls just east of the site, before dropping down another 300 feet to the current Sandy River floodplain. The area is part of the larger Puget Sound-Willamette Valley physiographic province, a tectonically active lowland situated between the Coast Range to the west and the Cascade Mountains to the east (Orr and Orr, 1999)[1].

The Ancient River Rock unit consists of sandstones, siltstones and conglomerates created from sediment deposits from ancient rivers which flowed through the region. Basement rock in the vicinity of the site are similar to those exposed in the adjacent Boring Lavas and foothills of the Cascade Mountains, which primarily consist of the Miocene (20 million to 10 million years before present) Columbia River Basalt Group (CRBG). The CRBG consists of thick flows of basalt which have been folded and faulted from the compressional tectonics of the region.

Field Explorations

The subsurface exploration program consisted of drilling three (3) borings and excavating nine (9) test pits. The borings were drilled using a truck-mounted drill rig operated by Western States Soil Conservation, Inc. of Hubbard, Oregon on February 19 and 20, 2018. Borings (B-1 to B-3) were drilled at the approximate locations shown on the Site Exploration Plan (Figure 2). The borings were advanced using mud-rotary drilling techniques and were drilled to depths between 51.5 and 100.2 feet below ground surface (BGS). Standard Penetration Test (SPT) soil samples were obtained at regular 5-foot intervals to a depth of 100 feet using a 140-pound Automatic Hammer. Uncorrected blow counts from the SPT sampling are reported on the boring logs. Corrected blow counts [$(N1)_{60}$] were used for our analysis unless otherwise noted.

[1] Orr, E.L. and Orr, W.N. (1999). *Geology of Oregon*. Kendall/Hunt Publishing, Iowa. Page 254.

The test pits were excavated using an extended-reach backhoe operated by Dan J. Fischer Excavating Inc. of North Plains, Oregon on February 23, 2018. The test pits (TP-1 to TP-9) were excavated at the approximate locations shown on the Site Exploration Plan (Figure 2). The test pits were excavated using a 24-inch wide bucket and were each excavated to a depth of 11 feet BGS. Bulk soil samples were obtained at periodic intervals from the excavated materials. A pocket penetrometer was used intermittently in order to estimate the unconfined compressive strength of the soil. The pocket penetrometer (PP) readings are reported on the test pit logs.

The subsurface materials encountered were logged and field classified in general accordance with the Manual-Visual Classification Method (American Society for Testing and Materials (ASTM) D 2488). The SPT samples were collected at desired depths and packaged in moisture-tight bags. The soil samples were reviewed in the laboratory in order to supplement field classifications. Interpreted boring logs and test pit logs are presented in Appendix B.

Subsurface Conditions

The site is currently an operating commercial plant and tree nursery. The site is generally flat to rolling with a slight knoll located near the existing water tanks at the south-center of the property. A dirt/gravel road network provides access to the site for all-terrain vehicles. Adjacent to the property, the land slopes gently to the west and south. However, the approximate 2100-feet long northeast facing property line lies at the top of a steep slope dropping approximately 300 feet down to SE Dodge Park Boulevard over a horizontal distance of approximately 200 feet.

Topsoil was encountered in each of the borings and test pits to depths ranging between 1.5 to 2 feet BGS. The topsoil consists of very soft to stiff silty clay with some sand. This is the till zone for the nursery. The topsoil is underlain by red-brown to brown silty clay with trace fine sand to sandy silt with clay (alluvium) to depths between 21 to 40 feet BGS. The clay is generally medium stiff to stiff with medium to high plasticity, while the silt is generally soft and interbedded with clay. Sands with silts (decomposed sedimentary rocks) were observed below the clay and silt layers to the maximum depth explored of 100.2 feet BGS. The sands are arranged in layers of silty sand to sands with silt and are generally loose to very dense with increasing density with depth. Between depths of 65 feet and 75 feet BGS, the sands are described as relict coarse sands and gravel. Below a depth of 75 feet, the sands are described as decomposed conglomerate.

Groundwater

Information provided by the US Geological Survey (USGS) *Estimated Depth to Groundwater Study of the Portland Metro Area*[2], along with a review of existing well logs and previous geotechnical investigations in the area, indicate the groundwater table is most likely at a depth of greater than 150-feet. Perched groundwater was observed in each of the borings at depths between 25 feet and 33 feet BGS. Seepage was also observed in TP-2 and TP-4 between depths of 6.5 to 8 feet.

[2] US Geological Survey (USGS). *Estimated Depth to Ground Water in the Portland, Oregon Area*. Accessed from website http://or.water.usgs.gov/projs_dir/puz/ on March 22, 2018.

Laboratory Testing

Laboratory tests were conducted on selected soil samples in accordance with standard ASTM methods. The tests conducted include:

- Natural moisture content of selected samples obtained from the borings in general accordance with guidelines presented in ASTM D2216.
- Atterberg Limits of selected samples obtained from the borings in general accordance with guidelines presented in ASTM D4318.
- Grain Size analysis of selected samples obtained from the borings in general accordance with guidelines presented in ASTM D1140.

The results of these tests are presented on the boring and test pit logs and in Appendix B. The following table summarizes pertinent laboratory tests.

Table 1 Laboratory Test Results

Boring Number and Depth (feet)	Percent Silt and Clay (< #200 Sieve)	Atterberg Limits
B-2 at 5 – 6.5	89.5	
B-2 at 10 – 11.5	91.8	Liquid Limit = 49.3 Plastic Limit = 27.8 Plasticity Index = 22
B-2 at 15 – 16.5	98.0	
B-2 at 20 – 21.5	97.7	Liquid Limit = 50.8 Plastic Limit = 29.3 Plasticity Index = 22
B-2 at 25 – 26.5	95.7	
B-2 at 30 – 31.5	96.2	Liquid Limit = 58.0 Plastic Limit = 27.7 Plasticity Index = 30
B-2 at 35 – 36.5	74.1	
B-2 at 50 – 51.5	26.8	
B-2 at 55 – 56.5	53.9	Liquid Limit = 38 Plastic Limit = 29.7 Plasticity Index = 8
B-2 at 60 – 61.5	53.7	
B-2 at 70 – 71.5	28.8	
B-2 at 80 – 81.5	29.1	
B-2 at 90 – 91.5	29.0	

3.0 DISCUSSION

The explored site is one of the proposed sites for the construction of a new Water Filtration Plant. At this point, PWB has not selected a preferred site or the location of facilities on the selected sites. We understand that the major work items for the proposed project may consists of a water Filtration Plant, two- or more water reservoirs and water conveyance pipelines in and out of the plant. Other miscellaneous support structures may also be required. The water reservoirs would be approximately 12- to 15- million gallon and will most likely be located underground. These reservoirs will have a width and length of 300- to 400- feet with a depth of 15- to 20- feet. We have provided general recommendations on the following pages. Please note that these recommendations will need to be modified with better subsurface characterization and analysis when the site is selected and the type and location of the facilities are better defined.

American Society of Civil Engineers (ASCE) 7-10 Seismic Design Criteria and Seismic Hazards

The Filtration Plant qualifies as an "Essential Facility" in accordance with ORS 455.447. PWB will decide the seismic resiliency level required for this Filtration Plant. This section provides the basic seismic design criteria in accordance with the 2014 Oregon Structural Specialty Code (2014 OSSC) which is based on the 2012 International Building Code (2012 IBC). The seismic design parameters in accordance with ASCE 7-10 are summarized in the Table below.

Table 2 ASCE 7-10 (2012 IBC) Seismic Design Parameters

	Short Period	1 Second
Maximum Credible Earthquake Spectral Acceleration (g)	S_s = 0.802	S_1 = 0.346
Site Class	E	
Site Coefficient	F_a = 1.138	F_v = 2.618
Adjusted Spectral Acceleration (g)	S_{MS} = 0.912	S_{M1} = 0.905
Design Spectral Response Acceleration Parameters (g)	S_{DS} = 0.608	S_{D1} = 0.603
Mapped PGA (g)	0.339	
F_{PGA}	1.084	
PGA_M (g)	0.367	

Liquefaction

A liquefaction analysis was completed using the mapped value of peak ground acceleration (PGA) adjusted for site effects, PGA_M of 0.367g. Groundwater was assumed at 25 feet BGS. The on-site soils show low to moderate liquefaction potential. This is in the zone between 25 to 45 feet where very loose to loose sands were encountered in boring B-1. The associated vertical settlements were calculated to be on the order of 2- to 6- inches. More refined testing and analysis should be performed during the design stage of the project.

Slope Stability Analysis / Lateral Spreading

The site is generally flat to rolling with a slight knoll located near the existing water tanks at the south-center of the property. Adjacent to the property, the land slopes gently to the west and south. However, the approximate 2100-feet long northeast facing property line lies at the top of a steep slope dropping approximately 300 feet down to SE Dodge Park Boulevard over a horizontal distance of approximately 200 feet. This is the slopes along which the pipelines will ingress and egress the site. Oregon's Department of Geology and Mineral Industries (DOGAMI) has mapped numerous landslides on this slope. The mapped landslides are located both below Dodge Park Blvd and crossing Dodge Park Blvd. The pipeline should be designed assuming it is within an active slope. Detailed subsurface characterization and analysis will be required along this slope to evaluate global slope stability and lateral spreading. The factors of safety are generally recommended to be 1.5 and 1.1 under static and seismic loading conditions, respectively.

For the rest of the site, slope stability and lateral spreading risks are low. The impacts of liquefaction will therefore primarily be vertical settlement and loss of support during a design seismic event. If these are a concern, we recommend that consideration should be given to support the structures on deep foundations.

Soil Profile

Based on the three borings advanced during this study, we developed a preliminary subsurface profile that can be used for preliminary geotechnical analysis. The upper layer is red-brown to

brown silty clay with trace fine sand to sandy silt with clay (alluvium) to depths between 21 to 40 feet BGS. The clay is generally medium stiff to stiff with medium to high plasticity, while the silt is generally soft and interbedded with clay. Sands with silts (decomposed sedimentary rocks) were observed below the clay and silt layers to the maximum depth explored of 100.2 feet BGS. The sands are arranged in layers of silty sand to sands with silt and are generally loose to very dense with increasing density with depth. Between depths of 65 feet and 75 feet BGS, the sands are described as relict coarse sands and gravel. Below a depth of 75 feet, the sands are described as decomposed conglomerate. Our interpreted soil profile is provided in Table 3 below:

Table 3 Preliminary Recommended Soil Parameters

Depth (feet)	Soil	Average $(N1)_{60}$	Total Unit Weight (pcf)	Angle of Internal Friction (degree)	Undrained Cohesion (psf)
0 - 10	Medium Stiff to stiff silty Clay	9	115	-	1,000
10 - 25	Stiff Clay	13	115	-	1,250
25 - 45	Loose to Medium Dense Sand/soft sandy Silt	3 to 22	115	28	250
45 -55	Dense Sand	30	130	38	-
55 - 71	Loose to medium Dense silty Sand	10	115	32	250
71 -75	Medium Dense Sand	15	115	35	-
75 - 100	Very Dense silty Sand with gravel	>50	135	40	-
This profile is based on three widely scattered borings across the site. Additional borings will be required at each structure to evaluate site-specific soil profiles					

Preliminary geotechnical design recommendations for shallow foundations, deep foundation, and temporary shoring are provided in Section 4 of the report.

4.0 PRELIMINARY GEOTECHNICAL DESIGN RECOMMENDATIONS

Spread Footings

Isolated spread/mat footings should be at least 24 inches wide, and the bottom of footings should be at least 24 inches below the lowest adjacent exterior grade.

An 8-inch thick layer of granular material should be installed on the footing subgrade to prevent disturbance since soft soils are present at the subgrade. Footings bearing on the 8 inch granular pad placed on firm subgrade should be sized for an allowable bearing capacity of 2,000 pounds per square foot (psf). This is a net bearing pressure. The weight of the footing and overlying backfill can be disregarded in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term-live loads and may be increased by one-third for short-term loads, such as those resulting from wind or seismic forces.

Based on our analysis, total post-construction settlement was calculated to be less than 1 inch, with post construction differential settlement of less than 0.5 inch over a 20-foot span, for maximum column and perimeter footing loads of less than 100 kips and 5 kips per linear foot. Please note that the preliminary analysis indicates that soils below the groundwater table are susceptible to liquefaction. Post-liquefaction settlements are discussed above. It is likely that structures founded on these shallow footing may be damaged during the design seismic event.

Lateral loads on footings can be resisted by passive earth pressure on the sides of the structures and by friction at the base of the footings. A nominal passive earth pressure of 300 pounds per cubic foot (pcf) may be used for footings confined by the existing structural fills. Adjacent floor slabs, pavements, or the upper 12-inch depth of adjacent unpaved areas should not be considered when calculating passive resistance. For footings in contact with native soils or fill, use a coefficient of friction equal to 0.45 when calculating resistance to sliding. These numbers do not include a factor of safety.

Deep Foundation Recommendations:

As discussed above, there is a potentially liquefiable layer between the depths of 25 to 45 feet. The associated post-liquefaction settlements are on the order of 2- to 6- inches. This liquefaction potential should be confirmed by further exploration and testing once the project footprint is established. Deep foundations like driven pipe piles, H-piles or drilled auger cast piles can be used to support the proposed structures. The preliminary capacities of these piles can be determined using the soil profile provided in Table 3. The capacities of these piles should be developed below the depth of liquefaction which is calculated to be 45 feet. Pile capacities will be evaluated later as the design moves further.

Retaining Wall Design Recommendations

It is possible that retaining walls will be required for the underground structures. These walls would be on the order of 10- to 20- feet deep. Our retaining wall design recommendations are based on the following assumptions: (1) the walls consist of conventional, cantilevered retaining walls; (2) the walls are less than 20 feet in height; (3) the backfill is drained; and (4) the backfill has a slope flatter than 4H: 1V. Review of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

Unrestrained site walls which retain native soils should be designed to resist active fluid unit weight of 40 pounds per cubic foot (pcf) where supporting slopes are flatter than 4H: 1V. This value should be increased to 60 pcf for 2H: 1V slopes. We do not recommend slopes steeper than 2H: 1V. The active fluid unit weight shall be increased to 60 pcf for restrained walls with slopes flatter than 4H: 1V. This value should be increased to 80 pcf for 2H: 1V slope. For embedded building walls, a superimposed seismic lateral force calculation is based on a dynamic force of $11H^2$ pounds per lineal foot of wall, where H is the height of the wall in feet, and applied at 0.6H from the base of the wall. If surcharges (e.g., slopes steeper than 4H:1V, foundations, vehicles, etc.) are located within a horizontal distance from the back of a wall equal to twice the height of the wall, then additional pressures will need to be accounted for in the wall design. Use Figure 3 to calculate the magnitude of these surcharges. The wall footings should be designed in accordance with the guidelines provided in the “Spread Footing Design Recommendation” section of this report.

The design parameters provided assume back-of-wall drains will be installed to prevent buildup of hydrostatic pressures behind all walls. A minimum 12 inch wide zone of drain rock, extending from the base of the wall to within 6 inches of finished grade, should be placed against the back of all retaining walls. Perforated collector pipes should be embedded at the base of the drain rock. The perforated collector pipes should discharge at an appropriate location away from the base of the wall. The backfill material placed behind the walls and extending a horizontal distance equal to at least the height of the retaining wall should consist of granular retaining wall backfill material meeting specifications provided in City of Portland Standard Construction Specifications (SCS) 510.12. We recommend the select granular wall backfill be separated from general fill, native soil and/or topsoil using a geotextile fabric that meets the requirements provided in SCS 2320.20 for drainage geotextiles. The wall backfill should be compacted to a minimum of 92 percent of the maximum dry density, as determined by ASTM D 1557. Backfill placed within 3 feet of the wall

should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (e.g., jumping jack or vibratory plate compactors).

Temporary Shoring Design Parameters

Subsurface conditions at the project site show predominately fine to coarse sands, clays, silts and gravels to the depths explored. Excavations in these soils may be readily accomplished with conventional earthwork equipment. We understand that cuts on the order of 15 to 20 feet may be required for the construction of underground reservoirs.

Trench cuts should stand vertical to a depth of approximately 4 feet – provided no groundwater seepage is present in the trench walls. Open excavation may be used to excavate trenches with depths between 4 and 8 feet with the walls of the excavation cut at a slope of 1H:1V – provided groundwater seepage is not present and with the understanding some sloughing may occur. The trenches should be flattened to 1.5H: 1V if excessive sloughing occurs or seepage is present. Deeper cuts can be attempted at slopes of 2H: 1V or flatter slopes. If these are not feasible than temporary shoring will be required.

Temporary shoring can be cantilever or may include one or more level of tiebacks. These shoring and excavations should be designed by a Licensed Engineer registered in the state of Oregon and constructed in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations.

Figure 4 provides pressure diagrams for the design of the shoring systems. For a cantilever type shoring system, use an active equivalent fluid weight (EFW) of 35 pounds per cubic feet (pcf) and a passive EFW of 300 pcf. Neglect the upper 2 feet of soils immediately below the base of excavation when calculating passive resistance. The passive pressure should be applied to 2 x Diameter of the piles for passive resistance calculations. These values are nominal values and do not contain a factor of safety.

For one or more levels of tieback type shoring, use the pressure diagram shown on Figure 4. The maximum pressure ordinate is on the order of 30H where H is the depth of excavation. Use an EFW of 300 pcf for passive resistance. Neglect the top 2 feet in calculation of passive resistance. The passive pressure should be applied to 2 x Diameter of the piles for passive resistance calculations. The soldier piles should be embedded a minimum of 10 feet below the base of excavation. Use ultimate bond strength of 10 psi for the preliminary design of tiebacks. The contractor should design the actual bond length of tiebacks based on the required loads provided in the plans. The bond zone should be behind a line drawn at 45 degrees to the horizontal starting at a distance of H/4 from the base of the excavation (no-bond zone). The minimum unbound zone should be 10 feet for bar anchors and 15 feet for strand anchors. For shoring locations where traffic may be present, use a minimum of 2 feet of traffic surcharge load. Additional surcharge loading may be required if cranes or other construction loads are present behind the shoring. Figure 3 can be used to calculate the surcharge loads on the shoring system.

Pavement Design Recommendations

Our pavement recommendations are based on the following assumptions.

- A resilient modulus of 4,500 psi for the native site soils.
- A resilient modulus of 20,000 psi estimated for the base rock.
- Initial and terminal serviceability index of 4.2 and 2.5, respectively.
- Reliability and standard deviation of 85% and 0.45, respectively.

- Structural coefficient of 0.42 and 0.10 for the asphalt and base rock, respectively.
- We assumed several Equivalent Single Axle Loads (ESALs) for pavement design. The actual ESALs should be selected based on traffic levels anticipated as the project moves forward.

If any of these assumptions are incorrect, contact our office with the appropriate information so we may revise the pavement designs. Pavement designs were based on the 1993 AASHTO pavement design equations. The development of pavement designs for the project pavements are in general accordance with the design guidelines and procedures of the American Association of State Highway and Transportation Officials (AASHTO) and the Oregon Department of Transportation (ODOT) Pavement Design Manual. Summary of our pavement design recommendations are in the table below.

Table 4 Minimum Pavement Sections

Traffic Loading (ESALs)	Asphalt Cement Concrete (inch)	Aggregate Base Rock (inch)
10,000	3	8
50,000	4	10
100,000	4.5	12
250,000	5.5	12
500,000	6	15
1,000,000	7	15

The thicknesses shown in Table 4 are intended to be minimum acceptable values.

The asphalt cement (AC) binder should be PG 64-22 Performance Grade Asphalt Cement according to SCS 00744.11 – Asphalt Cement and Additives. The AC should consist of dense graded Level 3, 1/2-inch hot mix asphalt. The minimum lift thicknesses should be 2.0 inches. The AC should conform to SCS 00744.13 and be compacted to 91% of Rice Density of the mix, as determined in accordance with ASTM D 2041.

The pavement subgrade should be prepared in accordance with the “Site Preparation” and “Structural Fill” sections of this report.

5.0 PERTINENT CONSTRUCTION RECOMMENDATIONS

The construction should be carried out as indicated in accordance with the City of Portland Standard Construction Specifications, 2010 version (COP – SCS). We have assumed that final project specifications will be standalone specifications in “CSI” format.

We understand that the major work items for the proposed project may consists of a water Filtration Plant, two- or more water reservoirs and water conveyance pipelines in and out of the Filtration Plant. Other miscellaneous support structures may also be required. The water reservoirs would be approximately 12- to 15- million gallon and will most likely be located underground. These reservoirs will have width and length of 300- to 400- feet with a depth of 15- to 20- feet. Site access roads and parking areas may also be part of the project.

Site Preparation Fill Materials

The existing near-surface root zone should be stripped and removed from the project site in all proposed building, fill, and pavement areas and for a 5-foot margin around such areas. We

anticipate an average stripping depth of 1 to 2 feet with some localized deeper areas. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported off site for disposal or stockpiled for use in landscaped areas.

Trees and shrubs should be removed from all pavement and improvement areas. In addition, root balls should be grubbed out to the depth of the roots, which could exceed 3 feet BGS. Depending on the methods used to remove the root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend soil disturbed during grubbing operations be removed to expose firm undisturbed subgrade. The resulting excavations should be backfilled with structural fill.

Demolition should include removal of existing improvements throughout the project site. Underground utility lines, vaults, basement walls, or tanks should also be removed or grouted full if left in place. The voids resulting from removal of footings, buried tanks, etc. or loose soil in utility lines should be backfilled with compacted structural fill. The base of these excavations should be excavated to firm subgrade before filling with sides sloped at a minimum of 1H: 1V to allow for uniform compaction.

Following stripping and prior to placing fill, pavement, or building improvements, the exposed subgrade should be evaluated by proof rolling. The subgrade should be proof rolled with a fully loaded dump truck or similar heavy rubber-tire construction equipment to identify soft, loose, or unsuitable areas. Soft or loose zones identified during the field evaluation should be compacted to an unyielding condition or be excavated and replaced with structural fill.

Wet-Weather/Wet-Soil Conditions

Trafficability on the near-surface soils may be difficult during or after extended wet periods or when the moisture content of the surface soil is more than a few percentage points above optimum. Soils which have been disturbed during site-preparation activities, or soft or loose zones identified during probing or proof-rolling, should be removed and replaced with compacted structural fill.

Track-mounted excavating equipment may be required during wet weather. The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic. A 12- to 18-inch-thick mat of imported granular material is normally sufficient for light staging areas. The granular mat for haul roads and areas with repeated heavy-construction traffic typically needs to be increased to between 18- and 24-inches. The actual thickness of haul roads and staging areas should be based on the contractor's approach to site development and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. Additionally, a geotextile fabric should be placed as a barrier between the subgrade and imported granular material in areas of repeated construction traffic. The imported granular material should be 4- to 6-inch-minus pit run rock with less than 10% passing a U.S. Standard Number 200 sieve. Note that the thicknesses may need to be adjusted based on the performance of the site during construction.

Structural Fills

Fills should be placed over subgrade prepared in conformance with the previous section of this report. Material used as structural fill should be free of organic matter or other unsuitable materials and should meet the requirements of SCS 00330.12 – Borrow Material and SCS 00330.13 – Selected General Backfill, depending upon the application. Discussion of these materials is in the following sections.

Native Soils

The moisture content of the native soils in the upper 20 feet is on the order of 35 to 45 percent. Proper moisture conditioning for structural fill will require large areas and dry summer weather. We recommend that these soils not be used as structural fills unless they are amended by cement and or lime.

Imported Granular Fills

Imported granular material should be pit or quarry run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in SCS SS 00330.14 – Selected Granular Backfill, and SCS SS 00330.15 – Selected Stone Backfill. The imported granular material should be fairly well graded between coarse and fine material and have less than 5% by weight passing the U.S. Standard No. 200 Sieve.

Imported granular material should be placed in lifts with a maximum non-compacted thickness of 8 to 12 inches and be compacted to at least 95% of the maximum dry density, as determined by ASTM D 1557. During the wet season or when wet subgrade conditions exist, the initial lift should be approximately 18 inches in non-compacted thickness and should be compacted with a smooth-drum roller without using vibratory action.

Where imported granular material is placed over wet or soft soil subgrades, we recommend a geotextile be placed as a barrier between the subgrade and imported granular material. The geotextile should meet SCS 2320.20 for soil separation and/or stabilization. The geotextile should be installed in conformance with SCS 00350.40 – Geosynthetic Construction.

Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 2 feet above utility lines (e.g., the pipe zone) should consist of well-graded, granular material with a maximum particle size of 1.5 inches, have less than 10% by weight passing the U.S. Standard No. 200 Sieve, and meet SCS 405.12 - Pipe Zone Bedding. The pipe zone backfill should be compacted to at least 90% of the maximum dry density, as determined by ASTM D 1557 or as required by the pipe manufacturer or local building department.

Within roadway alignments or beneath building pads, the remainder of the trench backfill should consist of well-graded, granular material with a maximum particle size of 2.5 inches, have less than 10% by weight passing the U.S. Standard No. 200 Sieve, and meet SCS SS 405.14 - Trench Backfill, Class B. This material should be compacted to at least 92% of the maximum dry density as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department. The upper 2-feet of the trench backfill should be compacted to at least 95% of the maximum dry density as determined by ASTM D 1557.

Outside of structural improvement areas (e.g., roadway alignments or building pads), trench backfill placed above the pipe zone may consist of general fill materials free of organics and materials over 6 inches in size, and meet SCS SS 405.14 - Trench Backfill, Class A, C, or D. This general trench backfill should be compacted to at least 90% of the maximum dry density, as determined by ASTM D 1557 or as required by the pipe manufacturer or local building department.

Retaining Wall Backfill

Backfill material placed behind retaining walls and extending a horizontal distance of 0.5H, where H is the height of the retaining wall, should consist of select granular material meeting SCS 510.12 –

Granular Wall Backfill. We recommend the select granular wall backfill be separated from general fill, native soil and/or topsoil using a geotextile fabric that meets the requirements provided in SCS 2320.20 for drainage geotextiles. The geotextile should be installed in conformance with SCS 00350.40 – Geosynthetic Construction.

Trench Drain and Retaining Wall Drain Backfill

Backfill for subsurface trench drains and for a minimum 1-foot-wide zone against the back of retaining walls should consist of drain rock meeting the specifications provided in SCS 00430.11 – Granular Drain Backfill Material. A pre-fabricated drain board can be substituted for the drain rock. The drain rock should be wrapped in a geotextile fabric meeting the specifications provided in SCS 2320.20 for soil separation and/or stabilization. The geotextile should be installed in conformance with SCS SS 00350.40 – Geosynthetic Construction.

Floor Slab Base Rock

Base aggregate for floor slabs should be clean, crushed rock or crushed gravel. The base aggregate should contain no deleterious materials, meet specifications provided in SCS 02630.10 – Dense Graded Aggregate 1”-0”, and have less than 5% by weight passing the U.S. Standard No. 200 Sieve. The imported granular material should be placed in one lift and compacted to at least 95% of the maximum dry density, as determined by ASTM D 1557.

Pavement Base Aggregate

Imported base aggregate for roads and parking lots should be clean, crushed rock or crushed gravel. The base aggregate should meet the gradation defined in SCS 02630.10 – Dense Graded Aggregate 1”-0,” with the exception that the aggregate should have less than 5% passing a U.S. Standard No. 200 Sieve. The base aggregate should be compacted to at least 95% of the maximum dry density, as determined by ASTM D 1557.

Recycled Concrete, Asphalt and Base Rock

Asphalt pavement, concrete, and base rock from the existing site improvements can be used in general structural fills, provided no particles greater than 6 inches are present. It also must be thoroughly mixed with soil, sand or gravel such that there are no voids between the fragments. In addition, these materials should not be contaminated as determined by PWB’s environmental consultant. Since this fill is made of non-homogeneous materials, the acceptance of this fill will be based on visuals observation and proof-rolling.

Drainage Considerations

Surface and Subsurface Drainage Requirements

The Contractor shall be made responsible for temporary drainage of surface water and groundwater as necessary to prevent standing water and/or erosion at the working surface. We recommend removing only the foliage necessary for construction to help minimize erosion.

The ground surface around the structures should be sloped to create a minimum gradient of 2% away from the building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or into a storm drainage system. “Trapped” planting areas should not be created next to any building without providing means for drainage. The roof downspouts should discharge onto splash blocks or pavement surfaces which direct water away from the buildings, or into smooth-walled underground drain lines that carry the water to appropriate discharge locations at least 10 feet away from any buildings.

Foundation Drains

We recommend foundation drains around the perimeter foundations of all new structures. The foundation drains should be at least 12 inches below the base of the slab. The foundation drain should consist of perforated collector pipes embedded in a minimum 2-foot-wide zone of angular drain rock. The drain rock should meet specifications provided in the “Structural Fill” section of this report. The drain rock should be wrapped in a geotextile fabric. The collector pipes should discharge at an appropriate location away from the base of the footings. Unless measures are taken to prevent backflow into the wall’s drainage system, the discharge pipe should not be tied directly into storm water drain system.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their engineers, for aiding in the design and construction of the proposed project. This report is preliminary in nature and should not be relied for the final design of the facilities. Additional field exploration, testing and analysis will be required if this site is selected as the preferred site.

The opinions, comments, and conclusions presented in this report were based upon information derived from our literature review, field investigation, and laboratory testing. Conditions between or beyond our exploratory borings may vary from those encountered. Unanticipated soil conditions and seasonal soil moisture variations are commonly encountered and cannot be fully determined by merely taking soil samples or soil borings. Such variations may result in changes to our recommendations and may require additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

7.0 RESTRICTIONS

This report is for the exclusive use of the client for design of the development, as described in our proposal for this particular project, and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without the expressed written consent of the client and ROG.

Sincerely,
RhinoOne Geotechnical

Christina Hemberry, PE
Geotechnical Engineer

Rajiv Ali, PE GE
Principal Geotechnical Engineer

APPENDIX A

Figures

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FUTURE FILTRATION PLANT

PORTLAND WATER BUREAU

35320 SE CARPENTER LANE, GRESHAM, OREGON 97080

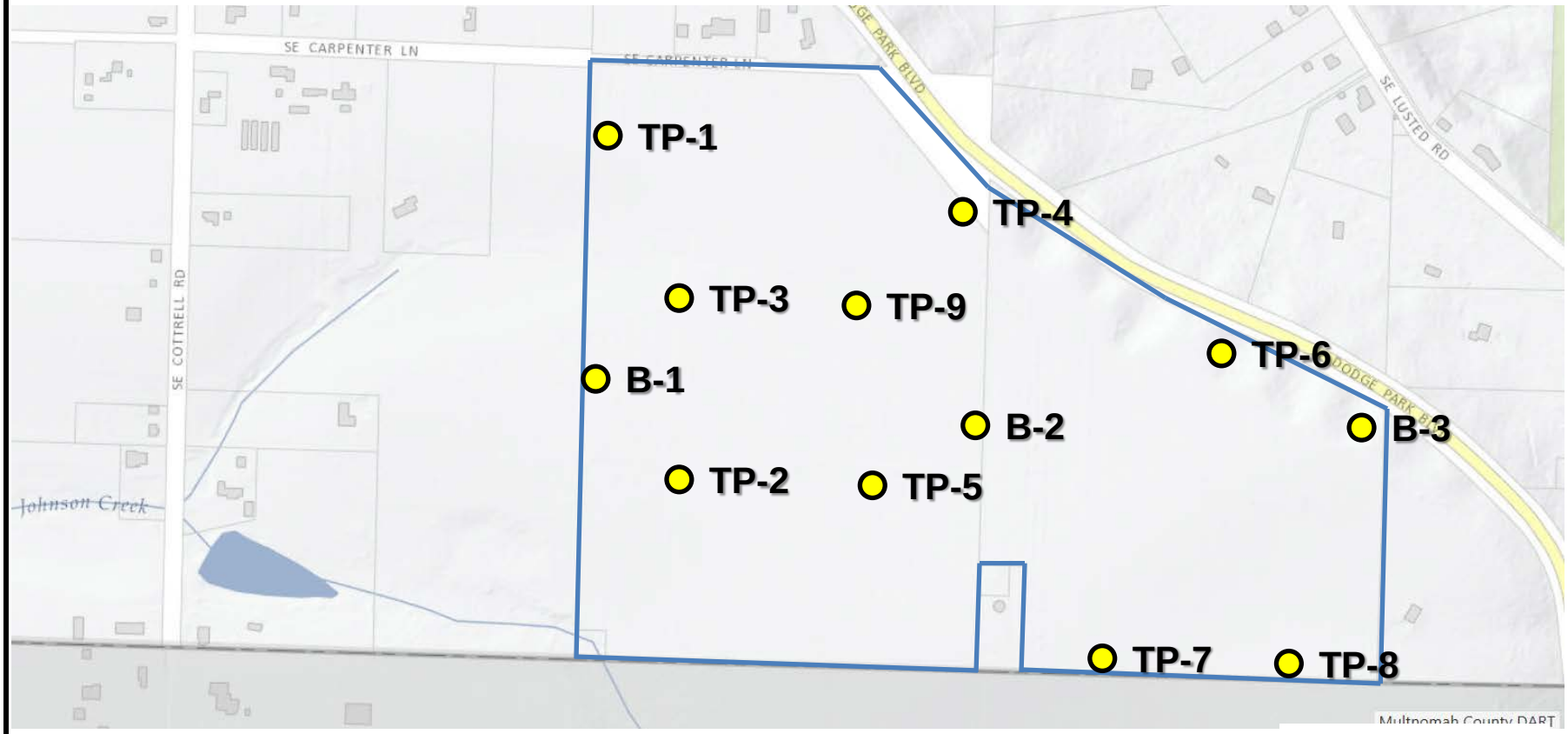
FIGURE 1 - SITE LOCATION MAP

PROJECT

HDR-2018-008

DATE

MAY 2018

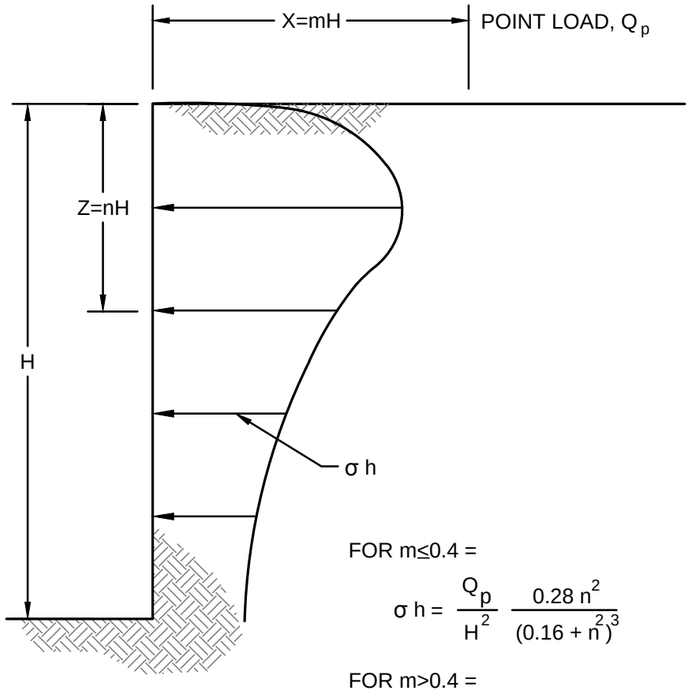


Legend:

B-1

Boring Number and Approximate Location

RhinoOne GEOTECHNICAL 4610 NE 77th Avenue, Suite 126 Vancouver, Washington 98662 360-258-1738	**Future Filtration Plant** Portland Water Bureau 35320 SE Carpenter Lane, Gresham, Oregon	Project Number: HDR-2018-008
	Figure 2 – Site Exploration Plan	Date: May 2018

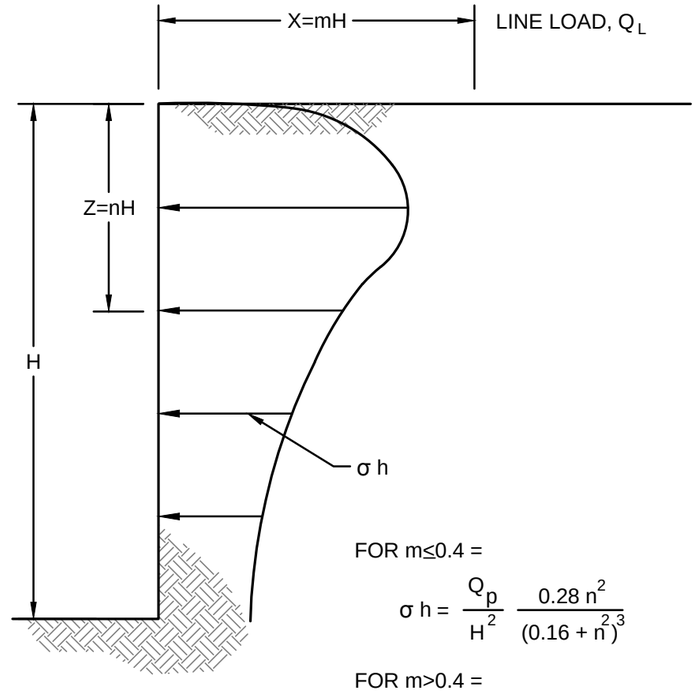


FOR m≤0.4 =

$$\sigma h = \frac{Q_p}{H^2} \frac{0.28\, n^2}{(0.16 + n^2)^3}$$

FOR m>0.4 =

$$\sigma h = \frac{Q_p}{H^2} \frac{1.77 m^2 n^2}{(m^2 + n^2)^3}$$



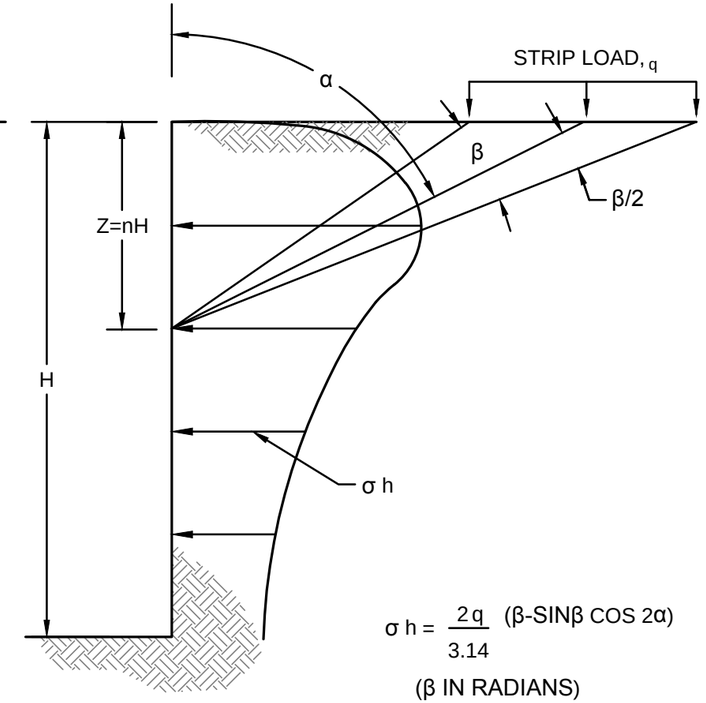
FOR m≤0.4 =

$$\sigma h = \frac{Q_p}{H^2} \frac{0.28\, n^2}{(0.16 + n^2)^3}$$

FOR m>0.4 =

$$\sigma h = \frac{Q_L}{H} \frac{1.28 m^2 n}{(m^2 + n^2)^2}$$

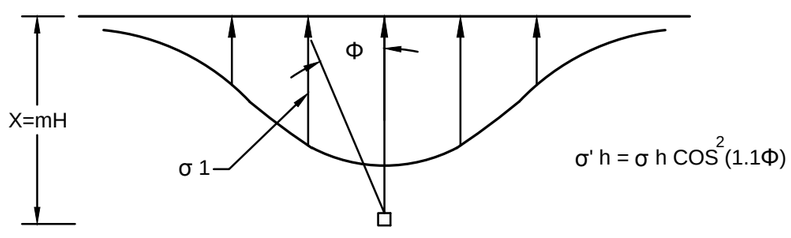
LINE LOAD PARALLEL TO WALL



$$\sigma h = \frac{2q}{3.14} (\beta - \sin\beta \cos 2\alpha)$$

(β IN RADIANS)

STRIP LOAD PARALLEL TO WALL



DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD

NOTES:

1. THESE GUIDELINES APPLY TO RIGID WALLS.
2. PRINCIPLE OF SUPERPOSITION CAN BE USED FOR DIFFERENT LOAD COMBINATIONS.
3. THESE VALUES ARE NOMINAL (UN-FACTORED).

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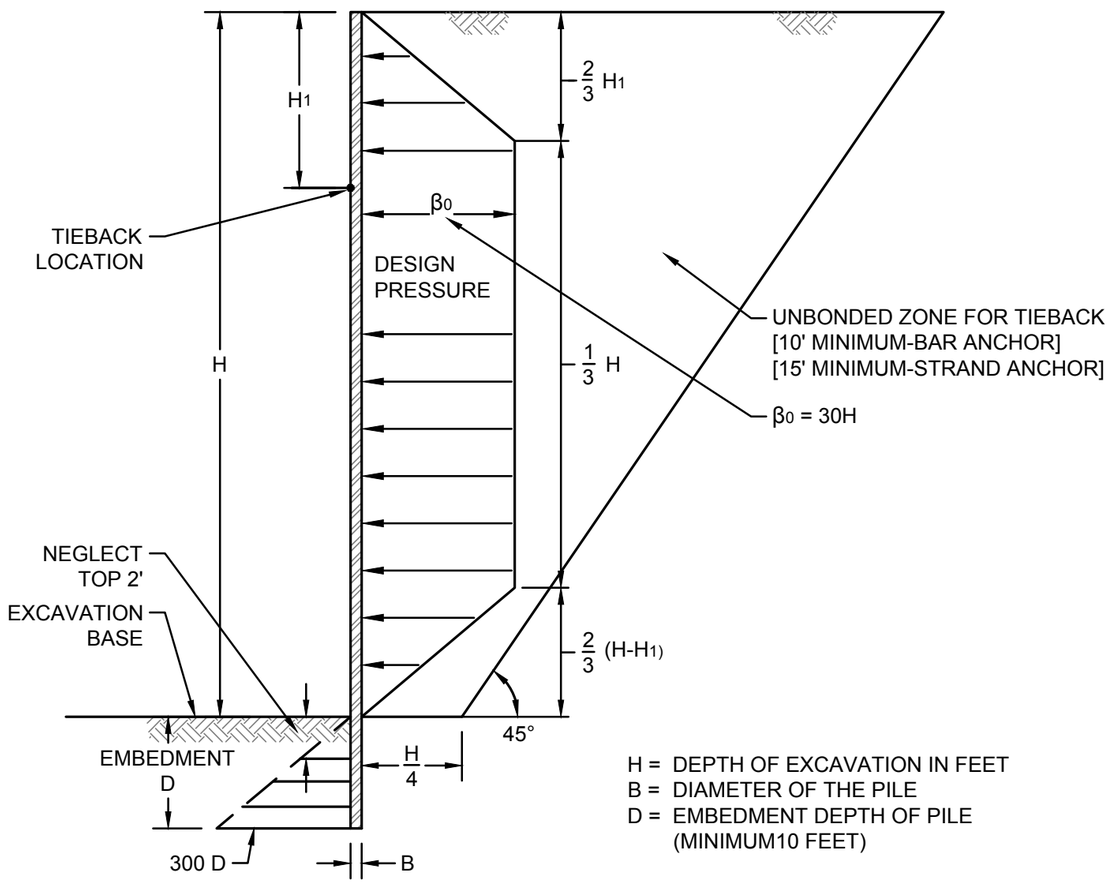
FIGURE 3 - SURCHARGE INDUCED LATERAL EARTH PRESSURES

PROJECT

HDR-2018-008

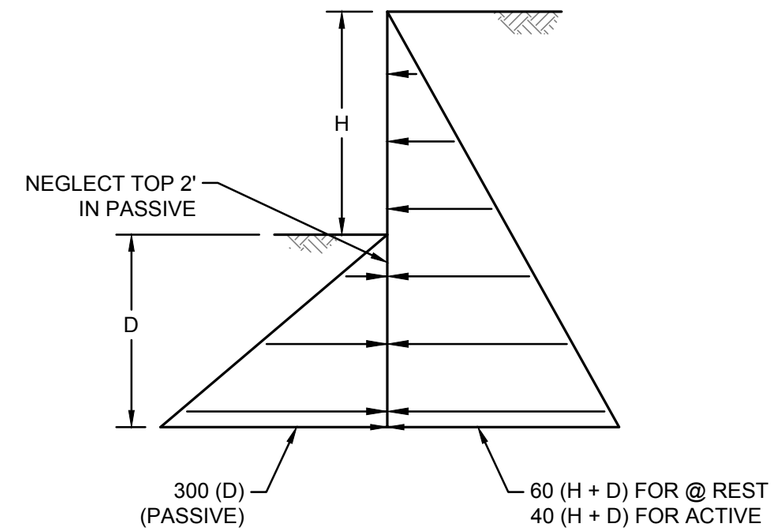
DATE

MAY 2018



H = DEPTH OF EXCAVATION IN FEET
B = DIAMETER OF THE PILE
D = EMBEDMENT DEPTH OF PILE (MINIMUM10 FEET)

PRESSURE DIAGRAM W/ ONE LEVEL TO TIEBACK



CANTILEVER WALL

NOTES:

1. SURCHARGE LOADS ASSOCIATED WITH CONSTRUCTION ACTIVITIES AND TRAFFIC OR ADJACENT STRUCTURES SHOULD BE ADDED TO THE EARTH PRESSURE SHOWN ABOVE. FOR TRAFFIC SURCHARGE ADD 2' OF SOILS.
2. TIEBACKS SHOULD BE STRESSED TO 80 PERCENT OF DESIGN LOAD.
3. THE LATERAL EARTH PRESSURES ARE NOMINAL (UN-FACTORED).
4. FOR PILE EMBEDMENT DESIGN USE SKIN FRICTION = 0.4 ksf. END BEARING = 4 ksf.
5. PASSIVE RESISTANCE CAN BE APPLIED OVER 2 TIMES THE WIDTH OF THE SOLDIER PILE.

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FUTURE FILTRATION PLANT

PORTLAND WATER BUREAU

35320 SE CARPENTER LANE, GRESHAM, OREGON 97080

FIGURE 4 - PRESSURE DIAGRAM FOR SHORING DESIGN

PROJECT: HDR-2018-008

DATE: MAY 2018

APPENDIX B

Summary Boring Logs and Test Pit Logs
Laboratory Testing

RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-1
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 20, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 707 feet	
Diameter: 4-inches / Water Level: 25 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Materials Description	Moisture (%)	Remarks
							0		TP	Soft, dark brown, silty CLAY with sand (Till Zone)		
									CH-MH	Medium stiff, red-brown, silty CLAY; moist, medium to high plasticity (Native)		
							5					
1		100		3-3-4	7						34.9	
							10			Becomes stiff		
2		100		3-5-7	12						34.6	
							15			Becomes CLAY with trace coarse sand		
3		100		4-6-7	13						31.7	
							20					
4		100		3-4-5	9						32.0	
							25		SM	Loose, brown with light grey, silty fine SAND with some clay; wet, interbedded layers of silty clay Becomes grey, silty fine to coarse SAND		
5		100		3-4-3	7						40.8	
							30		SP	Very loose, ash grey, SAND with some silt and trace coarse gravel; wet		
6		100		0-0-1	1						77.9	

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-1
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 20, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 707 feet	
Diameter: 4-inches / Water Level: 25 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Materials Description	Moisture (%)	Remarks
							35					
7		100		3-4-5	9				SP	Becomes loose, SAND with some silt and fine gravel, relic coarse sands and gravels	50.7	
							40					
8		100		8-12-19	31				SM	Dense, grey, silty SAND with some gravel; wet	25.7	
									SP	Very dense, grey, SAND with some silt and gravel		
							45					
9		78		24-50/3"	50/3"						19.4	
							50		ML	Stiff, brown, sandy SILT; wet		
10		100		3-5-6	11						53.4	
										Boring terminated at 51.5 feet BGS; backfilled with bentonite chips		
							55					
							60					
							65					

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-2
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 19, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 730 feet	
Diameter: 4-inches / Water Level: 33 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Materials Description	Moisture (%)	Remarks
							0		TP	Soft, dark brown, silty CLAY with sand (Till Zone)		
									CH-MH	Medium stiff, red-brown, silty CLAY with trace coarse sand; moist, medium plasticity (Native)		
1		100		1-2-3	5		5				40.3	89.5% Fines
							10		CH	Stiff, red-brown, CLAY; moist, high plasticity		
2		100		2-4-5	9						38.5	LL = 49.3 PI = 22 91.8% Fines
							15					
3		100		3-4-5	9						38.6	98.0% Fines
							20					
4		100		3-5-7	12						35.0	LL = 50.8 PI = 22 97.7% Fines
							25			Becomes grey with red, CLAY with trace coarse sand		
5		100		3-4-7	11						31.1	95.7% Fines
							30			Becomes brown, CLAY, heavy grey mottling, relict sands		
6		100		4-7-7	14						32.0	LL = 58.0 PI = 30 96.2% Fines
						▼			MH	Soft, brown, fine to coarse sandy SILT with some clay; wet, interbedded layers of clay		

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-2
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 19, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 730 feet	
Diameter: 4-inches / Water Level: 33 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Materials Description	Moisture (%)	Remarks
							35		MH	Soft, brown, fine to coarse sandy SILT with some clay; wet, interbedded layers of clay		
7		100		2-1-2	3						71.7	74.1% Fines
							40		SM	Medium dense, grey, silty fine to coarse SAND; wet		
8		100		3-7-8	15						62.4	
							45			Becomes dense, silty SAND with trace gravel; moist to wet		
9		100		8-9-23	32						26.1	
									SP	Dense, grey, SAND with some silt and gravel; wet		
							50					
10		82		30-22-11	33						18.9	26.8% Fines
							55		MH-CH	Medium stiff, grey, clayey SILT with some sand and gravel; wet, medium plasticity		
11		100		5-3-6	9				SM	Loose, red-brown, silty fine to coarse SAND; wet	50.3	LL = 38 PI = 8 53.9% Fines
							60					
12		100		2-2-3	5						81.3	53.7% Fines
							65			Becomes medium dense, relict coarse sands and gravels		
13		100		3-8-12	20						62.5	

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-2
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 19, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 730 feet	
Diameter: 4-inches / Water Level: 33 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
							70				
14		100		6-7-12	19				SM Medium dense, red-brown, silty SAND; wet, relict coarse sands and gravels	61.3	28.8% Fines
									SP Medium dense, red-brown, fine to coarse SAND with some silt; wet		
							75				
15		100		14-25-50	75				SM Very dense, grey, silty SAND; moist, decomposed conglomerate	38.6	
							80				
16		100		15-29-50/4"	79/10"					32.8	29.1% Fines
							85				
17		100		17-33-50/5"	83/11"					29.4	
							90				
18		100		25-50/2"	50/2"				Becomes silty SAND with some gravel	25.5	29.0% Fines
							95				
19		100		50/4"	50/4"					20.7	
							100				
20		100		50/3"	50/3"				Boring terminated at 100.2 feet BGS; backfilled with bentonite/grout mix, top 5 feet was backfilled with bentonite chips	15.6	

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-3
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 20, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 738 feet	
Diameter: 4-inches / Water Level: 25 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
							0		TP Soft, dark brown, silty CLAY with sand (Till Zone)		
									CH Stiff, red-brown, silty CLAY; moist, medium plasticity (Native)		
							5				
1		100		4-6-8	14					33.9	
							10		Becomes CLAY		
2		100		2-4-5	9					42.2	
							15				
3		100		3-3-6	9					37.9	
							20		Becomes very soft		
4		100		0-1-2	3				SM Very loose, grey, silty SAND; wet, some relict gravels	68.6	
						▼	25		Becomes silty fine to coarse SAND with some gravel		
5		100		1-0-1	1					79.0	
							30		Becomes loose		
6		100		2-2-3	5					70.0	

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: B-3
Project: PWB Filtration Plant	Driller: Western States Soil Conservation	
Project Number: HDR-2018-008	Date: February 20, 2018	
Drilling Method: Mud Rotary	Elevation: Approximately 738 feet	
Diameter: 4-inches / Water Level: 25 feet	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Materials Description	Moisture (%)	Remarks
							35		SM	Medium dense, grey, silty fine to coarse SAND with some gravel; wet		
7		100		12-8-8	16						39.3	
							40			Becomes grey-brown, silty SAND		
8		100		10-8-8	16						23.2	
							45		ML	Soft, grey-brown, fine sandy SILT; wet		
9		100		2-1-2	3						65.2	
							50		SM	Very dense, grey, silty SAND with some fine gravel; moist to wet		
10		100		21-36-49	85						37.7	
										Boring terminated at 51.5 feet BGS; backfilled with bentonite chips		
							55					
							60					
							65					

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RhinoOne GEOTECHNICAL

Future Filtration Plant
Portland Water Bureau
SE Carpenter Lane, Gresham, Oregon

Boring Number:

TP-1

Project: PWB Filtration Plant	Driller: Dan Fischer Excavating
Project Number: HDR-2018-008	Date: February 23, 2018
Drilling Method: Deere 35C Excavator	Elevation: Approximately 712 feet
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
						GWT not encountered	0		TP: Medium stiff, brown, silty CLAY with some sand; moist, fine to coarse sands, medium plasticity (Till Zone)		PP=0.75 tsf
									CH-MH: Medium stiff, red-brown, silty CLAY with trace fine sand; moist, high plasticity (Native)		
1	X	100					2			32.4	PP=1.0 tsf
									Becomes very stiff, silty CLAY		
2	X	100					4			29.8	PP=3.25 tsf
							6				
3	X	100					8			33.7	
4	X	100					10			33.5	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-2
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 716 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
							0		TP: Very soft to soft, brown, silty CLAY with some sand; moist, medium plasticity (Till Zone)		PP=0.25 tsf
						GWT not encountered			CH-MH: Stiff, brown, silty CLAY with trace fine sand; moist, high plasticity, fine to coarse sands (Native)		PP=1.75 tsf
1	X	100					2			30.5	PP=1.75 tsf
									Becomes very stiff, red-brown, silty CLAY with trace sand		PP=3.25 tsf
2	X	100					4			31.9	
							6				Moderate seepage from 6.5 to 8.5 ft; soils are not saturated
3	X	100					8			30.9	
							10				
4	X	100								34.2	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-3
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 708 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Materials Description	Moisture (%)	Remarks
							0		TP	Stiff, brown, silty CLAY with some sand; moist, medium plasticity, fine to coarse sands (Till Zone)		
1		100				GWT not encountered					28.8	PP=0.75 tsf
2		100							CH-MH	Very soft to soft, brown, silty CLAY with some sand; moist to wet, medium plasticity (Native)	28.7	PP=0.25 tsf
							2			Becomes stiff		PP=1.75 tsf
										Becomes very stiff, silty CLAY, high plasticity		PP=3.5 tsf
							4					
3		100									29.4	
							6					
							8					
4		100					10				34.5	
										Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12					

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RhinoOne GEOTECHNICAL

Future Filtration Plant
Portland Water Bureau
SE Carpenter Lane, Gresham, Oregon

Boring Number:

TP-4

Project: PWB Filtration Plant	Driller: Dan Fischer Excavating
Project Number: HDR-2018-008	Date: February 23, 2018
Drilling Method: Deere 35C Excavator	Elevation: Approximately 722 feet
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
							0		TP: Stiff, brown, silty CLAY with some sand; moist, medium plasticity (Till Zone)		
1	X	100				GWT not encountered				24.9	PP=1.5 tsf
									CH-MH: Stiff, red-brown, sandy silty CLAY; moist, medium plasticity (Native)		PP=1.5 tsf
							2		Becomes medium stiff to stiff, moist to wet		
2	X	100								35.6	PP=1.0 tsf
									Becomes very stiff, silty CLAY; moist, high plasticity		
							4				
							6				
3	X	100								32.0	PP=2.5 tsf
							8				Light seepage from 8 to 9 ft
							10				
4	X	100								33.6	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-5
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 727 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
						GWT not encountered	0		TP: Medium stiff, brown, silty CLAY with some sand; moist, medium plasticity, fine to coarse sands (Till Zone)		PP=0.75 tsf
									CH-MH: Medium stiff, brown, silty CLAY with trace sand; moist, high plasticity (Native)		
1	X	100					2			33.1	PP=0.75 tsf
									Becomes very stiff, red-brown		
2	X	100					4			25.8	PP=2.5 tsf
							6				
							8				
3	X	100								34.5	
							10				
4	X	100								36.9	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-6
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 733 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
						GWT not encountered	0	TP	Stiff, dark brown, silty CLAY with some sand; moist, medium to high plasticity (Till Zone)		PP=1.25 tsf
								CH-MH	Stiff, brown, silty CLAY; moist, high plasticity (Native)		PP=1.25 tsf
							2				
1	X	100								30.2	PP=1.75 tsf
									Becomes very stiff		PP=3.25 tsf
							4		Becomes red-brown, blocky		
2	X	100								30.0	
							6				
3	X	100					8			35.1	
							10				
4	X	100								34.1	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-7
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 738 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
							0		TP: Stiff, dark brown, silty CLAY with some sand; moist, medium to high plasticity (Till Zone)		
1	☒	100				GWT not encountered				27.5	PP=1.25 tsf
									CH-MH: Stiff, brown, silty CLAY with trace sand; moist, high plasticity (Native)		
							2		Becomes very stiff		PP=2.25 tsf
2	☒	100								30.3	PP=3.5 tsf
							4				
							6				
							8				
3	☒	100								32.7	
							10				
4	☒	100								35.6	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-8
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 722 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
						GWT not encountered	0		TP: Stiff, dark brown, silty CLAY with some sand; moist, medium to high plasticity (Till Zone)		PP=1.25 tsf
									CH-MH: Stiff, brown, silty CLAY with trace sand; moist, high plasticity (Native)		
							2				
1	X	100								30.3	PP=1.75 tsf
									Becomes very stiff		PP=2.75 tsf
							4				
2	X	100								36.5	PP=3.75 tsf
							6				
3	X	100					8			67.0	
							10				
4	X	100								35.7	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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RhinoOne GEOTECHNICAL	Future Filtration Plant Portland Water Bureau SE Carpenter Lane, Gresham, Oregon	Boring Number: TP-9
Project: PWB Filtration Plant	Driller: Dan Fischer Excavating	
Project Number: HDR-2018-008	Date: February 23, 2018	
Drilling Method: Deere 35C Excavator	Elevation: Approximately 717 feet	
Diameter: 24-inches / Water Level: Not Encountered	Logged by: Peter H	

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Materials Description	Moisture (%)	Remarks
							0		TP: Very stiff, brown, silty CLAY with some sand; damp, medium plasticity, fine to coarse sands (Till Zone)		
1	X	100				GWT not encountered					PP=2.5 tsf
									CH-MH: Stiff, brown, silty CLAY with trace sand; moist, high plasticity (Native)		PP=1.75 tsf
							2				
2	X	100							Becomes very stiff, silty CLAY; damp to moist	28.2	PP=3.5 tsf
							4				
3	X	100							Becomes red-brown	29.8	PP=3.5 tsf
							6				
							8				
4	X	100								33.8	PP=2.5 tsf
							10				
5	X	100								34.2	
									Test pit terminated at 11.0 feet BGS; backfilled with excavated material and lightly compacted		
							12				

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MATERIALS TESTING & INSPECTION

MATERIAL FINER THAN THE #200 SIEVE - SOIL

❑ Environmental Services ❑ Geotechnical Engineering ❑ Construction Materials Testing ❑ Special Inspections

Rajiv Ali
Rhino One Geotechnical
4610 Northeast 77th Avenue, Suite 126
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Phone: 360-258-1738
Fax:
Other: E-REPORTS ONLY

Project: **PWB Filtration Plant**
Permit #: **HDR-2017-008**
Project Manager: **Karrie Eixenberger**
Lab Technician: **Mitchell Eixenberger**
Test Date: **3-16-18**

As requested MTI has performed wash sieve testing on the sample referenced below. The testing was performed in accordance with current standards indicated below. The results obtained in our laboratory were as follows:

Source:	Borings							
Date Obtained:	2-20-18							
Sample ID:	See below							
Sampling and Preparation:	ASTM D75:	X	AASHTO T2:		ASTM D421:	X	AASHTO T87:	
Test Standard:	ASTM D1140:	X						

Sample ID	% Passing #200 Sieve
B-2 @5 – 6.5 ft	89.5
B-2 @ 10 – 11.5 ft	91.8
B-2 @ 15 – 16.5 ft	98.0
B-2 @ 20 – 21.5 ft	97.7
B-2 @ 25 – 26.5 ft	95.7
B-2 @ 30 – 31.5 ft	96.2
B-2 @35 – 36.5 ft	74.1
B-2 @ 50 – 51.5 ft	26.8
B-2 @ 55 – 56.5 ft	53.9
B-2 @ 60 – 61.5 ft	53.7
B-2 @ 70 – 71.5 ft	28.8
B-2 @ 80 – 81.5 ft	29.1
B-2 @ 90 – 91.5 ft	29.0

If there are questions concerning this report (*18-1017* 200 Washes), please contact the project manager at (503) 747-7159.

Respectfully submitted,
MATERIALS TESTING & INSPECTION, INC.

cc: Christina Hemberry, Rhino One Geotechnical;

Rajiv Ali
Rhino One Geotechnical
4610 Northeast 77th Avenue, Suite 126
Vancouver, WA 98662

Phone: 360-258-1738
Fax:
Other: E-REPORTS ONLY

Project: **PWB Filtration Plant**
Permit #: **HDR-2017-008**
Project Manager: **Karrie Eixenberger**
Lab Technician: **Karrie Eixenberger**
Test Date: **3-16-18**

As requested MTI has performed Atterberg limits testing on the sample referenced below. The testing was performed in accordance with current standards indicated below. The results obtained in our laboratory are as follows:

Source and Description:	Borings							
Date Obtained:	2-20-18							
Sample ID:	See below							
Sampling and Preparation:	ASTM D75:	X	AASHTO T2:		ASTM D421:		AASHTO T87:	
Test Standard:	ASTM D4318:	X	AASHTO T89/90:					

Sample ID	B-2 @10-11.5 ft	B-2 @20-21.5 ft	B-2 @30-31.5 ft	B-2 @55-56.5ft
Liquid Limit	49.3	50.8	58.0	38
Plastic Limit	27.8	29.3	27.7	29.7
Plasticity Index	22	22	30	8
Classification	CH	MH	CH	ML

If there are questions concerning this report (*18-1017* Atterbergs), please contact the project manager at (503) 747-7159.

Respectfully submitted,
MATERIALS TESTING & INSPECTION, INC.

cc: Christina Hemberry, Rhino One Geotechnical;

RhinoOne GEOTECHNICAL

Project Name:	PWB Filtration Plant	Tested By:	**RA**
Project Number:	HDR-2018-008	Laboratory No:	**2018-00049**
Date	21-Feb-18		

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	B-1	B-1	B-1	B-1	B-1	B-1	B-1	B-1	B-1	B-1	B-2
Depth:	5-6.5	10.0-11.5	15-16.5	20.0-21.5	25-26.5	30.0-31.5	35-36.5	40.0-41.5	45-46.5	50.0-51.5	5-6.5
Tare Number:	001	002	013	015	016	026	018	006	005	025	004
Weight of Tare (Wt.):	51.25	51.58	50.26	51.55	51.66	51.42	51.58	51.12	51.72	51.55	51.36
Weight of Tare + Wet Soil:	166.2	172.31	189.34	190.2	184.58	183.13	151.19	173.53	162.81	157.67	161.68
Weight of Tare + Dry Soil:	136.48	141.27	155.88	156.58	146.05	125.46	117.67	148.5	144.78	120.73	129.97
Weight of Dry Soil:	85.23	89.69	105.62	105.03	94.39	74.04	66.09	97.38	93.06	69.18	78.61
Weight of water:	29.72	31.04	33.46	33.62	38.53	57.67	33.52	25.03	18.03	36.94	31.71
Water Content (%):	34.9%	34.6%	31.7%	32.0%	40.8%	77.9%	50.7%	25.7%	19.4%	53.4%	40.3%
Soil Description:											

RhinoOne GEOTECHNICAL

Project Name:	PWB Filtration Plant	Tested By:	**RA**
Project Number:	HDR-2018-008	Laboratory No:	**2018-00049**
Date	21-Feb-18		

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	B-2	B-2	B-2	B-2	B-2	B-2	B-2	B-2	B-2	B-2	
Depth:	10.0-11.5	15-16.5	20.0-21.5	25-26.5	30.0-31.5	35-36.5	40.0-41.5	45-46.5	50.0-51.5	55-46.5	
Tare Number:	008	019	020	021	022	023	027	009	011	003	
Weight of Tare (Wt.):	51.82	51.37	51.76	51.01	51.79	51.7	51.54	51.49	51.61	51.25	
Weight of Tare + Wet Soil:	165.69	169.43	159.04	152.28	185.11	160.46	159.47	156.53	153.32	151.06	
Weight of Tare + Dry Soil:	134.01	136.55	131.23	128.23	152.77	115.03	117.98	134.8	137.14	117.65	
Weight of Dry Soil:	82.19	85.18	79.47	77.22	100.98	63.33	66.44	83.31	85.53	66.4	
Weight of water:	31.68	32.88	27.81	24.05	32.34	45.43	41.49	21.73	16.18	33.41	
Water Content (%):	38.5%	38.6%	35.0%	31.1%	32.0%	71.7%	62.4%	26.1%	18.9%	50.3%	
Soil Description:											

RhinoOne GEOTECHNICAL

Project Name:	PWB Filtration Plant	Tested By:	**RA**
Project Number:	HDR-2018-008	Laboratory No:	**2018-00049**
Date	21-Feb-18		

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	B-2	B-2	B-2	B-2	B-2	B-2	B-2	B-2	B-2			
Depth:	60.0-51.5	65-66.5	70.0-71.5	75-76.5	80.0-81.5	85-86.5	90.0-91.5	95-96.5	100.0-101.5			
Tare Number:	014	024	028	029	030	012	032	031	007			
Weight of Tare (Wt.):	51.22	51.66	51.48	51.55	51.68	51.54	51.45	51.68	51.72			
Weight of Tare + Wet Soil:	164.53	211.38	176	186.52	188.56	213.32	175.5	208.12	157.85			
Weight of Tare + Dry Soil:	113.73	149.95	128.68	148.93	154.75	176.52	150.28	181.25	143.5			
Weight of Dry Soil:	62.51	98.29	77.2	97.38	103.07	124.98	98.83	129.57	91.78			
Weight of water:	50.8	61.43	47.32	37.59	33.81	36.8	25.22	26.87	14.35			
Water Content (%):	81.3%	62.5%	61.3%	38.6%	32.8%	29.4%	25.5%	20.7%	15.6%			
Soil Description:												

RhinoOne GEOTECHNICAL

Project Name:	PWB Filtration Plant	Tested By:	**RA**
Project Number:	HDR-2018-008	Laboratory No:	**2018-00049B**
Date	21-Feb-18		

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	B-3	B-3	B-3	B-3	B-3	B-3	B-3	B-3	B-3	B-3	
Depth:	5-6.5	10.0-11.5	15-16.5	20.0-21.5	25-26.5	30.0-31.5	35-36.5	40.0-41.5	45-46.5	50.0-51.5	
Tare Number:	001	002	013	015	016	026	018	006	005	025	
Weight of Tare (Wt.):	51.25	51.58	50.26	51.55	51.66	51.42	51.58	51.12	51.72	51.55	
Weight of Tare + Wet Soil:	188.26	158.19	151.92	164.67	164.81	153.78	157.92	153.66	160.21	165.94	
Weight of Tare + Dry Soil:	153.54	126.56	123.96	118.64	114.86	111.64	127.92	134.32	117.41	134.64	
Weight of Dry Soil:	102.29	74.98	73.7	67.09	63.2	60.22	76.34	83.2	65.69	83.09	
Weight of water:	34.72	31.63	27.96	46.03	49.95	42.14	30	19.34	42.8	31.3	
Water Content (%):	33.9%	42.2%	37.9%	68.6%	79.0%	70.0%	39.3%	23.2%	65.2%	37.7%	
Soil Description:											

RhinoOne GEOTECHNICAL

Project Name: PWB Filtration Plant

Project Number: HDR-2018-008

Date 24-Feb-18

Tested By: **RA**

Laboratory No: **2018-00049C**

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	TP-1	TP-1	TP-1	TP-1	TP-2	TP-2	TP-2	TP-2	TP-3	TP-3	TP-3	TP-3
Depth:	2-2.5	4-4.5	7.5-8	10-10.5	2-2.5	4-4.5	7.5-8	10.5-11	0.5-1	1.5-2	4-4.5	9.5-10
Tare Number:	001	002	013	015	016	026	018	006	005	025	004	036
Weight of Tare (Wt.):	51.25	51.58	50.26	51.55	51.66	51.42	51.58	51.12	51.72	51.55	51.36	51.07
Weight of Tare + Wet Soil:	165.11	156.34	152.07	164.72	188.34	153.96	157.57	175.47	151.8	152.66	152	174.52
Weight of Tare + Dry Soil:	137.25	132.27	126.41	136.34	156.37	129.17	132.58	143.77	129.41	130.14	129.13	142.83
Weight of Dry Soil:	86	80.69	76.15	84.79	104.71	77.75	81	92.65	77.69	78.59	77.77	91.76
Weight of water:	27.86	24.07	25.66	28.38	31.97	24.79	24.99	31.7	22.39	22.52	22.87	31.69
Water Content (%):	32.4%	29.8%	33.7%	33.5%	30.5%	31.9%	30.9%	34.2%	28.8%	28.7%	29.4%	34.5%
Soil Description:												

RhinoOne GEOTECHNICAL

Project Name: PWB Filtration Plant

Project Number: HDR-2018-008

Date 24-Feb-18

Tested By: **RA**

Laboratory No: **2018-00049C**

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	TP-4	TP-4	TP-4	TP-4	TP-5	TP-5	TP-5	TP-5	TP-6	TP-6	TP-6	TP-6
Depth:	0.5-1	2.5-3.0	7.0-7.5	10.5-11	2-2.5	4-4.5	8-8.5	10-10.5	2-2.5	4-4.5	7.5-8.0	10-10.5
Tare Number:	008	019	020	021	022	023	027	009	011	003	038	017
Weight of Tare (Wt.):	51.82	51.37	51.76	51.01	51.79	51.7	51.54	51.49	51.61	51.25	51.57	51.63
Weight of Tare + Wet Soil:	162.69	167.34	162.97	165.03	157.4	150.1	200.59	161.09	159.7	153.58	166.8	153.87
Weight of Tare + Dry Soil:	140.62	136.88	135.98	136.36	131.13	129.94	162.36	131.52	134.62	129.98	136.89	127.89
Weight of Dry Soil:	88.8	85.51	84.22	85.35	79.34	78.24	110.82	80.03	83.01	78.73	85.32	76.26
Weight of water:	22.07	30.46	26.99	28.67	26.27	20.16	38.23	29.57	25.08	23.6	29.91	25.98
Water Content (%):	24.9%	35.6%	32.0%	33.6%	33.1%	25.8%	34.5%	36.9%	30.2%	30.0%	35.1%	34.1%
Soil Description:												

RhinoOne GEOTECHNICAL

Project Name:	PWB Filtration Plant	Tested By:	**RA**
Project Number:	HDR-2018-008	Laboratory No:	**2018-00049C**
Date	24-Feb-18		

OVEN DRY MOISTURE CONTENT - ASTM D 2216

Sample ID:	TP-7	TP-7	TP-7	TP-7	TP-8	TP-8	TP-8	TP-8	TP-9	TP-9	TP-9	TP-9
Depth:	0.5-1	2.5-3.0	8-8.5	10.5-11	2-2.5	4-4.5	7.5-8	10.5-11	2-2.5	4-4.5	8 - 8.5	9.5-10
Tare Number:	014	024	028	029	030	012	032	031	007	033	010	034
Weight of Tare (Wt.):	51.22	51.66	51.48	51.55	51.68	51.54	51.45	51.68	51.72	50.87	51.56	51.92
Weight of Tare + Wet Soil:	153.54	150.8	152.26	153.63	154.01	156.46	183.43	175.6	182.81	165.23	197.06	174.21
Weight of Tare + Dry Soil:	131.47	127.72	127.43	126.82	130.21	128.39	130.46	142.97	153.98	138.98	160.3	143.02
Weight of Dry Soil:	80.25	76.06	75.95	75.27	78.53	76.85	79.01	91.29	102.26	88.11	108.74	91.1
Weight of water:	22.07	23.08	24.83	26.81	23.8	28.07	52.97	32.63	28.83	26.25	36.76	31.19
Water Content (%):	27.5%	30.3%	32.7%	35.6%	30.3%	36.5%	67.0%	35.7%	28.2%	29.8%	33.8%	34.2%
Soil Description:												

Carpenter Lane Site Evaluation

CARPENTER LANE SITE EVALUATION

Prepared for:

City of Portland Water Bureau
1120 SW 5th Avenue #600
Portland, OR 97204

Prepared by:

AKANA
Plan + Design + Engineer + Manage
6400 SE Lake Road, Suite 270
Portland, OR 97222

1.0 INTRODUCTION/BACKGROUND

Akana was contracted by HDR Engineers Inc., to provide multi-disciplinary site assessment of City of Portland Water Bureau (PWB) Carpenter Lane Site herein referred to as the Subject property in unincorporated southeastern Multnomah County. PWB sought to conduct the evaluation of the site in order to identify the feasibility of redeveloping PWB owned Subject Property for the future PWB treatment plant as mandated by the EPA. The scope of the project was based on Akana's scope of work provided by HDR Engineers dated December 2017.

2.0 PURPOSE/OBJECTIVE

The objectives of this site evaluation are to research, identify and document the existing site conditions of PWB Subject Property. The scope of this analysis is limited to existing utilities as part of the general site investigation, cultural resource assessment, and environmental investigations of the site including on-site and desktop review for Phase I environmental site assessment, endangered species assessment, and wetland delineation for the purpose of identifying environmental permits that may be required to develop the site and estimated permitting schedule.

3.0 RESULTS AND FINDINGS

3.1 General Site Investigations

The following results outline the location of existing utilities on and adjacent to the Subject Property. The information was collected by on-site investigation and from utility providers for this area. See Appendix A for figures of the sites existing utilities.

Potable Water: The Subject Property is located within the Pleasant Home Water District. Pleasant Home Water District owns two lots along the southern boundary of the property. Two large water storage tanks are present on these lots. A water transmission line runs from these tanks northeast through the site within an easement. A request to Pleasant Home Water District was made for all available information on water transmission line and they advised minimal information could be provided at this stage of planning. There may be a connecting line running north through the site connecting to Carpenter Lane. Potable water is available to the site by an existing 12″ water main at Carpenter Lane.

Wastewater: The Subject Property is located within unincorporated Multnomah County. Wastewater service is not provided within this area. The closest sanitary sewer

system available would be within the Gresham urban boundary approximately 3.5 miles west of the site. The area is currently serviced by individual septic systems.

Natural Gas: Natural gas is available along Carpenter Lane though NW Natural. The gas line runs along the north side of the right of way.

Power: Power is provided in the area by Portland General Electric (PGE). There are power poles located along Carpenter Lane to the north, Dodge Park Boulevard, to the east and along the west side of the property. Service within the immediate area is single phase service providing between 50 and 100 amps. Three phase power or additional capacity needs would be determined based on the preliminary design with PGE.

Roadway: The Subject Property is currently accessed by SE Carpenter Lane. SE Carpenter Lane is a local road consisting of two 8′ travel lanes and no shoulder. The asphalt appears to be in fair condition with some existing cracks and potholes. North and east of the property is bordered by Dodge Park Boulevard, however, the site sits approximately 30 feet higher in elevation than the roadway. The existing terrain is wooded and at a steep slope along the entire length of the roadway. Additional investigation would be required to determine if an access road along Dodge Park Boulevard would be possible.

Utilities / Agency Contact Information:

Water, Pleasant Home Water District - Cassandra Lashbaugh (503) 201-4341

Gas, NW Natural - Bruce Dobbs (503) 226-4211 ext. 2378

Power, PGE - Gresham Office (503) 228-6322

3.2 Cultural Resources Assessment

Akana subcontracted Harris Environmental Group, Inc. (Harris Environmental) to perform a cultural resources assessment of the Subject Property. The assessment consisted of background research with the Oregon State Historic Preservation Office (SHPO) and consultation with historic maps and aerial photographs, as well as a site visit to assess the potential for extant archaeological or historical resources within the Subject Property.

The Subject Property is located in northwestern Oregon, in the eastern portion of Multnomah County in an area characterized by extensive agricultural and moderate residential development. It is located at the eastern terminus of Carpenter Lane, on a terrace above the Sandy River to the north/northeast. The Subject Property consists of approximately 108 acres of cultivated farmland that is currently owned by PWB who leases the land to Surface Nursery as a tree farm. It is characterized by plowed

agricultural fields, which have been planted in rows of saplings, left unplanted or lightly covered with grassy ground cover.

Background research revealed that the Subject Property has not been previously surveyed for cultural materials, and no sites are previously recorded within a one-mile (1.6 km) radius. General Land Office (GLO) maps show no historic properties within the boundaries of the Subject Property. Aerial photomaps revealed the presence of two structures within the Subject Property in the mid-20th century: one along the central portion of the western boundary and one in the northern portion where Carpenter Lane turns south. Later photographs reveal the presence of a third structure in the southern portion, to the immediate north of the water tower that borders the project area to the south. None of these structures are extant.

One feature of interest was identified during the background research- a trolley line corridor located directly adjacent to the northeastern and eastern side of the project area. The corridor of the trolley line that extended from Montavilla, through Gresham and to the Bull Run River was located in or near the road prism of Dodge Park Boulevard. The 1914 historical topographic map shows a railroad symbol at this location. This trolley line may have local significance to the area.

Following the background research, Harris Environmental archaeologist Dana L. Holschuh performed a site visit and assessment at the Subject Property on January 12th, 2018. This visit included a limited pedestrian survey, consisting of 5 parallel transects across the project area. All exposed soils were inspected for integrity and cultural materials. No subsurface testing was undertaken as part of this site visit and assessment. No cultural materials were observed, and soil on-site matched the descriptions given by the NRCS soil survey (2018). Soils are interpreted to be largely intact but have been heavily impacted by agricultural plowing.

Based on the results of both background research and the site visit, it is the opinion of Harris Environmental that the Subject Property has a low to moderate likelihood of containing intact archaeological and/or historical resources. One feature of interest, the historic trolley line corridor, was identified, and no sensitive areas were identified. Harris Environmental recommends a formal survey be conducted, which will include subsurface testing and additional research.

3.3 Environmental Investigations

3.3.A - Phase I Environmental Site Assessment

Summary- The Subject Property is currently owned by PWB and located approximately four miles east of US 26 at the south-eastern end of Carpenter Lane, with a physical address of 35050 SE Carpenter Lane, Gresham, OR 97080. Land/Lease ownership, titles,

and rights of way were not reviewed during the Phase I. The site coordinates are Latitude 45.466068 degrees north and Longitude -122.298133 degrees west. Legal property descriptions as provided by the Multnomah County Appraisal District are provided in Appendix A of the Phase I site assessment report included in this report as Appendix C.

The Subject Property consists of 108 acres of predominantly undeveloped agricultural and densely forested land. The northern portion of the Subject Property is densely forested along the south side of Dodge Park Boulevard. The central portion of the Subject Property has been mostly cleared and is currently being used for agricultural uses and nursery operation by Surface Nursery. Groundwater flow direction typically mimics surface topography that slopes gently to the southeast for the eastern half and southwest for the western half of the Subject Property.

The Subject Property is accessed through a controlled entry point for the Surface Nursery, Inc. operation at the western end of Carpenter Lane. Clearings have been made for vehicle access along the Subject Property's northern, eastern, western and southern boundaries. Multiple unpaved access roads are located through the middle of the Subject Property to support nursery and agricultural operations. A seven foot tall wire metal perimeter fence surrounds the Subject Property on the north and western sides. The fence consists of cut down sections of treated wood power poles, steel wire grid, barbed wire strands on the top and bottom, and a shade cloth visual barrier. The fence is used to keep out the wild herds of elk and deer that inhabit the local area of the Subject Property. Historical aerial photo records show that a single family residential structure and adjacent agricultural structure (barn) was historically located on the west-central border of the Subject Property. Based on historical aerial photographs, these structures are assumed to have been removed at an unknown date during the mid to late 1970's. No other paved roads, structures or improvements were observed on the Subject Property during site reconnaissance.

The Subject Property lies at an elevation of 741 feet above mean sea level as determined from the 2014 USGS topographic map provided on Figure 3-1. The general topographic gradient at the Subject Property ranges from approximately 650 feet at the southwest corner to 750 feet along the eastern boundary.

Phase I Findings and Conclusions

Subject Property - Akana personnel observed four separate locations of discarded debris on the Subject Property, these locations can be seen in Figure 2-1 of Appendix C in this report. The debris piles are considered *de minimis* conditions and are categorized as Areas of Potential Concern (AOPC). AOPC #1 is located in the north-central portion

of the Subject Property on the north side of the metal fence; at this location a pile of discarded used tires was abandoned. AOPC #2 is also located in the north-central portion of the Subject Property on the south side of the grove of trees where the site nursery operations stages trailers for planting. This area was observed on the northern edge of the cultivated agricultural field and consists of a pile of discarded and treated wooden utility poles. The wooden poles have heavy odor of creosote from wood preservation chemical treatment. AOPC #3 was observed on the west-central border of the Subject Property and consists of a variety of discarded debris including two abandoned trucks, abandoned oil containing tractor and truck parts, construction and plastic debris, and one steel 55 gallon drum labeled "Flammable Liquid". The soil around and under the empty drum did not show signs of staining and did not have a strong petroleum odor. AOPC #4 is located roughly 100 feet to the south of AOPC #3 on the western boundary and consists of a large burn pile in the same area of the historical agricultural structure identified in historical aerial photographs before 1973. During the site visit it was observed that the burn pile contained what appeared as nursery operation discarded trees and shrubs, and it was documented that some household debris including furniture had been discarded in the burn pile, and/or previously burned at the site.

During the course of the site reconnaissance and desktop review of the Subject Property, this assessment has determined that active agricultural activities have been continually ongoing on the majority of the land dating back to at least 1925. Agricultural activities refer to the cultivation of the soil, crops, trees and shrubs, with the lands often being treated annually with synthetic fertilizers, herbicides, and pesticides to aid in the cultivation process. Surface Nursery, Inc., the Subject Property's current tenant, informed Akana that they keep records of chemical applications on the Subject Property lands, and that they do not store the chemicals on the Subject Property, but they are instead stored at an offsite facility. All current and historically cultivated areas are considered a Recognized Environmental Concern (REC) for the purpose of this report. There are two primary environmental concerns associated with historical and active agricultural activities on the property. The first concern is the potential for the cultivated soils to contain elevated levels of agrochemicals and associated metals. The second environmental concern is the potential of Contaminant of Potential Concern (COPC) associated with agricultural activities to migrate onto offsite properties.

Area Properties- The Subject Property is bound to the north by Dodge Park Boulevard with undeveloped forest. To the east is Dodge Park Boulevard and to the south is a parcel of private property that is used for grazing and some agriculture uses. There are two single family residences located to the east and southeast of the Subject Property, with one of the residences listed as having a Leaking Underground Storage Tanks (LUST) that was documented to be removed and cleaned up in 2004. Agricultural fields

and the Pleasant Home Water District drinking water storage tanks are located on the adjacent properties to the south. An additional agricultural field with active shrub nursery operations separated by a dirt access road is located to the west of the Subject Property. Multiple single family residences are located at the northwest corner of the Subject property at the end of paved section of SE Carpenter Lane.

De Minimis Conditions- Akana observed multiple large refuse piles consisting of empty hazardous material barrels, mechanical equipment, abandoned vehicles, scrap building supplies, metal and plastic, household furnishings, and various other discarded items on a burn pile. These areas did not show evidence of soil staining, contamination, noxious or petroleum odors that would represent a REC and was identified at AOPC #1, 2, 3, 4; all these are considered to be housekeeping issues that meets the definition of *de minimis* conditions.

Phase I Environmental Site Assessment Recommendations- Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), this assessment was conducted to identify sites within the American Society for Testing and Materials (ASTM) required search distance that may pose a risk of environmental contamination by hazardous wastes and substances. The Subject Property was not listed with any past environmental violations in any of the regulatory agency databases. Due to the fact that the Subject Property has been historically cultivated and is actively cultivated by a nursery operation tenant, all of the cultivated agricultural and nursery lands have been identified as an REC. Akana recommends a Phase II ESA to conduct sampling of surface soils in the cultivated areas of the Subject Property to determine the horizontal and vertical extent of COPC associated with the likely use of pesticides for agricultural purposes. Soil sampling should be conducted in accordance with the Oregon Department of Environmental Quality (DEQ) Guidance for Evaluating Residual Pesticides on Lands Formerly Used for Agricultural Production under the Hazardous Substance Remedial Action Rules (Oregon Administrative Rules (OAR) 340-122-0010 through 0115).

At the time of site reconnaissance, the Subject Property contained a substantial amount of miscellaneous debris identified at AOPC #1, 2, 3, 4. The debris included; discarded furniture, abandoned vehicles, empty drums, mechanical equipment, scrap metal, scrap brick and building supplies and various other refuse that could be associated with the current nursery operation active on the site. These four separate locations of discarded debris are identified in this report as four separate AOPC that are considered *de minimis* conditions. Prior to redevelopment, the materials located at these four separately identified AOPC should be recycled and/or properly disposed of and documentation of proper disposal should be kept on file.

3.3.B - Endangered Species Act Review

Akana staff conducted both desktop review and site reconnaissance for a review of the Endangered Species Act compliance as it pertains to the Subject Property and the proposed action of geotechnical site investigations. The purpose of this assessment is to review the existing conditions of the proposed PWB Subject Property in sufficient detail to determine whether a proposed action may affect any of the threatened, endangered, proposed or sensitive species identified to possibly inhabit the Subject Property in Southeast Multnomah County.

The species and associated critical habitats identified in the Information, Planning, and Consultation System (IPAC System) and Oregon Biodiversity Information Center (ORBIC) data sets for the Subject Property are as follows:

A wetland delineation conducted onsite as part of this assessment determined that there are no wetlands or rivers and streams on the Subject Property and therefore all the listed aquatic and fish species identified in the ORBIC report were not included and the following list was limited only to upland species.

Threatened(T), Endangered(E), Proposed Threatened(PT) or Proposed Endangered(PE)

Northern Spotted Owl (Strix occidentalis caurina) T

Streaked Horned Lark (Eremophila alpestris strigata) T

Bradshaw's Desert-parsley (Lomatium bradshawii) E

Kincaid's Lupine (Lupinus oreganus) T

Nelson's Checker-mallow (Sidalcea nelsoniana) T

Water Howellia (Howellia aquatilis T

Willamette Daisy (Erigeron decumbens) E

Candidate Species-

No Candidate Species listed for proposed site.

Sensitive Species (SS) and Species of Concern (SOC)-

Oregon Slender Salamander (Batrachoseps wrighti) SOC

Critical Habitat-

Based on Akana's evaluations of the remnant onsite habitat no critical habitat for any of the above listed species was identified to be located on or in the general vicinity of the Subject Property in both the IPaC and the ORBIC search reports. The action addressed

in this assessment does not fall within Critical Habitat for any of the threatened and or endangered species.

Northern Spotted Owl (Stix occidentalis caurina) T
There is critical habitat for this species. Subject Property is outside the critical habitat.

Streaked Horned Lark (Eremophila alpestris strigata) T
There is critical habitat for this species. Subject Property is outside the critical habitat.

Bradshaw's Desert-parsley (Lomatium bradshawii) E
No critical habitat has been designated for this species, season of species identification due to vegetative growth not viable at the time of site visit recognizance.

Kincaid's Lupine (Lupinus oreganus) T
There is critical habitat for this species. Subject Property is outside the critical habitat.

Nelson's Checker-mallow (Sidalcea nelsoniana) T
No critical habitat has been designated for this species, remnant habitat vegetation searched on the site and no specimens were identified during site visit.

Water Howellia (Howellia aquatilis) T
No critical habitat has been designated for this species, season of species identification not viable at the time of site visit recognizance due to growth phase.

Willamette Daisy (Erigeron decumbens) E
No critical habitat has been designated for this species, season of species identification not viable at the time of site visit recognizance due to growth phase.

Oregon Slender Salamander (Batrachoseps wrighti) SOC
Species predominantly found in old decaying down logs, showing preference for old-growth timber areas. No old growth timber habitat identified on the Subject Property.

Subject Property Proposed Action

Proposed action for the redevelopment of the Subject Property at this time is limited to a geotechnical investigation planned for the months of February and March 2018. The majority of the Subject Project has been previously disturbed due to lands being actively cultivated during agricultural activities, and it is assumed that the geotechnical investigation sites will be limited to previously disturbed sites on the Subject Property

Endangered Species Act Review - Conclusion and Determination

Due to the Subject Property being historically and actively disturbed by agricultural cultivation, and the only forested habitat located on the northern border being clear cut multiple times in the last century, it is determined that the proposed activities would have no effect on threatened and endangered species. Akana recommends that the project proposed action be contained to the previously disturbed lands and to a reasonable extent and not to further disturb any remnant habitats. Akana recommends that once the full proposed action is defined for the Subject Property a updated Endangered Species Act review be conducted for the site based on the full scope of the proposed action for the Subject Property.

3.3.C - Wetland Delineation

PBS Engineering and Environmental completed a wetland determination field study for the Subject Property on January 12, 2018. The field study was conducted by Greg Swenson, Professional Wetland Scientist. The method used for determining the presence / absence of wetlands and waters followed the routine approach of the U.S. Army Corps of Engineers (USACE) *Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (Version 2.0) (U.S. Army Corps of Engineers 2010). The method meets the technical requirements for both the Oregon Department of State Lands and USACE. Soils, vegetation, and indicators of hydrology were recorded at two sample plot locations on standard wetland determination data forms. Wetland plant ratings were assigned based on the *2016 National Wetland Plant List* (Lichvar et. al. 2016). Plot locations were chosen to represent contrasts in landscape positions. No modification of the standard wetland boundary determination methodology (i.e., presence of hydric soil indicators, hydrophytic plant dominance, and wetland hydrology indicators) was necessary during the determination. Note: due to ongoing cultivation, most of the vegetation within the study area would not be reliable for wetland determination purposes; however, the plot locations had remnant vegetation that was less disturbed. The remnant vegetation was considered reliable as noted in the Wetland Delineation report attached as Appendix E.

Upland conditions were documented through the study area, therefore no wetlands or waters were documented on the Subject Property.

4.0 SUMMARY OF FINDINGS AND RECOMENDATIONS

General Site Investigations- Akana identified the visible onsite and adjacent utilities. Akana made requests with the utility providers for as-constructed plans and no as-

construct drawings were provided. Akana recommends that prior to the geotechnical investigation that one-call utility locates be requested by the contractor for the Subject Property to identify exact locations of all the utilities on the site.

Cultural Resources Assessment- One feature of interest and no significant sites were identified on the Subject Property. Additional cultural resources testing and research, as outlined in the cultural resources results and recommendations section.

Phase I Environmental Site Assessment- One REC was identified as all cultivated crop lands on the Subject Property. Four locations of discarded debris were identified as *de minimis* conditions on the Subject Property. The four identified debris sites (AOPC #1, 2, 3, 4) be cleaned up and properly disposed of by the owners of the debris or Subject Property owners. The identified cultivated crop lands are considered a REC and a Phase II environmental assessment should be conducted prior to redevelopment of the Subject Property.

Endangered Species Act Assessment- No critical habitat or threatened and endangered species were identified by Akana on the Subject Property through a thorough desktop review and site visit. Akana recommends that action of geotechnical investigation proceed without disturbing existing remnant habitat and that Endangered Species Act review be reevaluated based on updated actions once preliminary plans, site impacts and construction schedule are finalized.

Wetland Delineation- No wetlands were identified on the Subject Property and Akana recommends no further wetland investigations or wetland permitting needs will be required.

5.0 ANTICIPATED PERMITS AND TIMELINE

Phase II Investigation- Akana recommends PWB approve a Phase II Environmental Site Assessment Investigation on all cultivated agricultural lands of the Subject Property. Timeline for completion of Phase II Environmental Site Assessment Investigation would be approximately 60 days to complete from the notice to proceed.

Cultural Resource Assessment- Akana and its subcontractor recommend PWB approve to conduct a formal archaeological survey across the project area. As part of the survey, further background research into the history of the historic trolley line corridor would be conducted, along with a systematic grid of shovel test probes across the project area to test for subsurface deposits. Also recommended is the preparation of a protocol for inadvertent discovery of subsurface cultural resources during further site investigation and/or construction. Timeline for completion of this survey and protocol development would be approximately 60 days from the notice to proceed.

Endangered Species Act- Akana recommends PWB approve to conduct additional Endangered Species Act review once the proposed actions for the Subject property have been finalized and the full scope of Subject Property redevelopment has been defined and by PWB. Timeline for completion of Endangered Species Act compliance would be approximately 60 days to complete from the notice to proceed.

6.0 APPENDICES

APPENDIX A—GENERAL SITE INVESTIGATION FIGURES

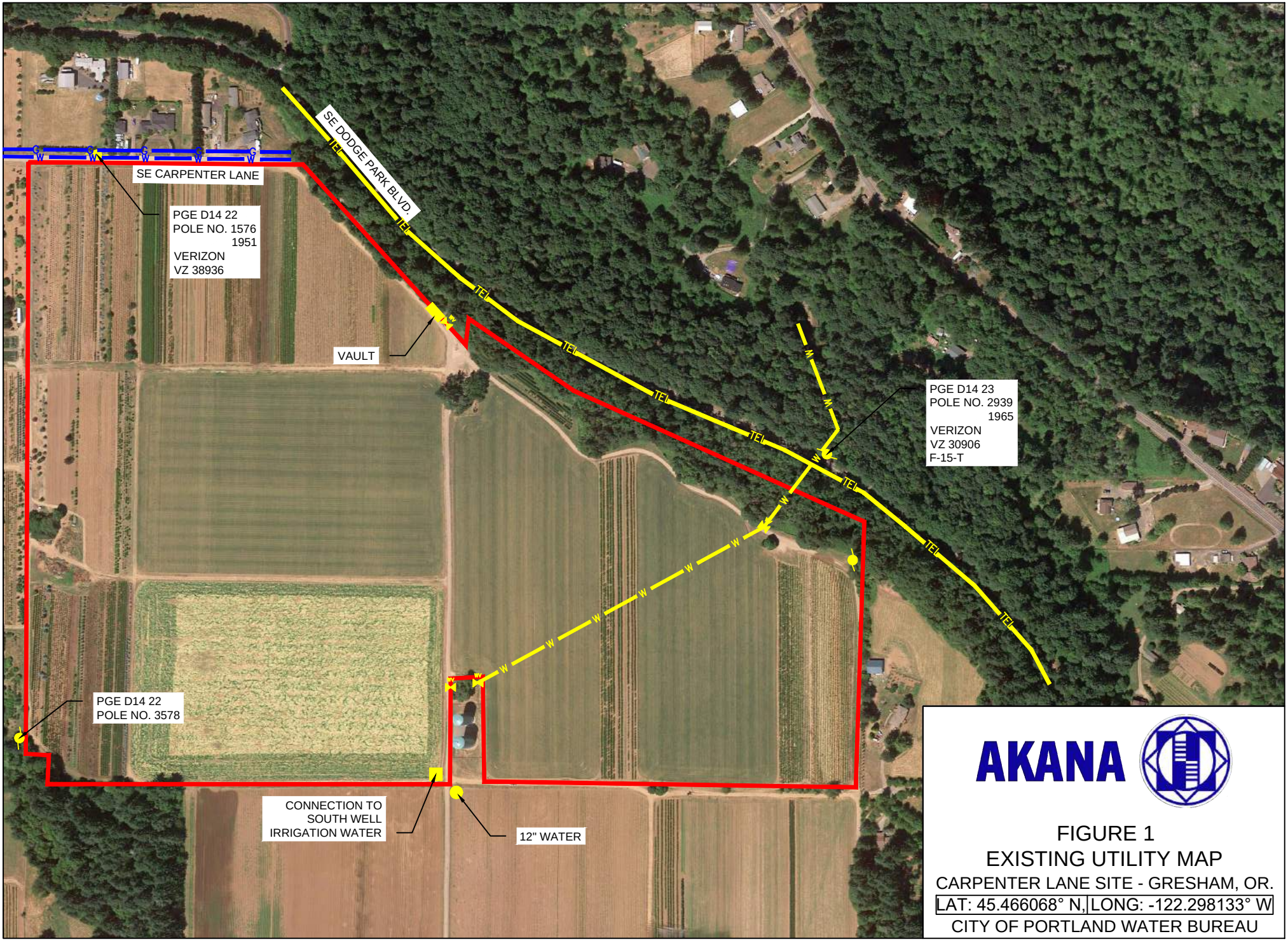
APPENDIX B—CULTURAL RESOURCES ASSESSMENT REPORT

APPENDIX C — PHASE I ENVIRONMENTAL SITE ASSESMENT REPORT

APPENDIX D – ENDANGERED SPECIES ACT SITE SPECIFIC DATA SETS

APPENDIX E— WETLAND DELINEATION REPORT

APPENDIX A—
GENERAL SITE INVESTIGATION FIGURES



AKANA

FIGURE 1
EXISTING UTILITY MAP
CARPENTER LANE SITE - GRESHAM, OR.
LAT: 45.466068° N, LONG: -122.298133° W
CITY OF PORTLAND WATER BUREAU

APPENDIX B—
CULTURAL RESOURCES ASSESSMENT REPORT

FINAL

Carpenter Lane Site Assessment Report

Prepared for
Akana

Submitted by
Dana L. Holschuh M.A., RPA, Project Director

3137 NE Rosa Parks Way
Portland, OR 97211

July 2018

Contract No. 18-005

Executive Summary

Harris Environmental Group, Inc. (HEG) was contracted by Akana to perform a cultural resources assessment of the proposed Carpenter Lane site selected by Portland Water Bureau (PWB) as a possible site for their new water filtration plant. The assessment consisted of background research with the Oregon State Historic Preservation Office (SHPO) and consultation with historic maps and aerial photographs, as well as a site visit to assess the potential for extant archaeological or historical resources within the proposed project site.

The proposed Carpenter Lane site, hereafter referred to as the subject property, is located in northwestern Oregon, in the eastern portion of Multnomah County in an area characterized by extensive agricultural and moderate residential development. It is located at the eastern terminus of Carpenter Lane, on a terrace above the Sandy River to the north/northeast. The subject property consists of approximately 108 acres of cultivated farmland that is currently being leased by Surface Nursery as a tree farm. It is characterized by plowed agricultural fields, which have been planted in rows of saplings, left unplanted or lightly covered with grassy ground cover.

Background research revealed that the subject property has not been previously surveyed for cultural materials, and no sites are previously recorded within a one-mile (1.6 km) radius. General Land Office (GLO) maps show no historic properties within the boundaries of the subject property. Aerial photomaps revealed the presence of two structures within the subject property in the mid-20th century: one along the central portion of the western boundary and one in the northern portion where Carpenter Lane turns south. Later photographs reveal the presence of a third structure in the southern portion, to the immediate north of the water tower that borders the subject property to the south. None of these structures are extant.

One feature of interest was identified during the background research- a trolley line corridor located directly adjacent to the northeastern and eastern side of the subject property. The corridor of the trolley line that extended from Montavilla, through Gresham and to the Bull Run River was located in or near the road prism of Dodge Park Boulevard. The 1914 historical topographic map shows a railroad symbol at this location. This trolley line may have local significance to the area.

HEG performed a site visit at the subject property on January 12th, 2018. HEG archaeologist Dana L. Holschuh performed a limited pedestrian survey, consisting of 5 parallel transects across the subject property. All exposed soils were inspected for integrity and cultural materials. No subsurface testing was undertaken during this site assessment. No cultural materials were observed, and soil on-site matched the descriptions given by the NRCS soil survey (2018). Soils are interpreted to be largely intact but have been heavily impacted by agricultural plowing.

Based on the results of both background research and the site visit, it is the opinion of HEG that the subject property has a low to moderate likelihood of containing intact archaeological and/or historical resources. No sensitive areas were identified.

The site visit described in this report represents a limited pedestrian survey intended to assess the likelihood of the subject property to contain intact deposits. It is the recommendation of HEG that a formal survey, including subsurface testing, is required in order to determine whether cultural deposits are located within the boundaries of the subject property.

Introduction

Harris Environmental Group, Inc. (HEG) was contracted by Akana to perform a cultural resources assessment of the proposed Carpenter Lane site selected by Portland Water Bureau (PWB) as a possible site for their new water filtration plant. The assessment was intended to evaluate the archaeological potential of the subject property. This assessment consisted of background research with the Oregon State Historic Preservation Office (SHPO) and consultation with historic maps and aerial photographs, as well as a site visit to assess the potential for intact archaeological or historical resources within the proposed project site. No archaeological testing was performed as part of this assessment.

The proposed Carpenter Lane site, hereafter referred to as the subject property, is located in northwestern Oregon, in the eastern portion of Multnomah County in an area characterized by extensive agricultural and moderate residential development. The subject property is located at the eastern terminus of Carpenter Lane, approximately 1.51 miles (2.43 km) northeast of Schmidt Airpark, approximately 3.38 Miles (5.44 km) north/northwest of the McKinnon Airpark, approximately 2.1 miles (3.38 km) south of Sandy River Oxbow State Park (Figure 1).

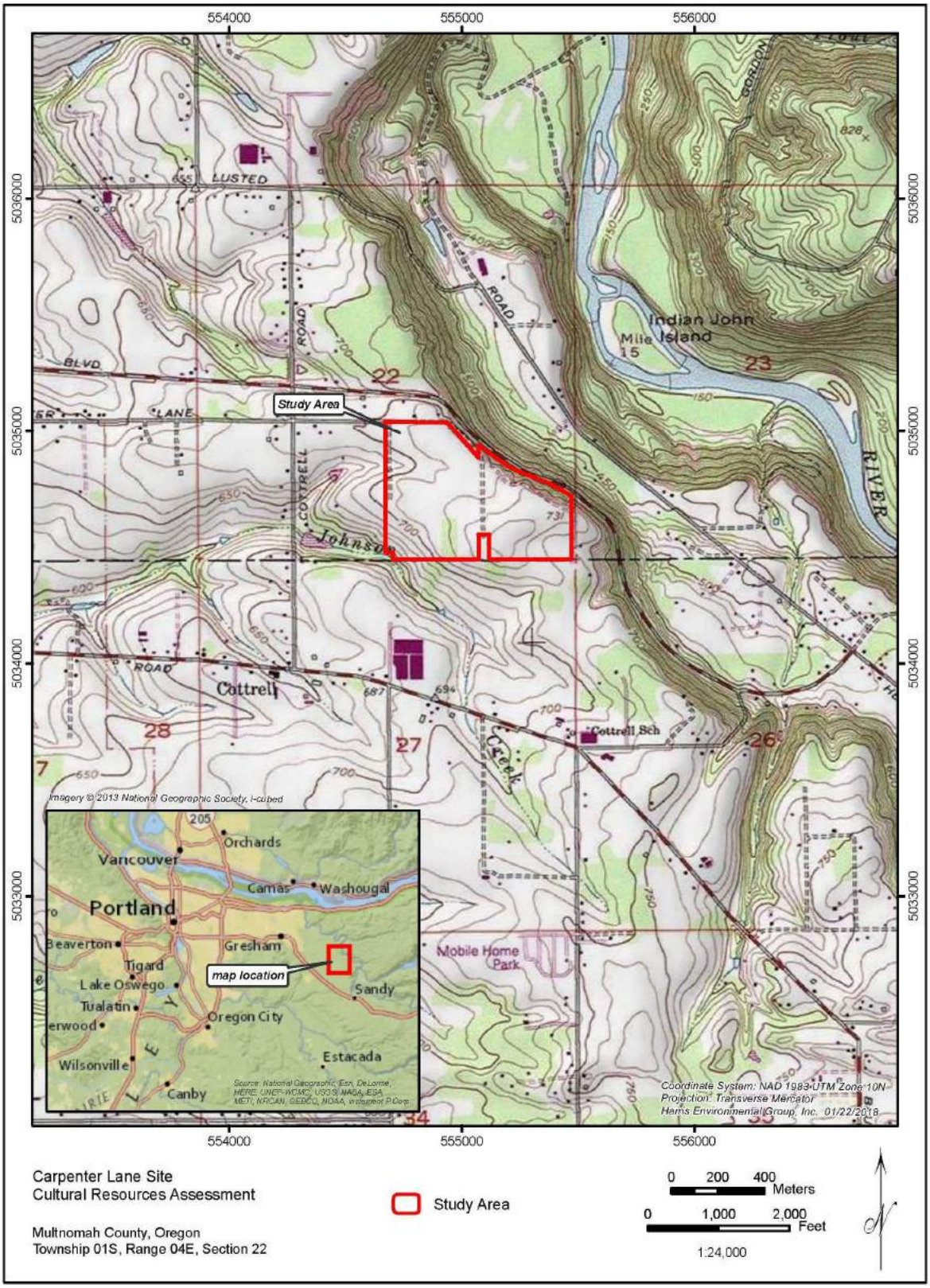


Figure 1- USGS map showing the location of the Carpenter Lane subject property.

The subject property consists of approximately 108 acres of cultivated farmland that is currently being leased by Surface Nursery as a tree farm. It is irregularly-shaped and is bounded by Carpenter Lane along its northern and northeastern boundaries, by residential properties along the eastern boundary, by a neighboring nursery along its western boundary, and by the continuation of Surface Nursery's tree farm along the southern boundary (Figure 2). Site access is provided by Carpenter Lane, which is paved along the northern border, becoming a gravel access road that runs along the northeastern border, turns south along the eastern border, and becomes a dirt track along the southern border.

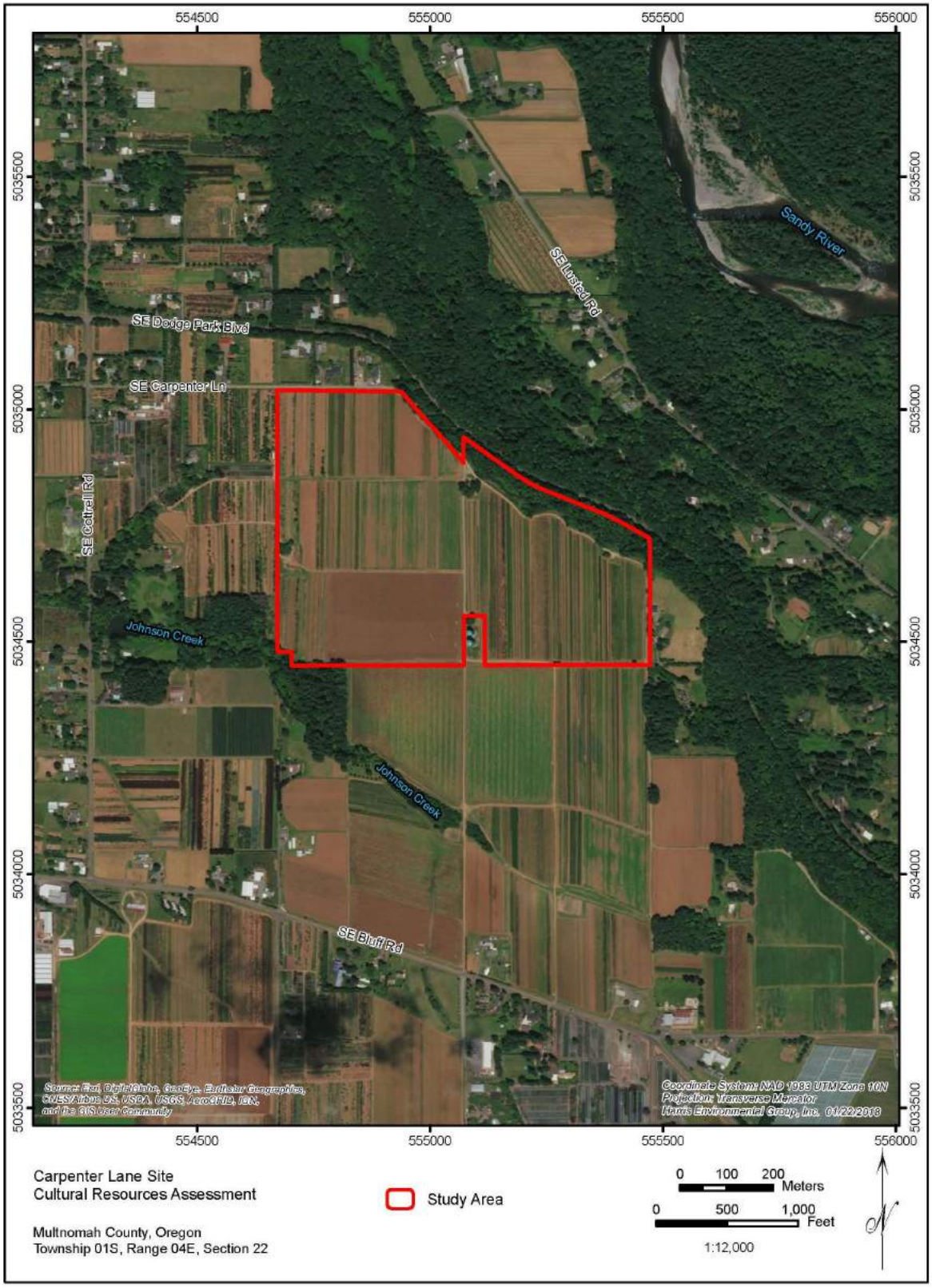


Figure 2. Aerial photomap overlaid with the boundaries of the Carpenter Lane subject property

The subject property is currently divided into a series of agricultural fields. Many of these are cultivated in rows of various size and species of trees (Figures 3 and 4). There are several fields that have been plowed and left uncultivated (Figure 5).

Figure 3. Photograph of field of planted tree saplings, looking west.

Figure 4. Photograph of planted field of slightly more mature saplings, looking south

Figure 5. Photograph of a plowed but uncultivated field within the subject property, looking south.

In addition to the plowed and cultivated fields, a few portions of the subject property are characterized by sparse grasses with limited vegetation along the margins (Figure 6).

Figure 6. Photograph showing a grass-covered field in the northeastern portion of the subject property, looking southwest.

There are three areas of mature trees within the boundaries of the subject property (Figure 2). One of these is located in the northern-central portion of the subject property, along the central gravel roadway where it turns to the south. This area is currently used to store trailer equipment (Figure 8). The southern-most stand of trees is located along the southern border, immediately north of the water towers on the adjacent property (Figure 8). The final stand is located along the western border of the subject property.

Figure 7. Photograph of the northern-most stand of mature trees, looking east.

Figure 8. The southern-most stand of mature trees, looking southeast.

Carpenter Lane turns south to become a gravel access road that runs through the central portion of the subject property (Figure 9). The western, southern, and eastern boundaries are composed of gravel roadways used to access the fields (Figure 10). Two dirt roadways extend west from the central gravel access to the western boundary, accessing the western fields.

Figure 9. Photograph of the gravel road that runs south through the center of the subject property.

Figure 10. Photograph of the dirt and gravel roadway that comprises the eastern boundary of the subject property, looking north/northwest

Background Research

The first portion of the Carpenter Lane site assessment project included performing background research to aid in ascertaining the likelihood that intact archaeological or historical resources are located within the boundaries of the subject property.

Soils and Environment

The subject property is located at the eastern edge of an upland area above the Sandy River, on a terrace at approximately 725 feet above mean sea level (amsl). Topographically, the subject property is mildly to moderately undulating with a high point in the southern-central portion and an overall north/northwestern aspect.

According the USDA Natural Resources Conservation Service's Web Soil Survey, soils across the majority of the subject property are mapped as Cazadero silty clay loam on 0 to 8 percent slopes. This soil is commonly found on convex side slopes of broad, rolling ridgetops and formed in old alluvium mixed with loess and volcanic ash. Typically, the surface layer consists of very dark brown silty clay loam to a depth of approximately 16 inches (40.64 cm). Below this, the subsoil is dark reddish brown silty clay loam over reddish brown silty clay to a depth of at least 60 inches (152.4 cm) (Green 1983; NRCS 2018).

Map Research

Historic map research was conducted using General Land Office (GLO) maps created in the 1800s. These maps depict natural and cultural features that existed during that period, as well as donation land claims (DLCs), which show land ownership.

Consultation with the GLO maps did not reveal any previous features that indicate the presence of historical or archaeological resources within the subject property. The subject property, within the southeastern portion of Section 22, Township 1 South, Range 4 East, is located within unclaimed land on the 1855 map of the area. The region is labeled as "Land Rolling. Soil 2nd Rate. Timber Fir, Cedar and Maple. Undergrowth vine maple & hazel" (GLO 1855). The 1862 GLO map shows the subject property also within unclaimed land. Two DLCs are located in the vicinity- that attributed to P.D. Terwilliger (Claim No. 38, measuring 160 acres) within Section 21, to the west of the subject property, and that attributed to L. Williams (Claim No. 37, measuring 320 acres) within Section 28, to the southwest (GLO 1862).

Historic aerial photographs reveal that the subject property has been under cultivation since at least the mid-20th century (Figures 11 and 12). While there are no extant structures within the subject property currently, map research revealed that there are three areas where structures have been previously located, all of which correlate with areas of mature trees that are still extant.

As seen in Figure 11, there are two structures that appear on the 1948 aerial photograph- one in the northern/central portion of the subject property, and one along the central portion of the western border. The western structure is a farmhouse that was occupied by the Porter family, according to a neighbor who was interviewed by Akana. It was accessed by the existing gravel driveway that forms the western boundary of the current subject property. This structure is visible on aerial photomaps until the 1970s, when it was demolished.

The second structure that appears on this early aerial is located in the northern portion of the subject property, amid a stand of trees where Carpenter Lane turns to the south and currently forms a parking area for trailer equipment (Figure 11). The function of this former structure is unknown, but it is a possibly farm building that was in use throughout the 20th century, appearing on aerial photomaps until approximately the 1980s. A third structure is visible on later maps of the subject property, beginning around 2005. It is located immediately north of the large water tower(s), along the southern boundary of the subject property within a small stand of mature trees. This structure is visible until the late 2000s. Its function is undetermined, but it appears to be a small shed or other small structure (Figure 12).

Figure 11. 1948 aerial photomap overlaid with the subject property and the locations of two historic structures, no longer extant.

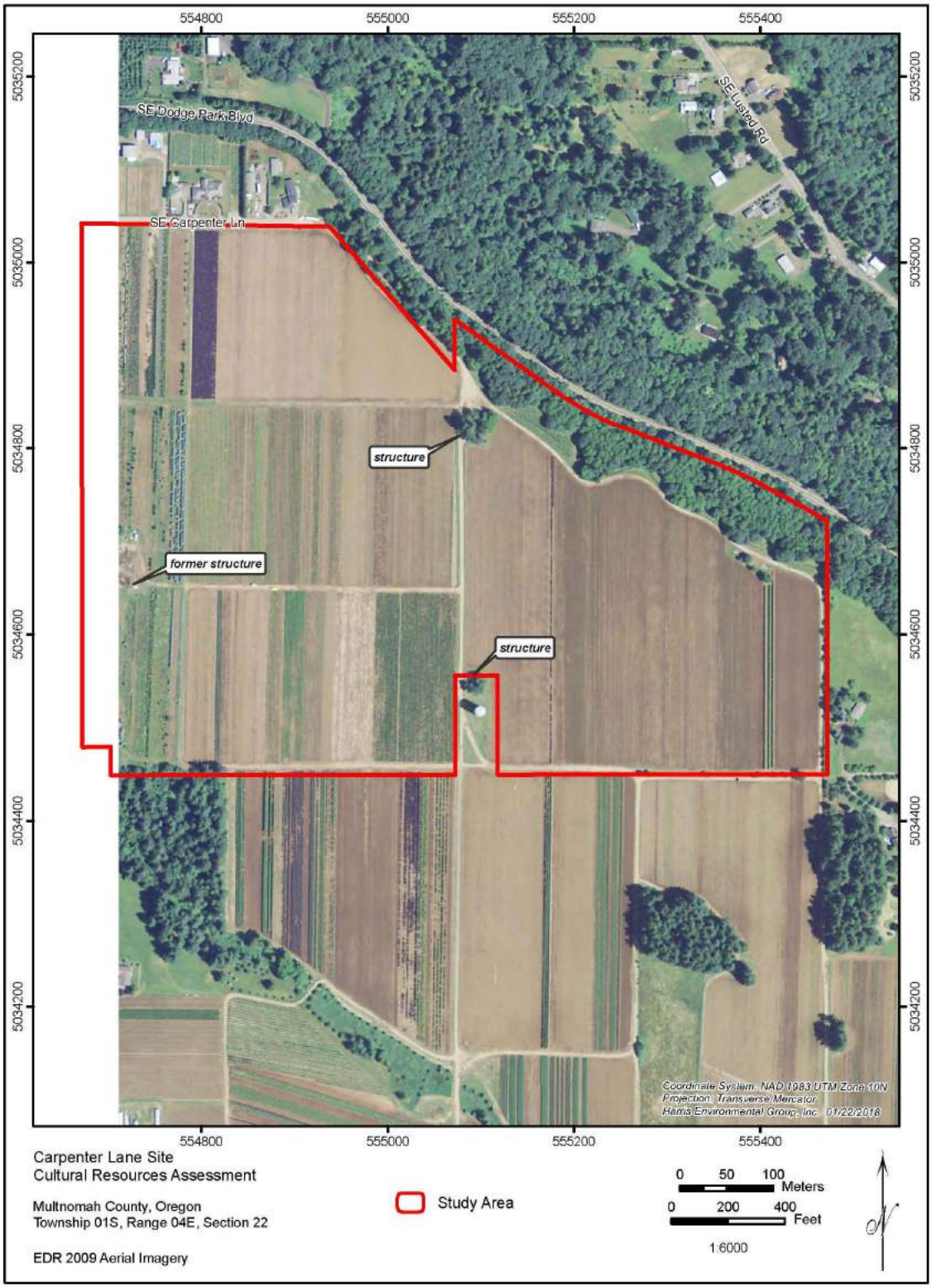


Figure 12. 2009 Aerial photomap overlaid with the subject property and the locations of two structures, no longer extant.

Previous Archaeology

Background research conducted via the Oregon Archaeological Records Remote Access (OARRA) web portal, maintained by the SHPO revealed that the subject property has not been previously surveyed for cultural resources. The property is located at the eastern margin of the Portland Basin, and is therefore included in the Archaeological Context Statement for that region (Ames 1992).

The nearest previously conducted survey to the subject property was performed approximately 0.62 miles (0.99 km) to the north, as a part of the Bull Run water system seismic upgrade project. The survey included two areas, one of which is Diack's Pond located to the north of the subject property. No cultural materials were identified during this survey (McDaniel 2005).

The nearest previously recorded site is located approximately 1.75 miles (2.83 km) to the north along the Sandy River. This site, 35MU275, consists of two discrete remnants (Loci A and B) of a sandbag riprap retaining wall built by the Corps in 1965 after a particularly damaging 1964 flood event. The sandbag riprap wall is composed of stacked nylon or burlap bags filled with sand and a cementing agent, which has solidified turning the bags into irregularly shaped blocks (Windler 2017). Locus A is the larger remnant of the two and consists of at least 16 courses of bags above the water-level, while Locus B consists of six courses of bags, with the topmost course covered in 1 to 2 inches of poured concrete. The site dates from 1965–1976 and is listed in poor condition and not eligible for inclusion on the National Register of Historic Places (NRHP) (Windler 2017).

One historic resource is located directly adjacent to the northeastern and eastern side of the subject property. The corridor of the trolley line that extended from Montavilla, through Gresham and to the Bull Run River was located in or near the road prism of Dodge Park Boulevard. The 1914 historical topographic map shows a railroad symbol at this location. This trolley line may have local significance to the area.

Site Visit

For the second part of the site assessment, HEG performed a site visit at the Carpenter Lane subject property on January 12th, 2018. Upon arrival at the subject property, HEG archaeologist Dana Holschuh, M.A., RPA met with personnel from Surface Nursery, Akana, and PBS Engineering + Environmental (PBS) to establish site boundaries, access, and site visit protocol, including the site health and safety plan.

The purpose of the site visit was to assess the likelihood of encountering intact archaeological or historical deposits within the subject property. In order to accomplish this, during the site visit, HEG performed a limited pedestrian survey across the landform, inspecting the soils, infrastructure, and general conditions on-site. During the limited pedestrian survey, transects were walked generally oriented north-south across the various fields, and along the boundaries of the subject property (Figure 13). These transects sampled each portion of the subject property. All exposed soils were inspected for cultural materials and assessed for integrity. Photographs were taken at various locations across the subject property to document the conditions across the site.

HEG inspected each area where a structure had previously been documented in order to ascertain whether structural remains or other archaeological deposits might still be in evidence.

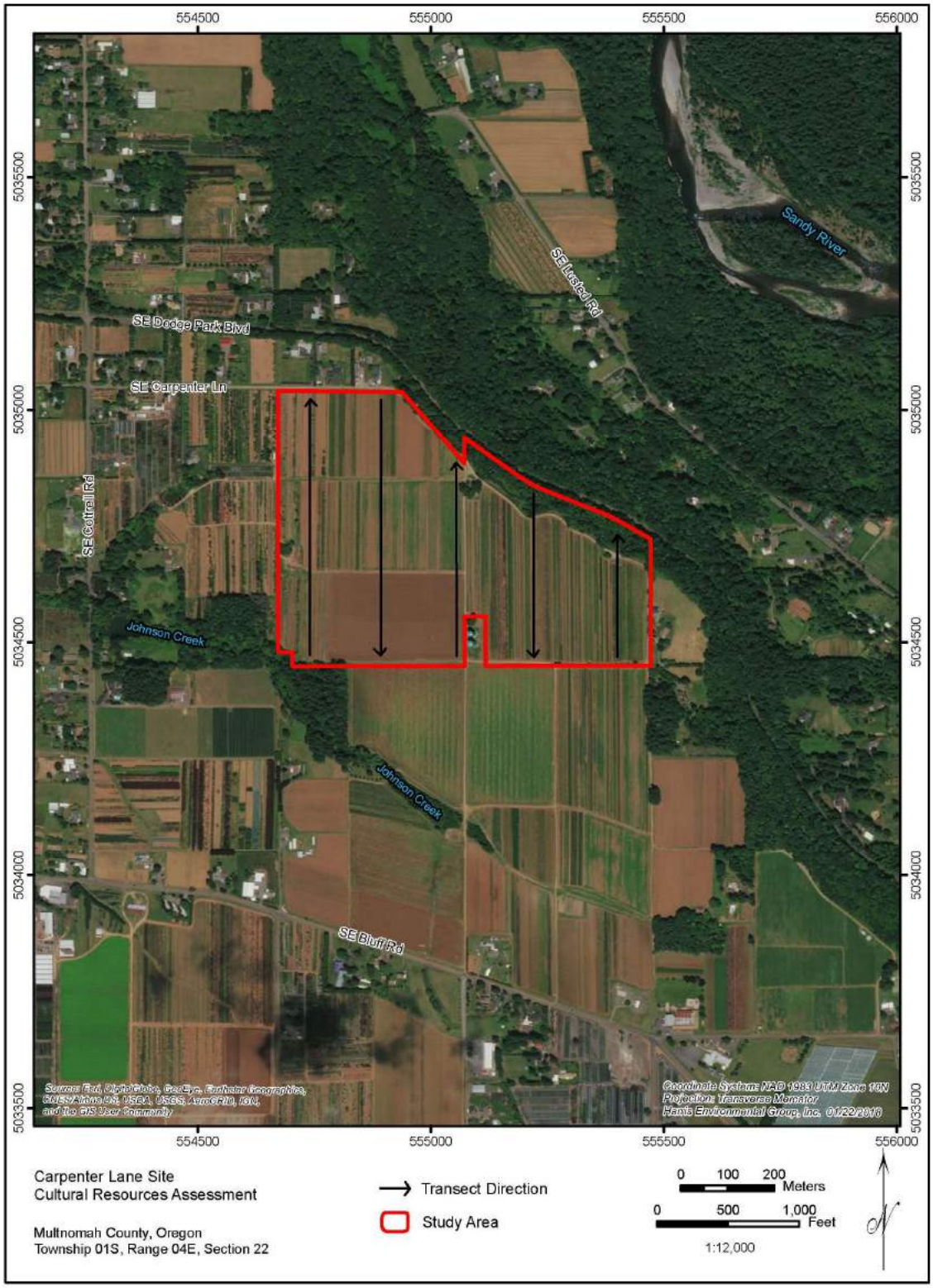


Figure 13. Aerial photomap of the subject property, showing the approximate extent and orientation of the transects walked by HEG during the limited pedestrian survey.

Results and Recommendations

HEG has completed background research and a site assessment within the Carpenter Lane subject property. Background research revealed that although the subject property has a moderate probability to contain cultural resources, based on its location above the Sandy River, there are no previously recorded historic properties, including archaeological resources, within its boundaries. The subject property is characterized by planted tree farm nursery, and has been under cultivation for at least the last 70 years, as evidenced by aerial photographs. Aerials photographs revealed three areas where structures had previously been located.

During the site visit, HEG observed excellent soil visibility, with nearly 100% of the soils across the portions of the subject property under active cultivation (Figures 3-5). Soils observed during the limited walkover survey were dark brown clay loam, with some areas of reddish soil visible where plowing had penetrated to the subsoil (Figure 14). The soils observed are consistent with the descriptions given by the NRCS (2018), and are interpreted to be primarily intact, although disturbed in the upper portions due to decades of agricultural plowing.

Figure 14. Photograph of the soils observed within the subject property, with reddish brown subsoil visible within plowed areas.

No extant structures are currently located within the subject property. HEG inspected all three areas where structures appeared on historic aerial photographs and did not observe evidence of these structures. Modern milled lumber and concrete were observed within the approximate

footprint of the southernmost structure however these items are not definitively associated with the structure. No other evidence for structural remains were observed.

The location of the subject property, on a previously un-surveyed terrace above the Sandy River, at the eastern margin of the Portland Basin, increases the probability of encountering pre-contact archaeological resources. However, the long history of agricultural plowing within the upper sediments decrease the likelihood that any archaeological deposits will retain integrity. **Based on the results of both background research and the site visit, it is the opinion of Harris Environmental that the subject property has a low to moderate likelihood of containing intact archaeological and/or historical resources. Harris Environmental recommends additional testing and research as outlined below:**

1. The site visit described in this report represents a limited pedestrian survey intended to assess the likelihood of the subject property to contain intact deposits, only. No subsurface testing was performed as part of this assessment. As the planned project includes the possibility of deep excavation at the site to deal with hydraulic needs, **it is the recommendation of Harris Environmental that subsurface testing be performed in a systematic grid across the subject property in order to determine whether cultural deposits are located within the boundaries of the subject property that would be affected by the proposed project**.

2. Background research and consultation with HDR revealed that a historic trolley line corridor is located adjacent to the subject property. **Harris Environmental recommends further archival research on this resource** in order to identify the location of this rail corridor its connections to the community surrounding the project site and to the history of the water system in the region. Preliminary research can be accomplished at locations including, but not limited to: the Oregon Historical Society, Portland city archive, the Gresham Library, and the Sandy library. We also recommend contact with Portland General Electric about historical materials about the trolley and its uses, especially for freight, that PGE might have in order to characterize resources that might be disturbed by excavation for ancillary facilities for the treatment plant (access roads or pipe corridors) and to identify potential opportunities for educational interpretation at the site as a cultural amenity for the surrounding community and as a resource for water system education.

Although the potential is low, there remains a possibility that unidentified archeological materials/resources exist in the subject property, especially subsurface materials or features. In the unlikely event of an inadvertent discovery of potentially significant archaeological materials (bones, shell, stone tools, hearths, etc.) and/or human remains found on the subject property, all work in the immediate vicinity must stop, the area must be secured, and the discovery must be reported to the State Historic Preservation Office (SHPO) and the Commission on Indian Services (CIS). Native American ancestral remains, funerary objects, sacred objects, and objects of cultural patrimony associated with Oregon Tribes are protected under state law, which includes criminal penalties (ORS 97.740-.994 and ORS 358.905-.961). State law [ORS 97.745 (4)] requires that any discovered human remains suspected to be Native American shall be reported to the State Police,

SHPO, CIS, and all appropriate Native American Tribes as provided by CIS. Compliance with all applicable laws pertaining to archaeological resources and human remains is required.

The following Inadvertent Discovery Plan (IDP) should be followed if cultural materials including human remains are encountered during construction.

Protocol for coordination in the event of inadvertent discovery:

- In the event of an inadvertent discovery of possible cultural materials, including human remains, all work will stop immediately in the vicinity of the find. A 30-meter buffer should be placed around the discovery with work being able to proceed outside of this buffered area unless additional cultural materials are encountered.
- The area will be secured and protected.
- The project manager/land manager will be notified. The project/land manager will notify the State Historic Preservation Office (SHPO). If possible human remains are encountered, the Oregon State Police, Commission on Indian Services (CIS), SHPO, and appropriate Tribes will also be notified.

  - Oregon State Police: Chris Allori 503-731-4717
  - CIS: Karen Quigley 503- 986-1067
  - Appropriate Tribes: As designated by CIS
  - SHPO: Dennis Griffin 503-986-0674, John Pouley 503-986-0675, or Matt Diederich 503-986-0577.

- No work may resume until consultation with the SHPO has occurred and a professional archaeologist is able to assess the discovery.
- If human remains are encountered, do not disturb them in any way. *Do not call 911*. Do not speak with the media. Secure the location. Do not take Photos. The location should be secured and work will not resume in the area of discovery until all parties involved agree upon a course of action.
- A professional archaeologist may be needed to assess the discovery and they will consult with SHPO and appropriate Tribal Governments to determine an appropriate course of action.
- Archaeological excavations may be required. This is handled on a case by case basis by the professional archaeologist and project manager, in consultation with SHPO and appropriate Tribes.

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APPENDIX C –

PHASE I ENVIRONMENTAL SITE ASSESMENT REPORT

Phase I Environmental Site Assessment

Carpenter Lane Site
Gresham, Oregon
January 2018

Prepared For:

City of Portland Water Bureau
1120 SW 5th Avenue #600
Portland, OR 97204

Prepared by:

AKANA
6400 SE Lake Road, Suite 270
Portland, OR 97222

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EXECUTIVE SUMMARY

This Phase I Environmental Site Assessment (ESA) was conducted by Akana for City of Portland Water Bureau's (PWB) proposed water treatment facility location on Carpenter Lane, located in southeastern Multnomah County, Gresham, Oregon.

The objective of the Phase I was to determine if Recognized Environmental Conditions (RECs) were present on-site. RECs are defined by the American Society for Testing and Materials (ASTM) Standard E 1527-13 as "*the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to any release to the environment; (2) under conditions that indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment*."

De minimis conditions, also described in this report, are those conditions that generally do not present a threat to human health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies. Conditions determined to be *de minimis* are not RECs.

We have performed a Phase I ESA in conformance with the scope and limitations of ASTM Practice E 1527-13 and 40 CFR Part 312, "Standards and Practices for All Appropriate Inquiries," for PWB Carpenter Lane site in Gresham, Oregon (herein after the Subject Property). Any exceptions to, or deletions from, these Practices are described in Section 9.0 of this report.

FINDINGS AND CONCLUSIONS

Subject Property

The Subject Property is currently owned by PWB and is located approximately four miles east of US 26. The Subject Property is south of Carpenter Lane, with the physical address of 35050 SE Carpenter Ln, Gresham, OR 97080. Land/Lease ownership, titles, and rights of way were not reviewed during the Phase I. Maps of the Subject Property are provided on Figures 2-1 and 2-2.

The Subject Property consists of 108 acres of predominantly agricultural land. The Subject Property has a northern border of Carpenter Lane on the western half of the property. On the eastern half of the property Dodge Park Boulevard creates the northern border. To the south of Dodge Park Boulevard there is a narrow strip of densely forested land on the Subject Property. Immediately south of the densely forested section of land is a metal fence with shade cloth that runs east to west on separating the forest and the cultivated lands on the Subject Property. To the south of the fence there is a dirt access road and cultivated farm lands extending to the south from the dirt access road.

No residential or agricultural related structures are located currently on the Subject Property but desktop review and site recognizance show locations of historical structures that have been removed on the Subject Property.

In the middle of the southern border of the Subject Property there is a separate land parcel approximated at 1.21 acres that is surrounded on the north, east and west sides by the Subject Property. The parcel has two vertical water tower tanks that are constructed on concrete pads and are surrounded by metal security fence with razor wire.

On the west-central border of the Subject Property Akana personnel also observed a large burn pile consisting of dead and discarded shrubs and trees, shrub and tree trimming, discarded furniture. The burn pile on the Subject Property was observed to cover a large area of over 1,500 square feet. To the north of the burn pile on the north side of a tree row Akana personnel observed two parked and disabled utility trucks, and various oil and hydraulic fluid containing mechanical equipment that have been abandoned, scrap metal, and various other trash items. An empty forty three gallon metal drum of unknown materials labeled with flammable warning label and second label with distributor information but no identification of the barrel contents. Akana personnel observed soils around the barrel to not have any strong odors or visible staining, and it was observed that the metal of the barrel was rusted and weathered. The integrity of the barrel was not determined during the site visit.

During field reconnaissance, the presence of the burn pile on the Subject Property was observed on the west-central portion of the Subject Property. The burned material was observed as a large burned up mound of charred materials with measurements of approximately 60 feet wide by 60 feet long and 8 feet high. The burn pile refers to unidentifiable woody debris, organic matter, soil, sand, or other debris brought to the burn pile location from unidentified locations with the majority visual identified. There are two primary environmental concerns associated with burn piles on the property. The first concern is the potential for the burned materials to have originated from an off-site contaminated source. The second environmental concern is the potential for contamination to be present on or in the soil beneath the burned fill materials. Historical aerial photographs of the area show this burn site to be the same approximate location of an agricultural outbuilding structure built sometime on or prior to 1948 and raised between 1975 and 1982.

Groundwater flow direction typically mimics surface topography that slopes gently to the southeast for the eastern half the Subject Property and generally flows to the southwest on the western half of the Subject Property.

Area Properties

The Subject Property is bound on the north by the eastern terminus of South East Carpenter Lane and a gravel road with undeveloped forest on the north side of the gravel road. To the east

are multiple single family residences and the end of the gravel road extending from Carpenter Lane. Agricultural fields and a gravel road that forms the border between Multnomah and Clackamas County are located on the adjacent properties to the south. The upper reaches of Johnson Creek are located outside the border of the southwest corner of the Subject Property. An agricultural field with active shrub nursery operations separated by a dirt access road is located to the west of the Subject Property. Multiple single family residences are located outside the northwest corner of the Subject property at the end of paved section of South East Carpenter Lane.

De Minimis Conditions

Akana observed four separate areas on the Subject Property with scattered debris consisting of empty flammable material barrels, hydrologic and mechanical equipment, two disabled vehicles, discarded tires, treated timbers, scrap plastic, scrap metal, scrap building supplies such as bricks and mortar and various other incinerated organic materials and inorganic debris trash items on a burn pile. One empty 43 gallon metal barrel labeled with flammable materials warning labels was noted to be stored under a tree row. These four separate areas identified in this report as Areas of Potential Concern (AOPC) did not show evidence of soil staining, contamination, extreme noxious or heavy petroleum odors that would represent a REC; therefore, this area is considered to be a housekeeping issue that meets the definition of *de minimis* conditions.

Recommendations

Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), this assessment was conducted to identify sites within the ASTM required search distance that may pose a risk of environmental contamination by hazardous wastes and substances. The Subject Property was not listed with any past environmental violations in any of the regulatory agency databases. Due to the fact that the Subject Property has been historically cultivated and is actively cultivated by a nursery operation tenant, all of the cultivated agricultural and nursery lands have been identified as a REC see figure 2-2. Akana recommends a Phase II ESA to conduct sampling of surface soils in the cultivated areas of the Subject Property to determine the horizontal and vertical extent of contaminants of potential concern (COPC) associated with agricultural activities. Soil sampling should be performed in conformance with the Oregon Department of Environmental Quality (DEQ) Guidance for Evaluating Residual Pesticides on Lands Formerly Used for Agricultural Production under the Hazardous Substance Remedial Action Rules (Oregon Administrative Rules (OAR) 340-122-0010 through 0115).

At the time of site reconnaissance the Subject Property contained a substantial amount of miscellaneous debris and trash items, discarded furniture, abandoned vehicles, empty barrel,

mechanical equipment, scrap metal, scrap brick and building supplies and various other trash items that could be associated with the occupants nursery operation active on the site. These four locations of discarded debris on the Subject Property are identified in this report as four separate AOPC # 1, 2, 3, 4 that are considered *de minimis* conditions see figure 2-2. Prior to redevelopment, the discarded debris materials located at these four separately identified AOPC should be recycled and/or properly disposed of and documentation of proper disposal should be kept on file.

SECTION 1
INTRODUCTION

1.1 Purpose

This Phase I ESA was conducted by Akana for PWB Subject Property located in southeastern Multnomah County, Gresham, Oregon. The objective of this assessment was to identify RECs associated with the property according to the American Society for Testing Materials (ASTM) E 1527-13 "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process."

The standard defines a REC as: "The presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to any release to the environment; (2) under conditions that indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment."

The term includes hazardous substances or petroleum products even under conditions in compliance with laws. The term is not intended to include *de minimis* conditions that generally do not present a threat to human health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies. Conditions determined to be *de minimis* are not RECs.

This report is in compliance with ASTM E 1527-13 and 40 Code of Federal Regulations Part 312, Standards and Practices for All Appropriate Inquiries. The standard is intended to permit a user to satisfy one of the requirements to qualify for the innocent landowner, contiguous property owner, or bona fide prospective purchaser limitations on CERCLA liability, which is the practice that constitutes "all appropriate inquiry into previous ownership and uses of the property consistent with good commercial or customary practice" as defined at 42 U.S.C. 9601(35) (B).

1.2 Scope of Work

The scope of work for ESAs typically includes the following activities:

1. Review available reports (if provided by Client) that will document previous environmental investigations conducted at the Subject Property.

2. Review reasonably obtainable standard historical sources to attempt to identify those uses or occupancies since the 1940s that are likely to have led to RECs. Typical historical sources that will be reviewed, if reasonably ascertainable, include aerial photographs, historical topographic maps, city directories, Sanborn fire insurance

maps, property tax files, regulatory agency files, and building department permit records.

3. Review readily available topographic, geologic, and hydrogeologic information to determine the types of soil and depth of groundwater that are expected at the Subject Property. Locate the registered water supply wells within a one half-mile radius of the site.

4. Review the following environmental record sources among others listed in the EDR report to identify RECs on the Subject Property and area properties:
   - Federal NPL Site List
   - Federal Proposed NPL Site List
   - Federal Superfund Liens
   - Federal Delisted NPL Site List
   - Federal CERCLIS List
   - Federal CORRACTS Corrective Action Reports
   - Federal RCRA TSD Facilities List
   - Federal RCRA Generators List
   - Federal ERNS List (property and adjoining properties only)
   - US ENG Controls
   - US INST Controls
   - Federal Brownfields
   - Federal Tribal Records
   - State and Tribal Lists of Hazardous Waste Sites Identified for Investigation or Remediation (NPL or CERCLIS equivalents)
   - State and Tribal Landfill and/or Solid Waste Disposal Site Lists
   - State and Tribal Registered, Leaking UST and AST Sites
   - State and Tribal Registered UST Sites
   - State and Tribal Closed Landfill Inventory
   - State and Tribal Registered AST Sites
   - State and Tribal Environmental Liens Listing
   - State and Tribal Spills Database
   - State and Tribal Sites with Institutional Controls
   - State and Tribal Voluntary Cleanup Program
   - State and Tribal Dry Cleaner Registration Database
   - State and Tribal Brownfield Site Assessments
   - Local Lists of Hazardous Waste Sites Identified for Investigation or Remediation (NPL or CERCLIS equivalents)
   - Local Landfill and/or Solid Waste Disposal Site Lists
   - Local Brownfield Site Assessments
   - Local CERCLA Lien Information

5. Review a current United States Geological Survey (USGS) 7.5 minute topographic map showing the area on which the Subject Property is located.

6. Conduct a single site reconnaissance of the Subject Property to collect information on RECs. The site reconnaissance includes a site visit to visually observe the real property, any structure(s) located on the property and the status of any on-site facilities. Perform a visual observation of adjacent properties for evidence of RECs.

7. Interview individual(s) who are reported to have a good knowledge of the history and physical characteristics of the Subject Property and review ASTM questionnaires from the current property owner and the purchaser (if applicable). If the property is abandoned, interview neighboring property owners and occupants to better determine site history.

8. Contact the following state or local agencies, as necessary, in person, by telephone, or in writing to obtain reasonably available information regarding RECs at the Subject Property:
   - Oregon Department of Environmental Quality (ODEQ) to inquire as to existing permits, current or previous permit violations, enforcement actions, or citizen complaints relative to the Subject Property
   - Multnomah county fire department for information concerning existing permits, current or previous permit violations, or citizen complaints relative to the subject site
   - City of Portland for information concerning existing permits, current or previous permit violations, or citizen complaints relative to the Subject Property
   - Portland General Electric utility for available information regarding the presence of polychlorinated biphenyl (PCB) containing or contaminated equipment on the Subject Property
   - City of Gresham building, planning and zoning records as well as city personnel
   - Multnomah County Health Department for information on recorded health code violations on the Subject Property

9. Submit one electronic copy of a Phase I ESA report for the Subject Property that documents the findings and observations. The report will also contain (as appendices) copies of pertinent documents regarding the site and photographs taken during the site visit.

1.3 Significant Assumptions

This Phase I ESA is intended for use on a voluntary basis by persons who wish to assess the environmental condition of the Subject Property taking into account commonly known and reasonably ascertainable information. No environmental site assessment can wholly eliminate

uncertainty regarding the potential for RECs in connection with a property. Performance of this assessment is intended to reduce, but not eliminate, uncertainty regarding the potential for RECs in connection with the Subject Property recognizing reasonable limits of time and cost.

It is understood that the User of this report has reviewed title and judicial records for environmental liens or activity and use limitations, has fully communicated to Akana any specialized or actual knowledge that is material to identifying RECs on the Subject Property, and has determined whether a significantly lower purchase price (if applicable) for the Subject Property is related to hazardous substances or petroleum products on the property.

1.4 Limitations and Exceedances

This Phase I ESA was performed in accordance with ASTM E 1527-13 "Standard Practice for Environmental Site Assessments," and 40 CFR Part 312, Standards and Practices for All Appropriate Inquiries. Any limitations, additions, or deviations from these Practices are stated in Section 7.0.

1.5 Special Terms and Conditions

This report has been prepared exclusively for PWB and its associated entities and each of their partners, directors, officers, employees and attorneys. Akana provided a Proposal to Mr. Andy McCaskill, HDR. The Proposal describes the scope of services, terms, and conditions for this Phase I ESA. Supporting documentation for this assessment is included in the Appendices.

1.6 User Reliance

HDR, PWB, its associated entities, and each of their partners, directors, officers, employees, and attorneys may rely upon the contents of this report. No additional parties may rely on the contents of this report unless written authorization is obtained from Akana. The contents of this report are valid for a period of 180 days from the date of the report. For property transactions that occur 180 days after, but within one year of the date of the report, this report may be updated as stated in the ASTM standard.

SECTION 2
SITE LOCATION AND DESCRIPTION

2.1 Site Location and General Description

The Subject Property is currently owned by PWB and located approximately four miles east of US 26. The Subject Property is located on the south side of the eastern end of Carpenter Lane. The physical address is 35050 SE Carpenter Ln, Gresham, OR 97080. Land/Lease ownership, titles, and rights of way were not reviewed during the Phase I. The Subject Property coordinates are Latitude 45.466068 degrees north and Longitude -122.298133 degrees west. Legal property descriptions as provided by the Multnomah County Appraisal District are provided in Appendix A.

2.2 Site Vicinity General Characteristics

The Subject Property consists of 108 acres of predominantly undeveloped agricultural and densely forested land. Two large water storage tanks surrounded by security fences on 1.21 acres of adjacent land to the south-central portion of the Subject Property is owned and operated by the Pleasant Homes Water District. The northern portion of the Subject Property is densely forested along the south side of Dodge Park Boulevard. The central portion of the Subject Property has been mostly cleared and is currently being used for agricultural use and nursery operations by Surface Nursery Inc. Groundwater flow direction typically mimics surface topography that slopes gently southeast for the eastern half of the Subject Property and slopes southwest for the western half of the Subject Property.

2.3 Description of Structures, Roads, Other Improvements

The Subject Property is accessed through a controlled entry point for Surface Nursery, Inc., operations located at the western end of Carpenter Lane and located on the Subject Property. Clearings have been made for vehicle access along the Subject Property's northern, eastern, western and southern boundaries, as well as multiple unpaved access roads through the middle of the Subject Property to support nursery and agricultural operations. A seven foot tall wire metal perimeter fence surrounds the Subject Property on the north and western sides, and consists of cut down sections of treated wood power poles with steel wire grid, barbed wire strands on the top and bottom, and a shade cloth visual barrier. The fence is used for attempting to keep the wild herd of elk and deer that inhabit the local area of the Subject Property. There are no structures located on the Subject Property. Historical aerial photo records show that a single family residential structure and adjacent agricultural structure (barn) were historically located along the west-central border of the Subject Property. Historical aerial photographs indicated that these structures were removed at an unknown date during the mid to late 1970's. No other paved roads, structures, or improvements were observed on the Subject Property

during site reconnaissance.

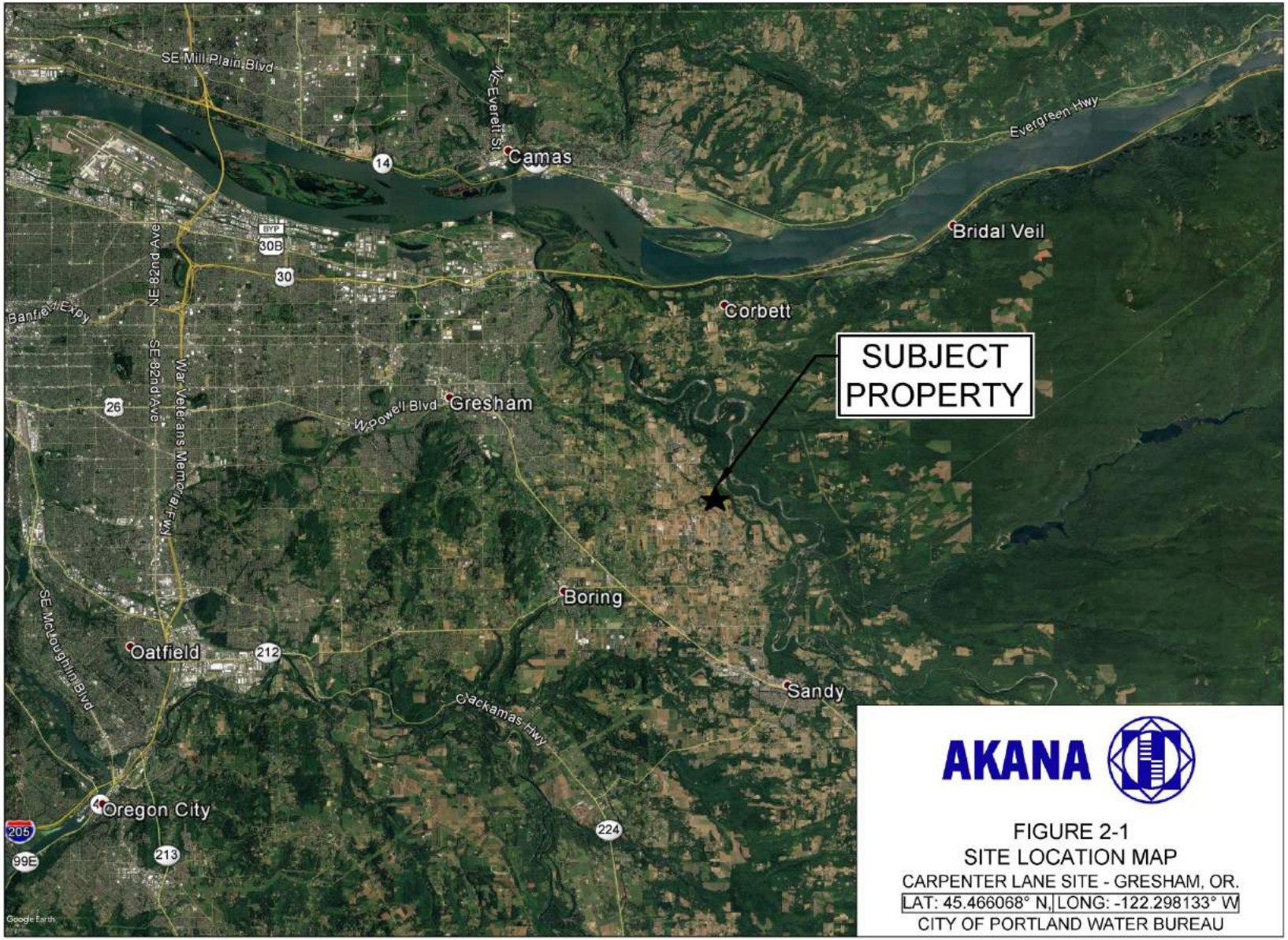
2.4 Current Uses of Adjoining Properties

North: The Subject Property is bound by Carpenter Lane for the eastern half and Dodge Park Boulevard on the west half to the north, with some single family residential structures and undeveloped forest on the north side of these roads.

East: To the east is Dodge Park Boulevard and private property with single family residences.

South: Agricultural lands with cultivated fields and nursery fields are located on the adjacent properties to the south. The property adjacent to the south-central portion of the Subject Property consists of two large water holding tanks owned by the Pleasant Home Water District. This parcel of land is surrounded by a metal and razor wire security fence around the two tanks.

West: A different nursery operator than the Subject Property leases called R&H Nursery operates on the land that is adjacent the Subject Property's western boundary, and consists of actively cultivated tree and shrub nursery fields, a parked semi-trailer, and two residential structures located 0.10 mile and 0.15 mile across the Subject Property's western boundary. On the adjacent property across the southwest corner from the Subject Property, there is a small structure of less than 10 square feet being used for irrigation parts and pump storage.


SE Mill Plain Blvd
NE Everett St
Camas
Evergreen Hwy
Bridal Veil
Corbett
SUBJECT PROPERTY
Banfield Expy
NE 82nd Ave
SE 82nd Ave
War Veterans Memorial Fwy
W Powell Blvd
Gresham
Boring
Oatfield
SE McLoughlin Blvd
Sandy
Clackamas Hwy
Oregon City
14
30B
30
26
212
224
205
99E
213
AKANA
FIGURE 2-1
SITE LOCATION MAP
CARPENTER LANE SITE - GRESHAM, OR.
LAT: 45.466068° N, LONG: -122.298133° W
CITY OF PORTLAND WATER BUREAU

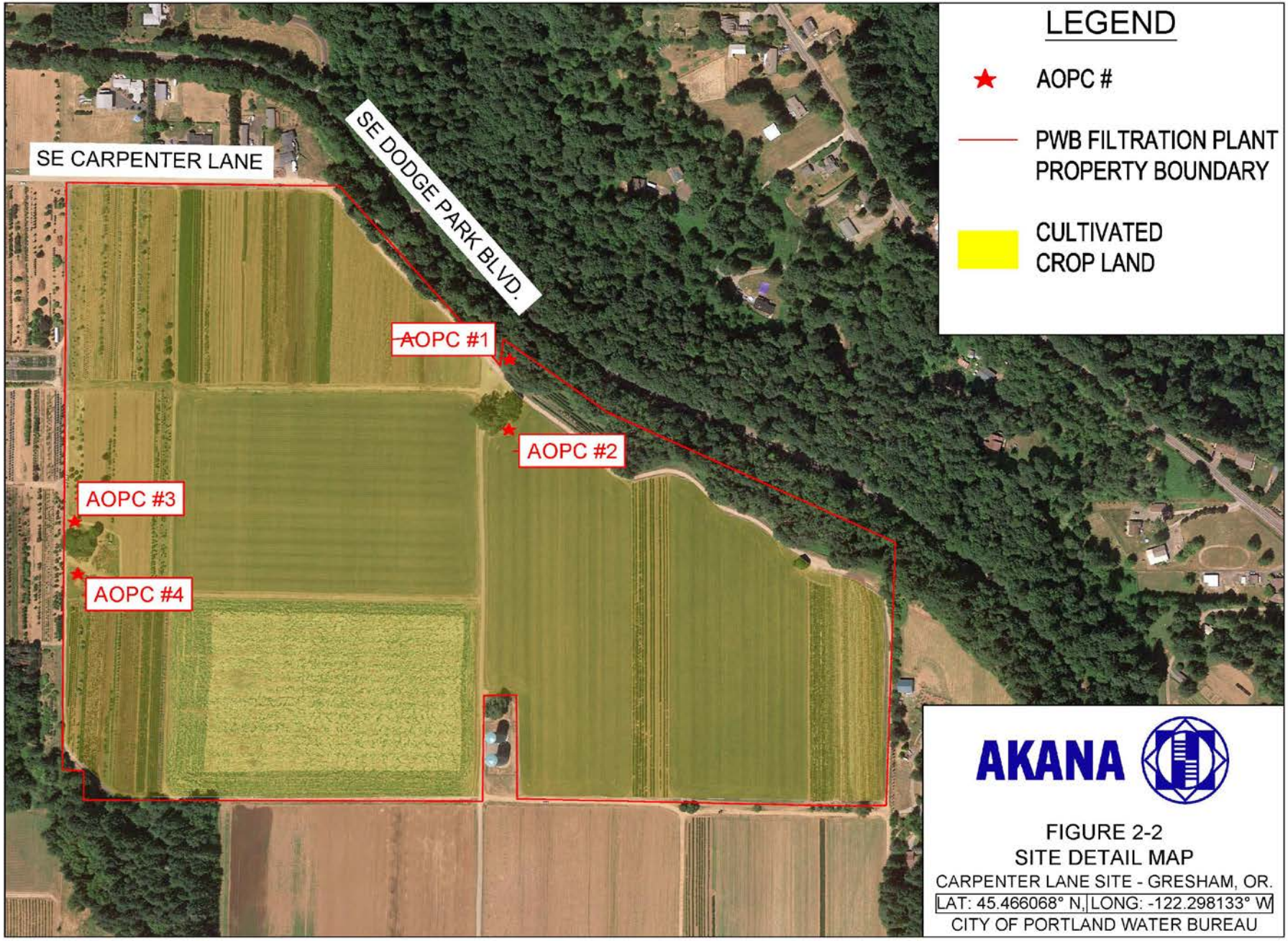


FIGURE 2-2
SITE DETAIL MAP
CARPENTER LANE SITE - GRESHAM, OR.
LAT: 45.466068° N, LONG: -122.298133° W
CITY OF PORTLAND WATER BUREAU

SECTION 3
DATABASE AND RECORDS REVIEW

3.1 Reason for Performing Phase I

The purpose of this Phase I ESA is to provide information that will give City of Portland Water Bureau the documentation that will enable them to qualify for a landowner liability protection to CERCLA liability and to understand the potential environmental conditions that could materially impact the operations associated with the Subject Property.

3.2 Topography

The Subject Property lies at an elevation of 741 feet above mean sea level as determined from the 2014 USGS topographic map provided on Figure 3-1. The general topographic gradient at the Subject Property ranges from approximately 650 feet at the southwest corner to 750 feet along the eastern boundary.

Akana reviewed available historical USGS Topographic Maps for the Subject Property, including the Boring, OR Quadrangle dated 1911, 1914, 1939, 1940; the Estacada, OR Quadrangle date 1916; and the Sandy, OR Quadrangle dated 1954, 1961, 1970, 1975, 1985, 2014 for information regarding past uses of the Subject Property.

The review of historical USGS Maps did not identify features indicative of RECs at the Subject Property or the adjacent properties. Copies of historical USGS Topographic Maps for the Subject Property are provided in Appendix B.

3.3 Local Geology

The Subject Property is located within the Western Cascades region of Oregon between the Willamette Valley and the High Cascades. The range contains many extinct shield volcanoes, cinder cones and lava flows, is highly eroded, and heavily forested.

The region was volcanically active from approximately 35 to 17 million years ago. The province is characterized as an older, deeply eroded volcanic range lying west of the more recent snow-covered High Cascade Range. They range in elevation from 1,700 feet (520 m) on the western margin to 5,800 feet (1,800 m) on the eastern margin. The Western Cascades began to form 40 million years ago with eruptions from a chain of volcanoes near the Eocene shoreline. As the regional angle of subduction steepened, volcanic activity gradually shifted to the east in the Miocene and Pliocene.

The Western Cascades are made up almost entirely of slightly deformed and partly altered volcanic flows and pyroclastic rocks which range in age from late Eocene to late Miocene. These

rocks have been heavily dissected by erosion and the only evidence remaining of the many volcanoes from which they were erupted are occasional remnants of volcanic necks or plugs which mark former vents. There is also minor Pliocene to Pleistocene intracanyon lavas derived from the High Cascades or rare local vents.

The Subject Property is underlain by the Troutdale Formation of the Willamette Group. The Troutdale Formation is described as fine grained sediments, fluvial mudstones, sandstones and conglomerates, and older fluvial terraces.

The geologic description can be located in Geology and Soil Report provided in Appendix I.

3.4 Local Hydrogeology

The Subject Property is located within the Columbia Plateau Regional Aquifer System (CPRAS). The primary aquifers of the CPRAS are basalts of the Columbia River Basalt Group (CRBG) and overlying basin-fill sediments. Miocene basaltic rocks are generally the major aquifers of the Columbia Plateau, descriptions provided in Appendix I.

3.5 Wetlands

EDR Physical Setting Report indicated no wetland areas on the Subject Property. An intermittent streambed listed as Johnson Creek slopes adjacent to the southwest corner of the Subject Property. Upper Johnson Creek is an intermittent streambed that is seasonally flooded. Akana also reviewed the US Fish & Wildlife Service website's wetlands mapper to verify the presence of no wetlands at the Subject Property.

As shown on the FEMA Map, the Subject Property is located within Zone C. Zone C is an area of minimal flood hazard, usually depicted on Flood Insurance Rate Maps (FIRMs) as above the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. EDR – used the incorrect panel – should be 41051C0435H Zone X. The FEMA FIRM is provided in Appendix G.

3.6 Soils

The soils that underlie the Subject Property are shown to be mainly Class C soils with layers impeding downward movement of water, or soils with moderately fine or fine textures. The predominant soil types of the Subject Property are the Cazadero soils and Haplumbrepts soils. These soils are classified as fine-grained soils, silts and clays. The Natural Resources Conservation Service map is found on page 5 of Appendix H.

3.7 Historical Land Use Information

Information sources consulted to evaluate past and present land use activities at the Subject Property include the following:

- Historical Aerial Photographs – EDR, January 22nd, 2018
- Water Well Report – EDR, January 22nd, 2018
- Historical Topographic Maps – EDR, January 22nd, 2018
- Historical Sanborn maps – EDR, January 22nd, 2018
- City Directories – EDR, January 22nd, 2018
- Environmental Liens – EDR, January 22nd, 2018

The ASTM E-1527-13 standard requires that review of historical sources be conducted from the present back to when the property first contained structures or was used for residential, agricultural, commercial, industrial, or governmental purposes. This task requires reviewing only as many of the "Standard Sources" as are necessary and both reasonably ascertainable and likely to be useful.

Historical information concerning the Subject Property that was available and received included historical aerial photographs for flight years 1948 through 2012.

3.8 Aerial Photographs

Aerial photographs from the EDR Aerial Photo Package for the years 1948, 1952, 1955, 1960, 1963, 1970, 1975, 1982, 1991, 1994, 2000, 2000, 2005, 2006, 2009, 2011, and 2012 are provided in Appendix D and described below.

<u>1948 Aerial Photograph Scale 1"= 500'</u>

In the 1948 photograph the Subject Property and the surrounding area consist of cultivated agricultural fields and grazing lands crossing north to south and east to west with multiple unpaved access roads to the agricultural field. Carpenter Lane is visible at the northwest corner of the Subject Property which turns to the south and ends at the Subject Property. One single residential structure adjacent to an agricultural structure is visible on the west-central border of the Subject Property. Lightly forested land, the road, and railroad right of way are visible along the northern boundary of the Subject Property in the 1948 Aerial Photograph. One section of densely forested land in the southwestern portion of the Subject Property appears to have been partially cleared in the 1948 photograph, but is generally undisturbed compared to the surrounding agricultural lands.

<u>1952 Aerial Photograph Scale 1"= 500'</u>

In the 1952 photograph the northern section appears to be more heavily forested than in the 1948 photograph, and the forested section in the southwest portion of the Subject Property appears to have been cleared of some additional trees.

<u>1955 Aerial Photograph Scale 1"= 500'</u>

In the 1955 photograph the northern section appears to be more heavily forested that in the 1952 photograph and the forested section in the southwest portion of the Subject Property appears to have been cleared of all trees.

1960 Aerial Photograph Scale 1″= 500′

The 1960 photograph shows the Subject Property and the surrounding area much as they were in the 1955 photograph.

1963 Aerial Photograph Scale 1″= 500′

The 1963 photograph shows the Subject Property and the surrounding area much as they were in the 1960 photograph.

1970 Aerial Photograph Scale 1″= 500′

The 1970 photograph shows that the forested section of land in the southwest area of the Subject Property has been completed cleared and grubbed, and the forested areas on the northern border appear to have become more densely forested. The 1970 photograph shows a residential structure that has been constructed on the property adjacent to the eastern boundary of the Subject Property. The 1970 photograph shows that the agricultural and grazing lands on the eastern side of the property have been converted to nursery crops.

1975 Aerial Photograph Scale 1″= 500′

In the 1975 photograph, the Subject Property remains mostly vacant and undeveloped with the only residential and agricultural structures still located on the west-central border of the Subject Property. On the northern portion of the Subject Property, the photograph shows that a dirt road has been cut and graded bordering the southern side of the densely forested section, with the access road separating the forested section to the north and the cultivated agricultural fields to the south.

1982 Aerial Photograph Scale 1″= 500′

The 1982 photograph shows that the residential and agricultural structures on the western border of the Subject Property have been removed and these areas have been revegetated. The 1982 photograph also shows that one water tower has been constructed across the south-central border of the Subject Property in a separate tax lot surrounded on the north, east, and west sides by the Subject Property.

1991 Aerial Photograph Scale 1″= 1000′

The 1991 photograph shows the Subject Property and the surrounding area much as they were in the 1982 photograph.

1994 Aerial Photograph Scale 1″= 500′

The 1994 photograph shows that the majority of the cultivated agricultural and grazing lands on the Subject Property have been converted into nursery fields possibly for tree and shrub production.

2000 Aerial Photograph Scale 1″= 500′

The 2000 photograph shows the Subject Property and the surrounding area much as they were in the 1994 photograph.

2000 Aerial Photograph Scale 1″= 750′

In the 2000 photograph taken at scale of 750′ per inch the resolution quality of the image is poor and details cannot be identified.

2005 Aerial Photograph Scale 1″= 500′

The 2005 photograph shows the Subject Property and the surrounding area much as they were in the 2000 and 1994 photographs.

2006 Aerial Photograph Scale 1″= 500′

The 2006 photograph shows the Subject Property and the surrounding area much as they were in the 2005 photograph.

2009 Aerial Photograph Scale 1″= 500′

In the 2009 photograph there are two additional white objects on the west-central border of the Subject Property in the general area of where the residential and agricultural structures were removed. These white objects may be the abandoned vehicles observed onsite during the site reconnaissance visit. Additional single family residential structures have been constructed to the north and west of the Subject Property.

2011 Aerial Photograph Scale 1″= 500′

The 2011 photograph shows the Subject Property and the surrounding area much as they were in the 2009 photograph.

2012 Aerial Photograph Scale 1″= 500′

The 2012 photograph shows the Subject Property and the surrounding area much as they were in the 2011 photograph.

3.9 City Directories

City directories list property occupants by individual property address and when available can often aid in determining historical property uses. City directory information was searched for

the Subject Property and surrounding area in approximately five-year intervals between 1924 and 2014. There are no RECs for the Subject Property and with the surrounding properties based on a search of three separate addresses adjacent to the Subject Property. EDR City Directory Report is provided in Appendix E.

3.10 Historical Sanborn Maps

EDR conducted a search for fire insurance maps by reviewing records from the Library of Congress, University Publications of America, and university, state and local libraries. Based on the information provided, no Sanborn Fire Insurance Map coverage is available for the Subject Property. The FIM No Coverage Report is provided in Appendix F.

3.11 Federal Databases

At the federal level, EDR provided information collected from databases maintained by the EPA, which contain locations of NPL sites and the location of facilities, which are regulated under the framework of RCRA. Information was supplied by EDR for NPL and RCRIS treatment, storage and disposal facilities; RCRIS small quantity generators, and large quantity generators; CORRACTS, and CERCLIS sites where the Lien on Property action is complete. EDR also provided information from EPA's ERNS database for incident reports on spills of hazardous materials or petroleum products at the Subject Property. As shown in Table 1, the database search of these information sources by EDR indicated no sites in the area of the Subject Property. Only those properties located that are considered of potential interest are discussed in the text below the table. Descriptions of all of the listed properties are provided in the EDR database. The EDR reports are included as Appendix G.

Table 1
Summary of Federal Database Findings

Database	Search Distance (miles)	Number of Sites	Closest Facilities/Topographic Relationship
NPL LIENS	TP	0	NA
ERNS	TP	0	NA
HMIRS	TP	0	NA
US FIN ASSUR	TP	0	NA
EPA WATCH LIST	TP	0	NA
TSCA	TP	0	NA
TRIS	TP	0	NA
SSTS	TP	0	NA
RMP	TP	0	NA
RAATS	TP	0	NA
PRP	TP	0	NA
PADS	TP	0	NA
ICIS	TP	0	NA

Table 1 Summary of Federal Database Findings			
Database	**Search Distance (miles)**	**Number of Sites**	**Closest Facilities/Topographic Relationship**
FTTS	TP	0	NA
MLTS	TP	0	NA
COAL ASH DOE	TP	0	NA
PCB TRANSFORMER	TP	0	NA
RADINFO	TP	0	NA
HIST FTTS	TP	0	NA
DOT OPS	TP	0	NA
INDIAN RESERV	TP	0	NA
LEAD SMELTERS	TP	0	NA
US AIRS	TP	0	NA
AIRS	TP	0	NA
ABANDONED MINES	TP	0	NA
FINDS	TP	0	NA
DOCKET HWC	TP	0	NA
ECHO	TP	0	NA
EDR HIST AUTO	0.125	0	NA
EDR HIST CLEANER	0.125	0	NA
RCRA-LQG	0.250	0	NA
RCRA-SQG	0.250	0	NA
RCRA-CESQG	0.250	0	NA
RCRA NonGen/NLR	0.250	0	NA
2020 COR ACTION	0.250	0	NA
US MINES	0.250	0	NA
FUELS PROGRAM	0.250	0	NA
FEDERAL FACILITY	0.500	0	NA
SEMS	0.500	0	NA
SEMS-ARCHIVE	0.500	0	NA
RCRA-TSDF	0.500	0	NA
LUCIS	0.500	0	NA
US ENG CONTROLS	0.500	0	NA
US INST CONTROL	0.500	0	NA
SCRD DRYCLEANERS	0.500	0	NA
COAL ASH EPA	0.500	0	NA
NPL	1.0000	0	NA
PROPOSED NPL	1.0000	0	NA

Table 1 Summary of Federal Database Findings			
Database	**Search Distance (miles)**	**Number of Sites**	**Closest Facilities/Topographic Relationship**
DELISTED NPL	1.0000	0	NA
CORRACTS	1.0000	0	NA
FUDS	1.0000	0	NA
DOD	1.0000	0	NA
ROD	1.0000	0	NA
CONSENT	1.0000	0	NA
FUSRAP	1.0000	0	NA
UXO	1.0000	0	NA
EDR MGP	1.0000	0	NA
Note – For definitions of acronyms see EDR databases in Appendix G			

The database searches located one orphan site identified in the LUST database to the southwest of the Subject Property at 8344 SE Cottrell Road, Boring, OR 97009. A site is referred to as an "orphan" site by EDR due to poor or inadequate address information. This location is adjacent to a small body of water associated with Johnson Creek and is within 0.25 mile of the Subject Property. Based on Akana desktop review, the orphan LUST site is located downgradient of the Subject Property at an elevation of 640 feet above sea level. Due to the observed topographical relationship, this site is not considered a REC in association with the Subject Property.

3.12 State/Tribal/Local Database

At the state, tribal and local levels, EDR provided information collected from databases maintained by the Ecology, other state and tribal databases to determine if any known environmental problems existed on or near the Subject Property. EDR provided Akana with information from the Ecology databases listed in Table 2. The database search of these information sources by EDR indicated four (4) LUST sites in the Subject Property area. Only those properties located such that they are considered of potential interest are discussed in the text below the table. After review, the state/tribal listings revealed no evidence of RECs in connection with the Subject Property. Descriptions of all of the listed properties are provided in the EDR database. The EDR reports are included as Appendix G.

Table 2 Summary of State and Tribal Database Findings			
Database	**Search Distance (miles)**	**Number of Sites**	**Closest Facilities/Topographic Relationship**
US HIST CDL	TP	0	NA
US CDL	TP	0	NA
CDL	TP	0	NA
LIENS 2	TP	0	NA
HMIRS	TP	0	NA
SPILLS	TP	0	NA
SPILLS 90	TP	0	NA
AIRS	TP	0	NA
US FINANCIAL ASSURANCE	TP	0	NA
NPDES	TP	0	NA
OR UIC	TP	0	NA
RGA HWS	TP	0	NA
RGA LF	TP	0	NA
RGA LUST	TP	0	NA
FEMA UST	0.250	0	NA
OR UST	0.250	0	NA
OR AST	0.250	0	NA
INDIAN UST	0.250	0	NA
OR DRYCLEANERS	0.250	0	NA
OR MANIFEST	0.250	0	NA
OR SWF/LF	0.500	0	NA
OR LUST	0.500	4	Heating oil tank, 0.1 mi. ESE, downgradient
			Heating oil tank, 0.15 mi. ENE, downgradient
			Heating oil tank, 0.25 mi. NNE, downgradient
			Heating oil tank, 0.46 mi. ESE, downgradient
INDIAN LUST	0.500	0	NA
OR INST CONTROL	0.500	0	NA
OR VCP	0.500	0	NA
INDIAN VCP	0.500	0	NA
OR BROWNFIELDS	0.500	0	NA
US BROWNFIELDS	0.500	0	NA

Table 2 Summary of State and Tribal Database Findings			
Database	**Search Distance (miles)**	**Number of Sites**	**Closest Facilities/Topographic Relationship**
OR SWRCY	0.500	0	NA
INDIAN ODI	0.500	0	NA
DEBRIS REGION 9	0.500	0	NA
ODI	0.500	0	NA
IHS OPEN DUMPS	0.500	0	NA
OR COAL ASH	0.500	0	NA
OR ECSI	1.0000	0	NA
Note – For definitions of acronyms see EDR databases in Appendix G.			

Four properties were located in the State/Tribal/Local Database LUST and are summarized below:

State/Tribal/Local Database Review

Facility Name:	**Heating Oil Tank**
Facility Location:	36625 SE Dodge Park Boulevard, Gresham, OR 97080
Distance/Topographic Elevation	0.100 Miles ESE / 624 Feet
Database(s):	LUST #S105075814 Northwestern Region
Database Summary:	Facility 03-01-6172 Cleanup Complete Date 07/12/2001
Conclusion:	Listing is for an offsite location at a lower elevation relative to the Subject Property. Site cleanup completed, therefore not considered a REC for the Subject Property.

Facility Name:	**Heating Oil Tank**
Facility Location:	36315 SE Lusted Road, Boring, OR 97009
Distance/Topographic Elevation	0.148 Miles ENE / 446 Feet
Database(s):	LUST #S106475925 Northwestern Region
Database Summary:	Facility 26-04-1132 Cleanup Complete Date 07/28/2004

Conclusion:	Listing is for an offsite location at a lower elevation relative to the Subject Property. Site cleanup completed, therefore not considered a REC for the Subject Property.

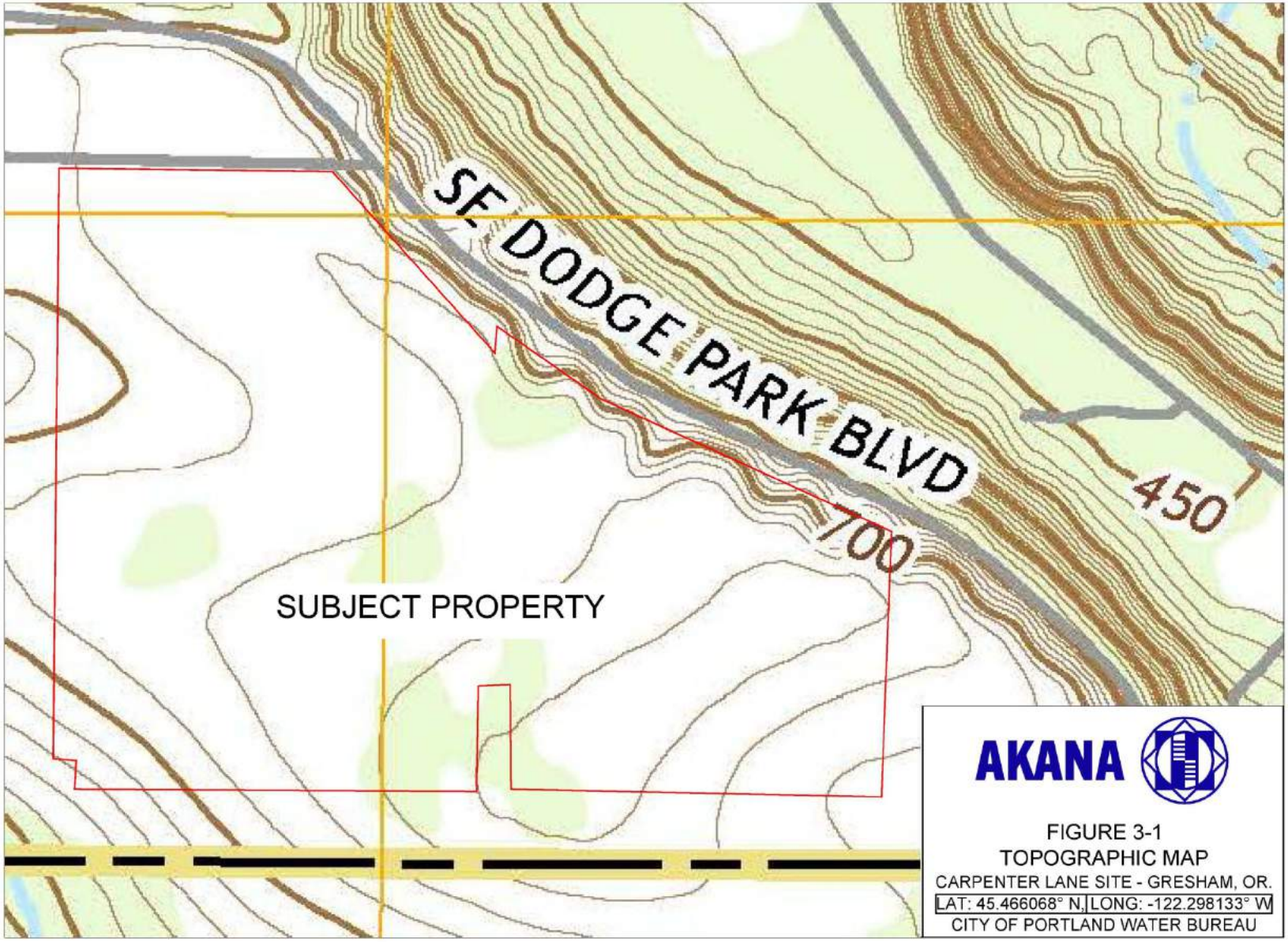
Facility Name:	**Heating Oil Tank**
Facility Location:	35638 SE Lusted Rd Boring, OR 97009
Distance/Topographic Elevation	0.252 Miles NNE / 445 Feet
Database(s):	LUST #S110292513 Northwestern Region
Database Summary:	Facility 03-10-0238 Cleanup Complete Date 02/17/2011
Conclusion:	Listing is for an offsite location at a lower elevation relative to the Subject Property. Site cleanup completed, therefore not considered a REC for the Subject Property.

Facility Name:	**Heating Oil Tank**
Facility Location:	37160 SE Lusted Road, Boring, OR 97009
Distance/Topographic Elevation	0.463 Miles NNE / 510 Feet
Database(s):	LUST #S111332384 Northwestern Region
Database Summary:	Facility 03-11-0759 Cleanup Complete Date 07/23/2012
Conclusion:	Listing is for an offsite location at a lower elevation relative to the Subject Property. Site cleanup completed, therefore not considered a REC for the Subject Property.

3.13 Water Well Search (Up to ½ Mile)

A water well search was performed by EDR to locate water supply wells within a 1/2 mile radius of the Subject Property. One Federal Public Water Supply system was located within 1/2 mile of the Subject Property.

EDR located two water wells on the Subject Property both listed as a State registered wells. The water well and pump/treatment house are located at the southwest corner of the Subject Property. One water well is registered to Jen Woody and was drilled to a depth of 300 feet on 12/30/2014. The other water well is registered to Karl Wozniak and was drilled to a depth of 100 feet on 04/19/2011. The EDR Water Well Report obtained by EDR is provided in Appendix H.


SE DODGE PARK BLVD
700
450
SUBJECT PROPERTY
AKANA
FIGURE 3-1
TOPOGRAPHIC MAP
CARPENTER LANE SITE - GRESHAM, OR.
LAT: 45.466068° N, LONG: -122.298133° W
CITY OF PORTLAND WATER BUREAU

SECTION 4
REGULATORY AGENCY RECORD REVIEW

Local and state agencies, such as various environmental departments, fire prevention bureaus, and building and planning departments were contacted to identify current or previous reports of hazardous materials use, storage, and unauthorized releases that may have impacted the subject property. In addition, information pertaining to Activity and Use Limitations (AULs) defined as legal or physical restrictions, limitations on the use of, or access to a site or facility, is requested. Records of communication for the applicable agencies are provided the sections 4.1 to 4.5 below and documents received from inquiries are included or will be included when received as Appendixes J and K.

4.1 Health Department

Akana submitted a formal open records request to Multnomah County Public Health Department in regards to health department records related to the Subject Property. The Multnomah County Health Department Environmental Health Division representative Julie Sullivan-Springgetty indicated over the phone that a search of the Subject Property tax lot resulted in no records from this department.

4.2 Fire Department

Akana submitted a formal open records request to Gresham District Fire Department in regards to fire department records related to the Subject Property. The Gresham Fire Department Administrative Assistant Alyssa Roupp indicated over the phone that a search of the Subject Property tax lots and the entire SE Carpenter Lane address set resulted in no records from this department other than medical responses.

4.3 Building and Planning Department

Akana submitted a formal open records request to the City of Gresham and Building Department for records related to the Subject Property. City of Gresham Permit Technician Lenora Pochop indicated over the phone that a search of the Subject Property tax lots resulted in no records from this department other than medical responses.

4.4 Portland General Electric

Akana staff has submitted a formal open records request with Portland General Electric (PGE) to verify the presence or absence of PCBs in the observed transformers. PGE responded with a letter indicating that PGE equipment on the Subject Property is not known to contain PBCs materials. This letter is provided in Appendix J.

4.5 City of Portland

Akana submitted a formal open records request to City of Portland's East County Records set in regards to occupancy and condemnation records related to the Subject Property. City of Portland Records Specialist Perry Cabot indicated over the phone that a search of the Subject Property tax lots resulted in no records from this department.

SECTION 5
USER/OWNER/OCCUPANT PROVIDED INFORMATION

5.1 User Provided Information

In order to qualify for one of the landowner liability protections (LLPs) offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2002, the User must provide certain information in the Phase I ESA. Failure to provide this information could result in a determination that "All Appropriate Inquiry" is not complete. To assist the user in identifying pertinent information, Akana utilizes a user questionnaire based on the ASTM 1527-13 standard.

5.1.1 Environmental Liens or Activity and Use Limitations

No federal, state, or local environmental records were provided to Akana by the User, and no environmental liens or AULs, judgments or pending enforcement actions for the Subject Property were found in federal, state or local regulatory agency databases.

In addition, EDR performed an Environmental Lien search and at this time no report has been provided in relation to the Subject Property. The EDR Environmental Liens Report was ordered but not received at the time of making this report and if information received at a later date indicates a change in Findings or Conclusions of this report, and addendum to this report will be prepared and Environmental Lien Report will be included as Appendix L.

5.1.2 Specialized Knowledge of User

Akana utilizes a user Questionnaire for All Appropriate Inquiry. Akana discussed the user Questionnaire questions over the phone January 19, 2017 with adjacent land and R& H Nursery owner Pat Holt, owner of R & H Nursery and adjacent land owner on the western border of the Subject Property. Mr. Holt indicated that he did not have any knowledge of, or indicate any evidence of, RECs regarding the past or present use of the Subject Property. The completed user Questionnaire is included as Appendix M.

In response to Akana's request for information on the Subject Property, the user report stated:

- Is unaware of any environmental cleanup liens against the property
- Indicated that AULs are in place on the Subject Property or have been filed or recorded in a registry
- Has no specialized knowledge relating to the property or nearby properties
- Indicated that the lease price being paid for the property reflects fair market
- Has no knowledge of past uses of the property
- Has no knowledge of any chemicals that are, or were, present on the property

- Has no knowledge of any spills or chemical releases on the property
- Has no knowledge of any environmental cleanups that may have taken place on the property
- Has no knowledge of the presence of contamination on the property

5.2 Owner/Occupant-Provided Information

Akana utilizes a transaction screening questionnaire (TSQ) to document responses from the Subject Property owner regarding environmental issues or potential environmental concerns at the Subject Property. PWB was contacted and Akana requested PWB assets management team was asked to completed a TSQ, at the time of writing this report the completed TSQ was not returned and if information received at a later date indicates a change in Findings or Conclusions of this report, and addendum to this report will be prepared and TSQ will be included as Appendix N.

5.2.1 Occupant-Provided Information

The Subject Property is currently owned by PWB. PWB was contacted by phone and email and at the time of writing this report PWB had not responded with any additional information about the Subject Property. The ASTM E 1527-13 standard does not require further background research through attempting to contact past owners.

5.3 Interviews

During the site recognizance visit on 1/12/2018 Akana personnel conducted an onsite interview with Shawn Neirson, V.P Production Manager of the Subject Property current tenant Surface Nursery Inc. Mr. Neirson told Akana about the construction of the fence on the north end of the Subject Property with old power poles sections to keep the local Elk and Deer herds out of the cultivated fields. Mr. Neirson also provided Akana with contact information for Mr. Pat Holt as a good source of local historical knowledge of the Subject Property. Mr. Neirson told Akana that he has no knowledge of hazardous materials releases or spills on the Subject Property and that Surface Nursery Inc., historically and actively apply agricultural chemicals to the cultivated lands as part of the nursery operations and that Surface Nursery has complete records of the chemical applications at the Surface Nursery Inc., offices.

Akana conducted a phone interview on January 19, 2017 with Pat Holt, owner of R & H Nursery and adjacent land owner on the western border of the Subject Property. Mr. Holt indicated that he has worked on the Subject Property since the early 1970's and noted that he is aware of the original residential and agricultural structures owned by the original owner Mr. Parker. Mr. Holt informed Akana that in the late 1970's both the residential and agricultural structures were removed and torn down but the original concrete foundation for the barn was left in place. Mr. Holt noted that he backfilled a drinking water cistern located on the Subject

Property with sand was backfilled with sand in the early 1980's. Mr. Holt informed Akana that he is unaware of any release of hazardous substances or petroleum products involving the Subject Property based on his knowledge and history with the site. Mr. Holt informed Akana that the abandoned equipment and vehicles along the western boundary of the Subject Property observed during site reconnaissance are his property and he has been storing them there for many years. Mr. Holt noted that he was unaware of the origins of the abandoned metal drum labeled "Flammable Liquids" observed during site reconnaissance. Mr. Holt informed Akana that he does not have any knowledge of, or indicate any evidence of, RECs regarding the past or present use of the Subject Property.

SECTION 6
SITE RECONNAISSANCE

6.1 Methodology and Limiting Conditions

The site visit was conducted on the morning and afternoon of January 12, 2018. Weather conditions during the site visit were overcast with some rain showers. Observations of the property were made on foot and attempts were made to observe conditions in as many areas of the Subject Property as practical given the abundance of dense vegetation and forest and without disturbing the cultivated crops growing in the fields. The site was crossed from east to west and north to south in several traverses. The eastern and western property boundaries were walked north to south. Lighting was sufficient to evaluate conditions throughout the property. Timothy Norman of Akana observed conditions at the Subject Property and adjoining properties. Photographs were taken during the site reconnaissance and are on file at Akana with selected photographs provided in Appendix O. Observations of the adjoining properties were made from the Subject Property and public roadways with the adjoining properties being readily observable.

6.2 Subject Property

6.2.1 General Property Features and Conditions

The Subject Property consists of 108 acres of predominantly cultivated agricultural and densely forested lands. With the exception of a densely forested strip of land paralleling the northwestern border of the Subject Property, the majority of the land has been previously cleared of forested areas and historically utilized as shade tree, shrub nursery, and agricultural lands since before 1948.

Akana personnel observed multiple large junk and discarded debris piles located in multiple locations consisting of creosote treated wooden utility poles, discarded tires, two disabled and abandoned vehicles, mechanical equipment, discarded household furniture, scrap metal & plastics, and discarded bricks and building supplies from structure demolition. One fifty five gallon metal drum labeled “Flammable Liquids” was noted in an AOPC along the western border.

6.2.2 Hazardous Substances and Petroleum Products

One fifty five gallon metal drum labeled “Flammable Liquids” was noted in an AOPC along the western border. No other areas of hazardous materials storage were identified on the Subject Property.

6.2.3 Aboveground or Underground Storage Tanks

No aboveground storage tanks (ASTs) or underground storage tanks (USTs) were identified on the Subject Property.

6.2.4 Polychlorinated Biphenyls (PCBs)

Power service to the adjacent property to the west of the Subject Property is supplied via pole mounted transformers supplied by PGE. Manufacturers of various types of electrical or hydraulic-powered equipment historically used PCBs as a dielectric fluid coolant and stabilizer. There are two (2) transformers located on the Subject Property. A formal records request was submitted to PGE for environmental and maintenance records for the two transformers. PGE provided a letter stating that PGE equipment on the Subject Property is not known to contain PCBs and is included in this report as Appendix J.

6.3 Adjoining Properties

North: The Subject Property is bound by Carpenter Lane for the eastern half and Dodge Park Boulevard on the west half to the north, with some single family residential structures and undeveloped forest on the north side of these roads.

East: To the east is Dodge Park Boulevard and private property with single family residences.

South: Agricultural lands with cultivated fields and nursery fields are located on the adjacent properties to the south. The property adjacent to the south-central portion of the Subject Property consists of two large water holding tanks owned by the Pleasant Home Water District. This parcel of land is surrounded by a metal and razor wire security fence around the two tanks.

West: A different nursery operator than the Subject Property leases called R&H Nursery operates on the land that is adjacent the Subject Property's western boundary, and consists of actively cultivated tree and shrub nursery fields, a parked semi-trailer, and two residential structures located 0.10 mile and 0.15 mile across the Subject Property's western boundary. On the adjacent property across the southwest corner from the Subject Property, there is a small structure of less than 10 square feet being used for irrigation parts and pump storage.

SECTION 7
NON-SCOPE ADDITIONAL ITEMS

The following environmental issues or conditions are outside the scope of ASTM 1527-13 and have not been included in this Phase I ESA. Some substances may be present on the Subject Property in quantities and under conditions that may lead to contamination of the Subject Property or of nearby properties but are not included in CERCLA's definition of hazardous substances (42 U.S.C. §960[14]) or do not otherwise present potential CERCLA liability. This list of non-scope considerations in not intended to be all-inclusive.

- Asbestos-Containing Building Materials
- Radon
- Lead-Based Paint
- Lead in Drinking Water
- Regulatory Compliance
- Cultural and Historic Resources
- Industrial Hygiene
- Health and Safety
- Ecological Resources
- Endangered Species
- Indoor Air Quality
- Biological Agents
- Mold
- Title Search

SECTION 8
SUMMARY, FINDINGS, CONCLUSIONS, DE MINIMIS CONDITIONS AND RECOMMENDATIONS

8.1 Summary

The Subject Property is currently owned by PWB and located approximately four miles east of US 26 at the south-eastern end of Carpenter Lane, with a physical address of 35050 SE Carpenter Lane, Gresham, OR 97080. Land/Lease ownership, titles, and rights of way were not reviewed during the Phase I. The site coordinates are Latitude 45.466068 degrees north and Longitude -122.298133 degrees west. Legal property descriptions as provided by the Multnomah County Appraisal District are provided in Appendix A.

The Subject Property consists of 108 acres of predominantly undeveloped agricultural and densely forested land. The northern portion of the Subject Property is densely forested along the south side of Dodge Park Boulevard. The central portion of the Subject Property has been mostly cleared and is currently being used for agricultural uses and nursery operation by Surface Nursery. Groundwater flow direction typically mimics surface topography that slopes gently to the southeast for the eastern half and southwest for the western half of the Subject Property.

The Subject Property is accessed through a controlled entry point for the Surface Nursery, Inc. operation at the western end of Carpenter Lane. Clearings have been made for vehicle access along the Subject Property's northern, eastern, western and southern boundaries as well as multiple unpaved access roads through the middle of the Subject Property to support nursery and agricultural operations. A seven foot tall wire metal perimeter fence surrounds the Subject Property on the north and western sides and consists of cut down sections of treated wood power poles, steel wire grid, barbed wire strands on the top and bottom, and a shade cloth visual barrier. The fence is used to keep out the wild herds of elk and deer that inhabit the local area of the Subject Property. Historical aerial photo records show that a single family residential structure and adjacent agricultural structure (barn) was historically located on the west-central border of the Subject Property. Based on historical aerial photographs, these structures are assumed to have been removed at an unknown date during the mid to late 1970's. No other paved roads, structures or improvements were observed on the Subject Property during site reconnaissance.

The Subject Property lies at an elevation of 741 feet above mean sea level as determined from the 2014 USGS topographic map provided on Figure 3-1. The general topographic gradient at the Subject Property ranges from approximately 650 feet at the southwest corner to 750 feet along the eastern boundary.

8.2 Findings and Conclusions

8.2.1 Subject Property

Akana personnel observed four separate locations of discarded debris on the Subject Property, these locations can be seen in Figure 2-1 and are considered *de minimis* conditions and are categorized as separate Areas of Potential Concern (AOPC). AOPC #1 located in the north-central portion of the Subject Property on the north side of the metal fence; at this location a pile of discarded used tires was abandoned. AOPC #2 is also located in the north-central portion of the Subject Property on the south side of the grove of trees where the site nursery operations staging trailers for planting. This area was observed on the northern edge of the cultivated agricultural field and consists of a pile of discarded and treated wooden utility poles. The wooden poles have heavy odor of creosote from wood preservation chemical treatment. AOPC #3 was observed on the west-central border of the Subject Property and consists of a variety of discarded debris including two abandoned trucks, abandoned oil containing tractor and truck parts, construction and plastic debris, and one steel 55 gallon drum labeled "Flammable Liquid". The soil around and under the empty barrel did not show signs of staining and did not have a strong petroleum odor. AOPC #4 is located roughly 100 feet to the south of AOPC #3 on the western boundary and consists of a large burn pile in the same area of the historical agricultural structure identified in historical aerial photographs before 1973. During the site visit it was observed that the burn pile contained what appeared as nursery operation slash and discarded trees and shrubs, and it was documented that some household debris including furniture had been discarded in the burn pile, and/or previously burned at the site.

During the course of the site reconnaissance and desktop review of the Subject Property, this assessment has determined that active agricultural activities have been continually ongoing on the majority of the land dating back to at least 1925. Agricultural activities refer to the cultivation of the soil, crops, trees and shrubs, with the lands often being treated annually with synthetic fertilizers, herbicides, and pesticides to aid in the cultivation process. Surface Nursery, Inc., the Subject Property's current tenant, informed Akana that they keep records of chemical applications on the Subject Property lands, and that they do not store the chemicals on the Subject Property, but is instead stored at an offsite facility. All current and historically cultivated crop lands on the Subject Property are considered a REC for the purpose of this report. There are two primary environmental concerns associated with historical and active agricultural activities on the property. The first concern is the potential for the cultivated soils to contain elevated levels of agrochemicals and associated metals. The second environmental concern is the potential of Contaminants of Potential Concern (COPC) associated with agricultural activities to migrate onto offsite properties.

8.2.2 Area Properties

The Subject Property is bound to the north by Dodge Park Boulevard with undeveloped forest. To the east is Dodge Park Boulevard and to the south is a parcel of private property that is used for grazing and some agriculture uses. There are two single family residences located to the east and southeast of the Subject Property, with one of the residences listed as having a LUST that was documented to be removed and cleaned up in 2004. Agricultural fields and the Pleasant Home Water District drinking water storage tanks are located on the adjacent properties to the south. An additional agricultural field with active shrub nursery operations separated by a dirt access road is located to the west of the Subject Property. Multiple single family residences are located at the northwest corner of the Subject property at the end of paved section of SE Carpenter Lane.

8.3 De Minimus Conditions

Akana observed a large junk pile consisting of empty hazardous material barrels, mechanical equipment, abandoned vehicles, scrap building supplies, metal and plastic, and various other trash items including household furnishings discarded on a burn pile. These sites are identified as AOPC # 1, 2, 3, 4 in this report. These areas did not show evidence of soil staining, contamination, noxious or petroleum odors that would represent a REC; therefore, these areas are considered to be a housekeeping issue that meets the definition of *de minimis* conditions.

8.4 Recommendations

Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), this assessment was conducted to identify sites within the ASTM required search distance that may pose a risk of environmental contamination by hazardous wastes and substances. The Subject Property was not listed with any past environmental violations in any of the regulatory agency databases.

Due to the fact that the Subject Property has been historically cultivated and is actively cultivated by a nursery operation tenant, all of the cultivated agricultural and nursery lands have been identified as a REC. Akana recommends a Phase II ESA to conduct sampling of surface soils in the cultivated areas of the Subject Property to determine the horizontal and vertical extent of COPC associated with the likely use of pesticides for agricultural purposes see Figure 2-2. Soil sampling should be conducted in accordance with the Oregon Department of Environmental Quality (DEQ) Guidance for Evaluating Residual Pesticides on Lands Formerly Used for Agricultural Production under the Hazardous Substance Remedial Action Rules (Oregon Administrative Rules (OAR) 340-122-0010 through 0115).

At the time of site reconnaissance the Subject Property contained a substantial amount of miscellaneous debris and trash items, discarded furniture, abandoned vehicles, empty drum,

mechanical equipment, scrap metal, scrap brick and building supplies and various other trash items that could be associated with the occupants nursery operation active on the site. These four separate locations of discarded debris are identified in this report as four separate AOPC #1, 2, 3, 4 that are considered *de minimis* conditions. Prior to redevelopment, the materials located at these four separately identified AOPC should be recycled and/or properly disposed of and documentation of proper disposal should be kept on file.

SECTION 9
DEVIATIONS

Akana's qualified environmental professionals have reviewed this report and certify to its accuracy and completeness in accordance with the standards and requirements set forth in ASTM-1527-13 and 40 CFR Section 312. There are no reported deviations with regard to this assessment.

SECTION 10
REFERENCES

EDR. (2018). *Historical Aerials – Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *Historical Topographic Maps – Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *Radius Report– Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *Water Well Report – Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *City Directories – Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *Physical Setting Maps – Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *FIM – Carpenter Lane PWB Site* Gresham, OR: EDR.

EDR. (2018). *Environmental Liens – Carpenter Lane PWB Site* Gresham, OR: EDR.

SECTION 11
GENERAL REMARKS

11.1 Standard of Care

The services performed by Akana have been conducted with that level of care and skill ordinarily exercised by reputable members of the profession, practicing in the same locality under similar budget and time constraints. No other warranty is made or intended.

11.2 Qualifications

We declare that, to the best of our professional knowledge and belief, we meet the definition of Environmental Professional as defined in ASTM E 1527-13 Standard Practice for Environmental Site Assessments and in Part 312.10 of 40 CFR 312.

We have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the Subject Property. We have developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in ASTM E 1527-13 "Standard Practice for Environmental Site Assessments" and 40 CFR Part 312.

SECTION 12
SIGNATURE PAGE

I have reviewed this report and certify to its accuracy and completeness in accordance with the standards and requirements set forth in ASTM-1527-13 and the All Appropriate Inquiry rules in 40 CFR §312. This Environmental Site Assessment Report has been prepared for the use and reliance of PWB (Client), its Partners, Directors, employees, legal representatives, and lenders.

Peter Van Zandt and Brent Hamil, P.G., meet the definition of environmental professionals as provided in §312.10 and have developed and performed the appropriate inquiries in conformance with the standards and practices set forth in 40 CFR part 312.

Peter Van Zandt
Qualified Environmental Professional
Environmental Scientist

8/06/2018
Date

Brent Hamil, P.G.
Qualified Environmental Professional
Senior Geologist

8/06/2018
Date

Expires June 30, 2019

APPENDIX A
APPRAISAL DISTRICT RECORDS

THIS MAP WAS PREPARED FOR ASSESSMENT PURPOSE ONLY

SE1/4 SEC. 22 T.1S. R.4E. W.M.
MULTNOMAH COUNTY
1" = 200'

IS 4E 22D & INDEX

IS 4E 22D & INDEX

APPENDIX B
EDR HISTORICAL TOPOGRAPHIC MAPS

PWB Carpenter Lane Site

SE Carpenter Lane

Gresham, OR 97080

Inquiry Number: 5165381.4

January 22, 2018

EDR Historical Topo Map Report

with QuadMatch™

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Historical Topo Map Report

01/22/18

Site Name:	Client Name:
PWB Carpenter Lane Site	Cooper Zietz Engineers, Inc DBA Akana.
SE Carpenter Lane	6400 SE Lake rd Suite 270
Gresham, OR 97080	Portland, OR 97222
EDR Inquiry # 5165381.4	Contact: Tim Norman

EDR Topographic Map Library has been searched by EDR and maps covering the target property location as provided by Cooper Zietz Engineers, Inc DBA Akana. were identified for the years listed below. EDR's Historical Topo Map Report is designed to assist professionals in evaluating potential liability on a target property resulting from past activities. EDRs Historical Topo Map Report includes a search of a collection of public and private color historical topographic maps, dating back to the late 1800s.

Search Results:

P.O.# NA

Project: 18-003

Coordinates:

Latitude:	45.464009 45° 27' 50" North
Longitude:	-122.295549 -122° 17' 44" West
UTM Zone:	Zone 10 North
UTM X Meters:	555071.54
UTM Y Meters:	5034739.35
Elevation:	722.00' above sea level

Maps Provided:

2014	1916
1985	1914
1975	1911
1970	
1961	
1954	
1940	
1939	

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Topo Sheet Key

This EDR Topo Map Report is based upon the following USGS topographic map sheets.

2014 Source Sheets

Sandy
2014
7.5-minute, 24000

1985 Source Sheets

Sandy
1985
7.5-minute, 24000
Aerial Photo Revised 1981

1975 Source Sheets

Sandy
1975
7.5-minute, 24000
Aerial Photo Revised 1975

1970 Source Sheets

Sandy
1970
7.5-minute, 24000
Aerial Photo Revised 1970

Topo Sheet Key

This EDR Topo Map Report is based upon the following USGS topographic map sheets.

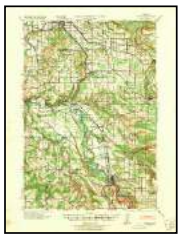
1961 Source Sheets

Sandy
1961
7.5-minute, 24000
Aerial Photo Revised 1960

1954 Source Sheets

Sandy
1954
7.5-minute, 24000
Aerial Photo Revised 1952

1940 Source Sheets



Boring
1940
15-minute, 62500

1939 Source Sheets

BORING
1939
15-minute, 50000

Topo Sheet Key

This EDR Topo Map Report is based upon the following USGS topographic map sheets.

1916 Source Sheets

Estacada
1916
30-minute, 125000

1914 Source Sheets

Boring
1914
15-minute, 62500

1911 Source Sheets

Boring
1911
15-minute, 48000

Historical Topo Map

2014

This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

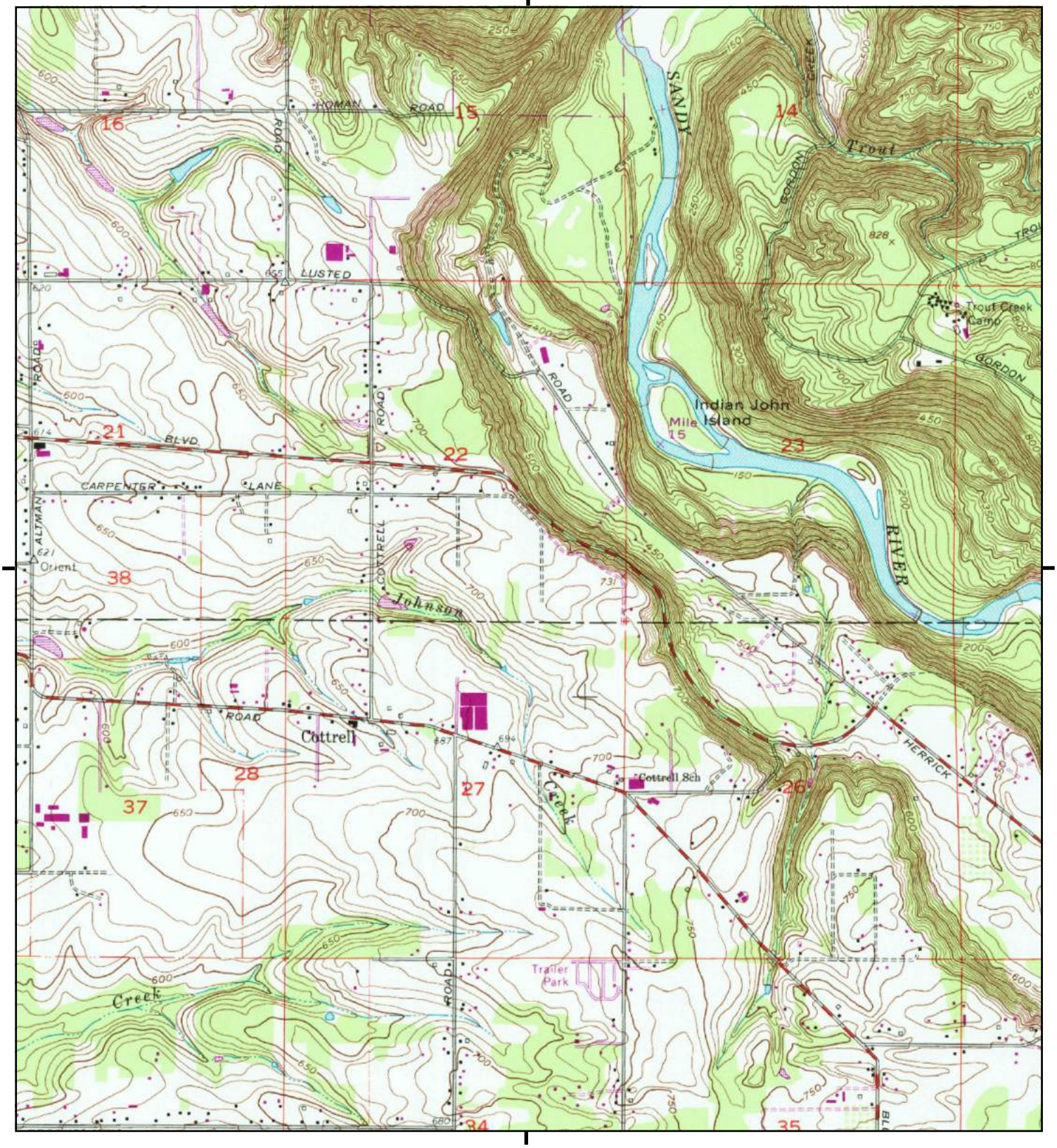
TP, Sandy, 2014, 7.5-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1985



This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

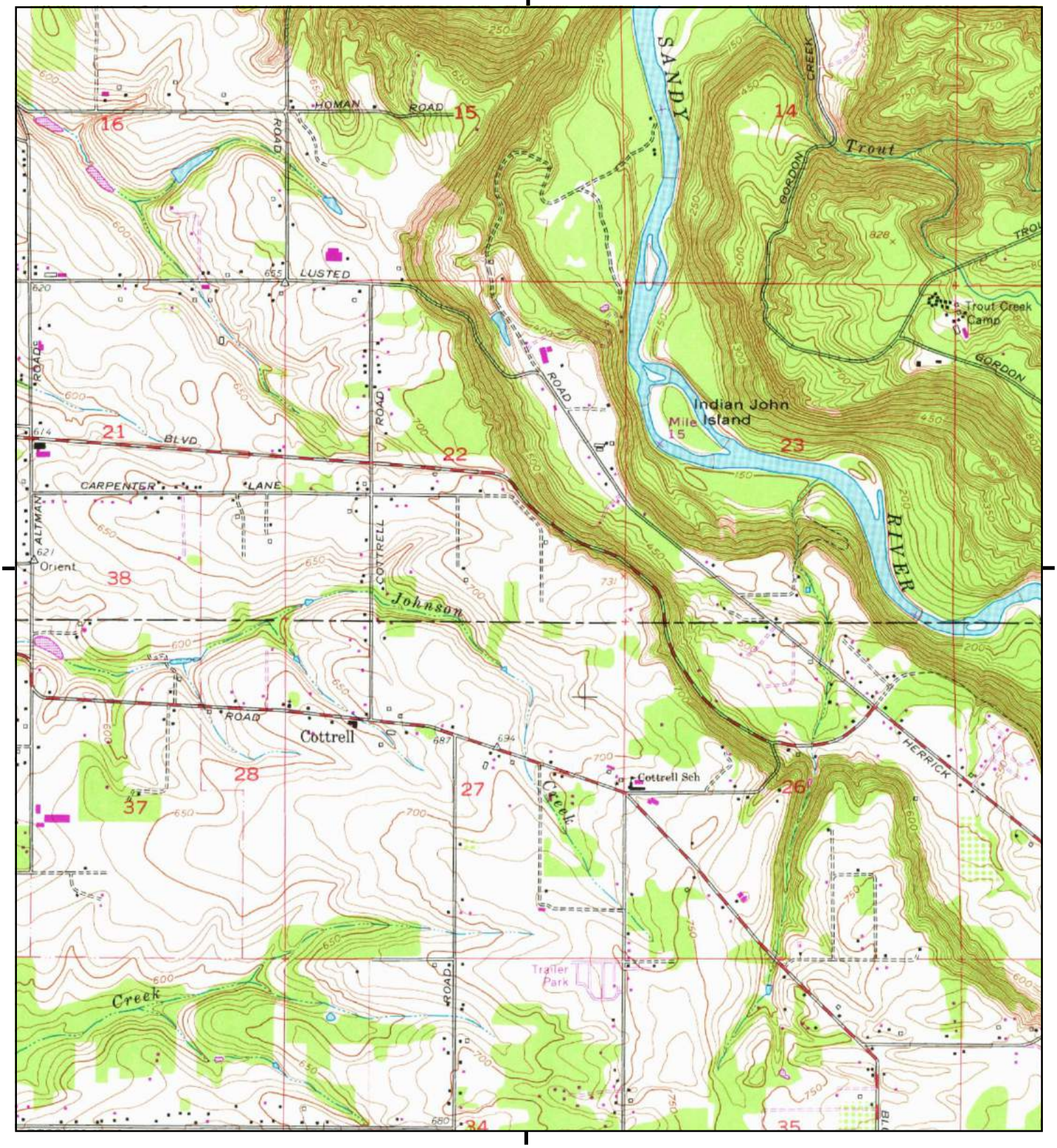
TP, Sandy, 1985, 7.5-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1975



This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

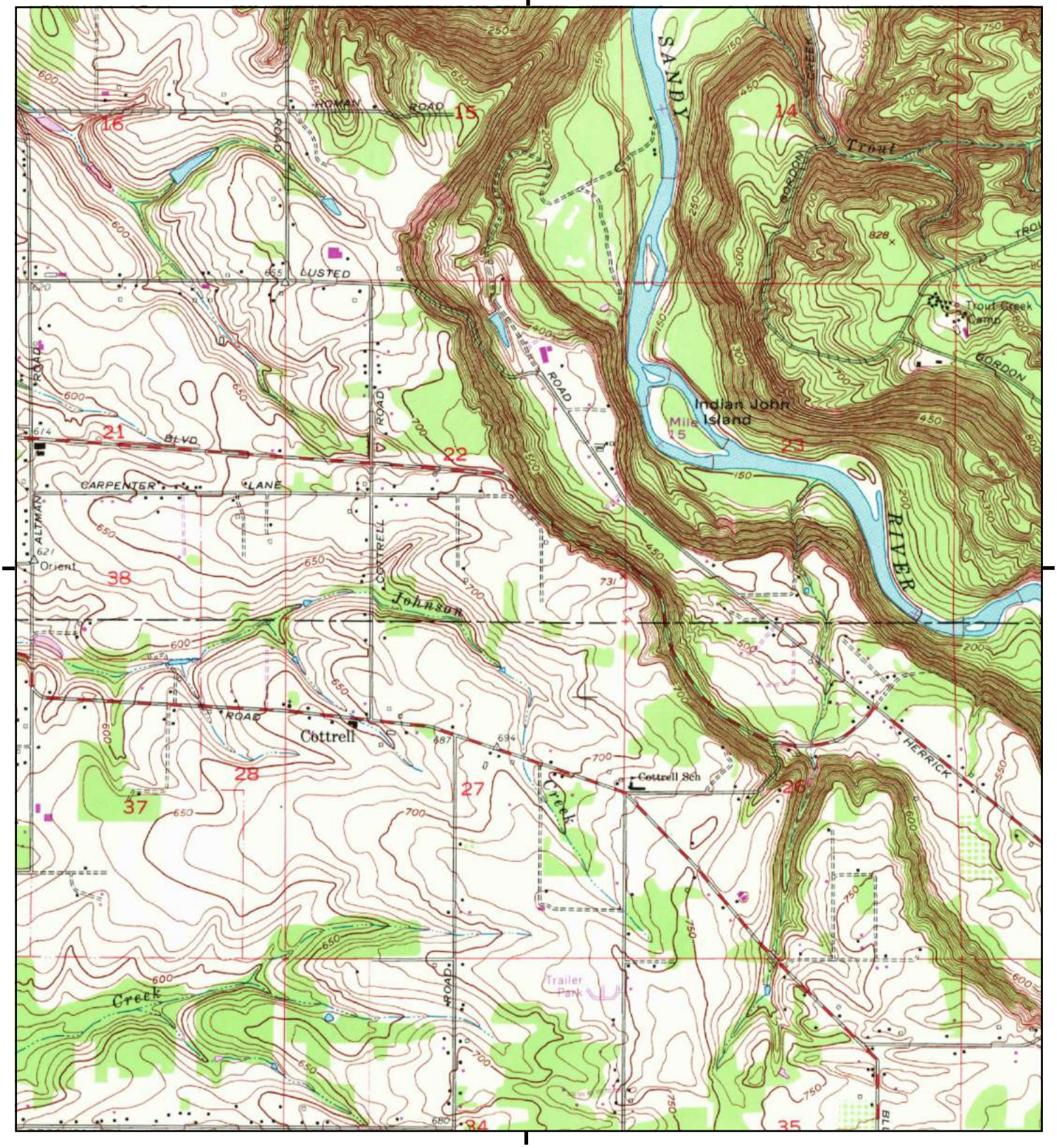
TP, Sandy, 1975, 7.5-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1970



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0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

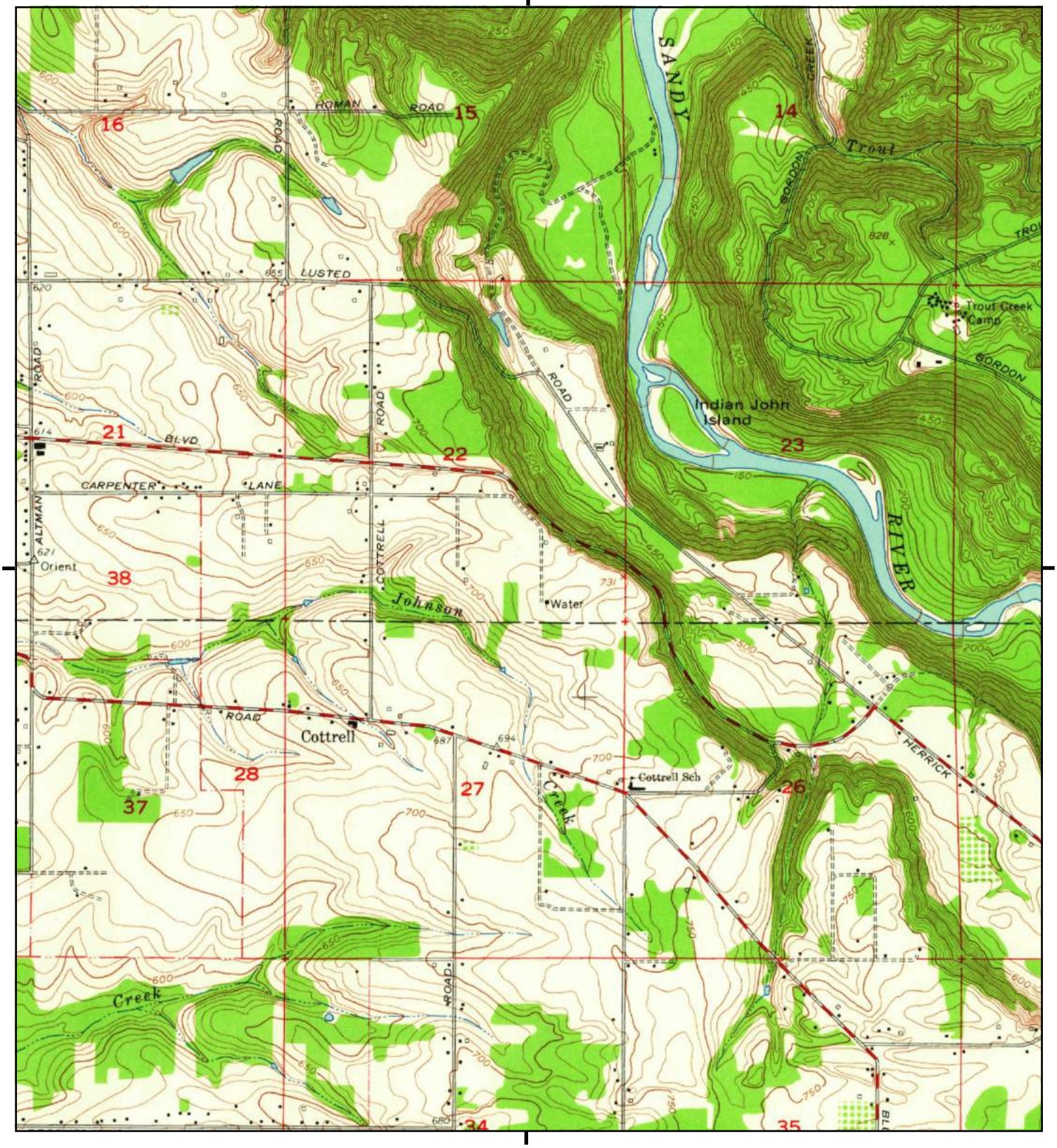
TP, Sandy, 1970, 7.5-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1961



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0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

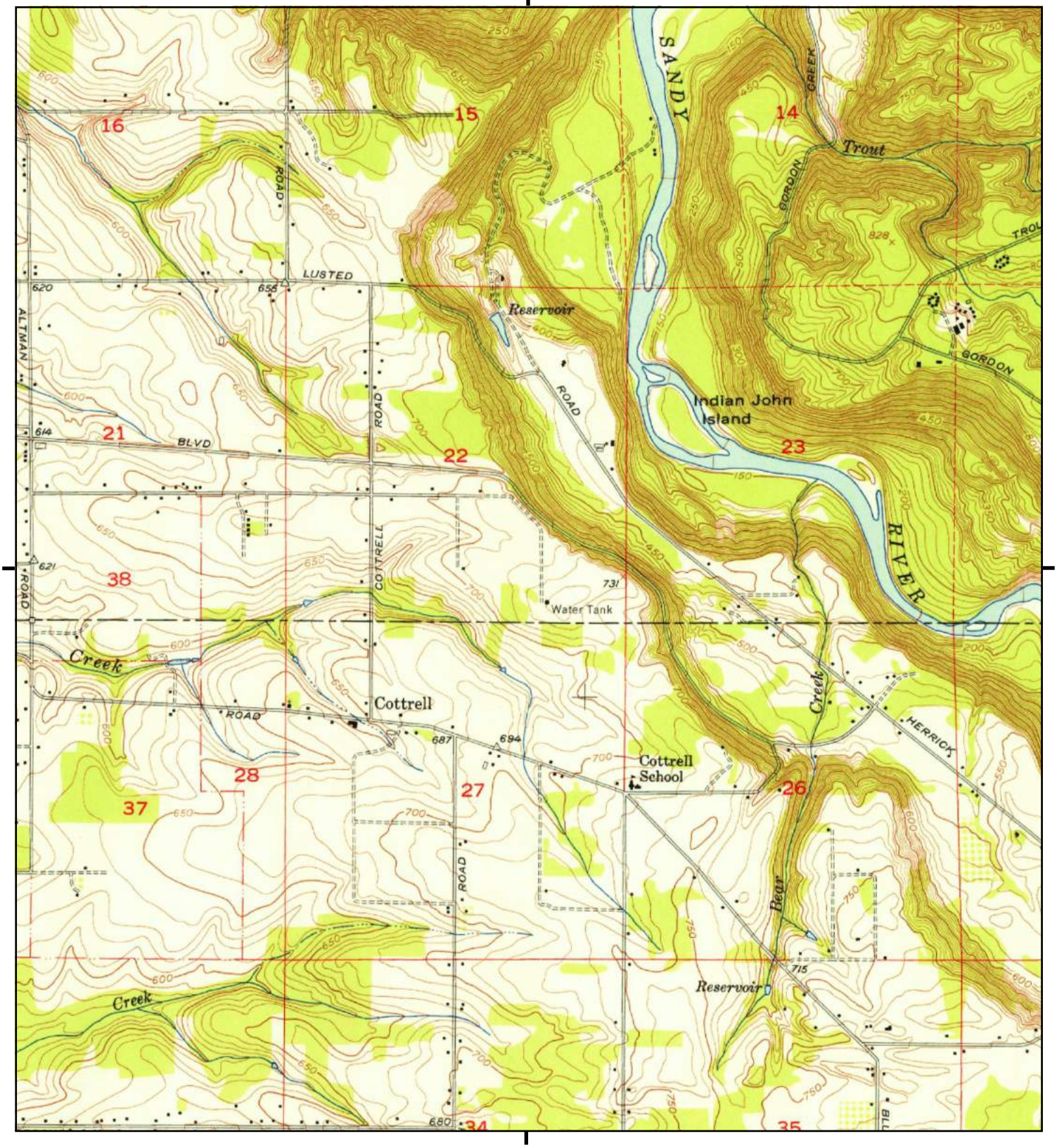
TP, Sandy, 1961, 7.5-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1954



This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

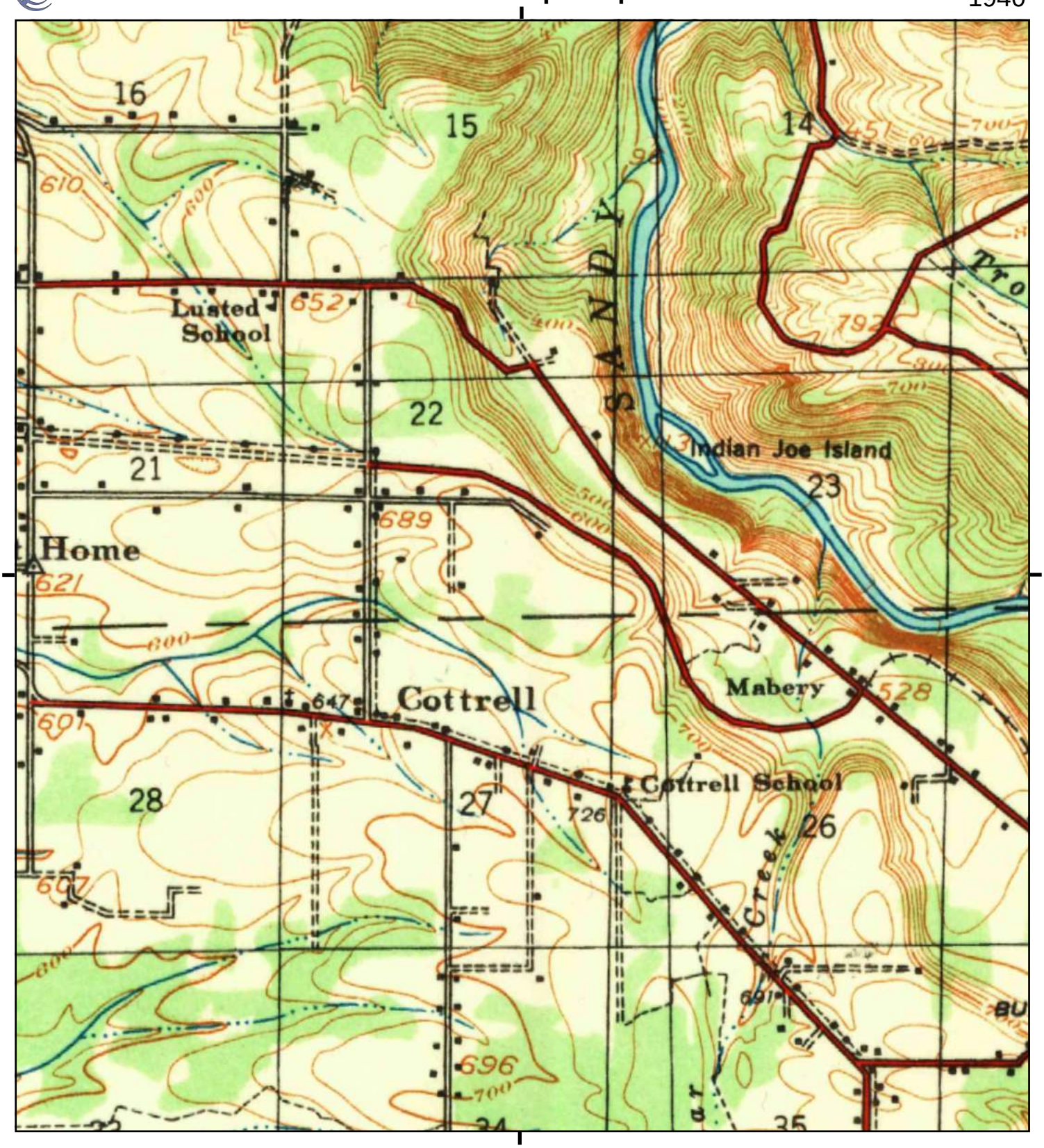
TP, Sandy, 1954, 7.5-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1940



This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

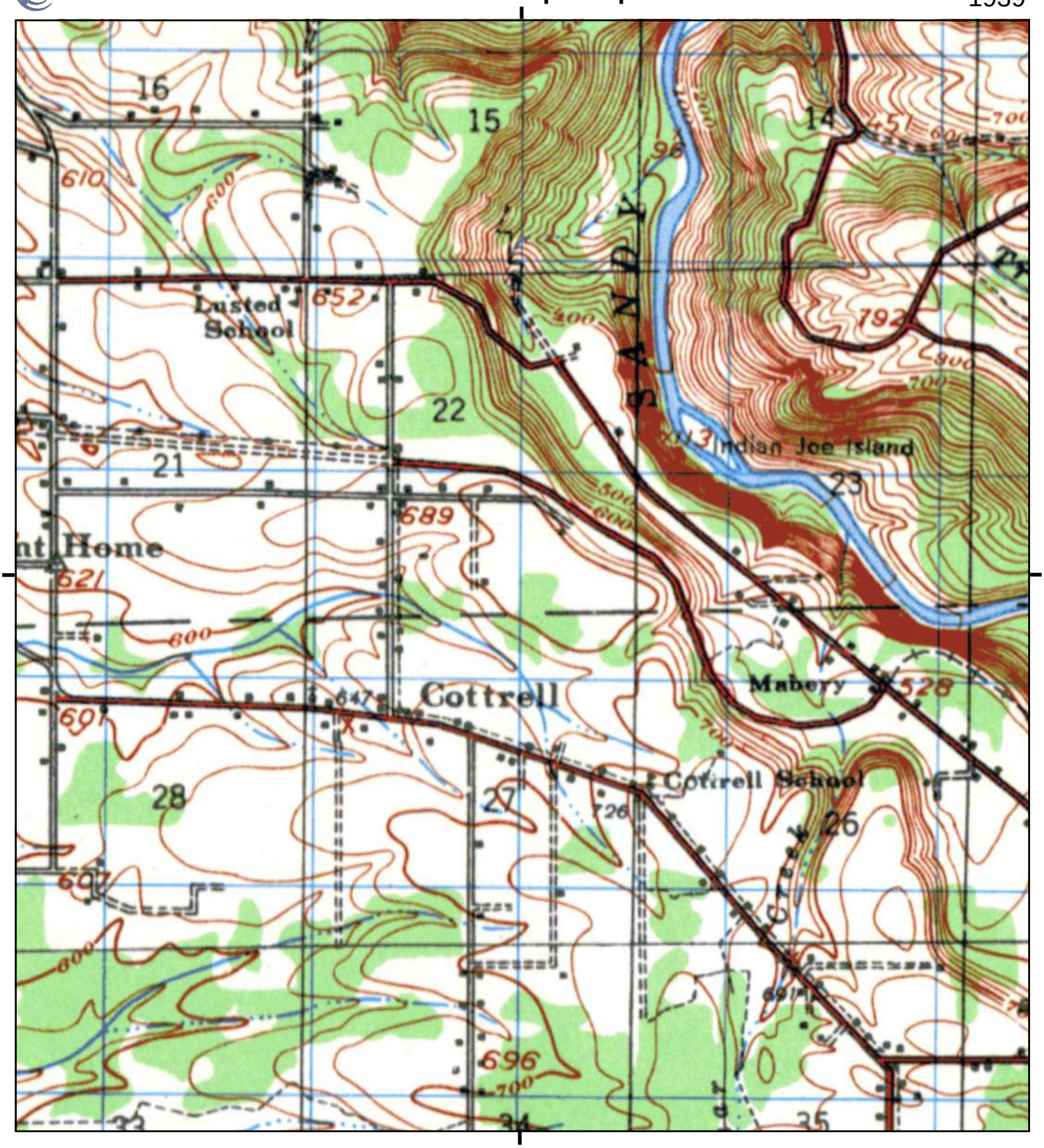
TP, Boring, 1940, 15-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1939



This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

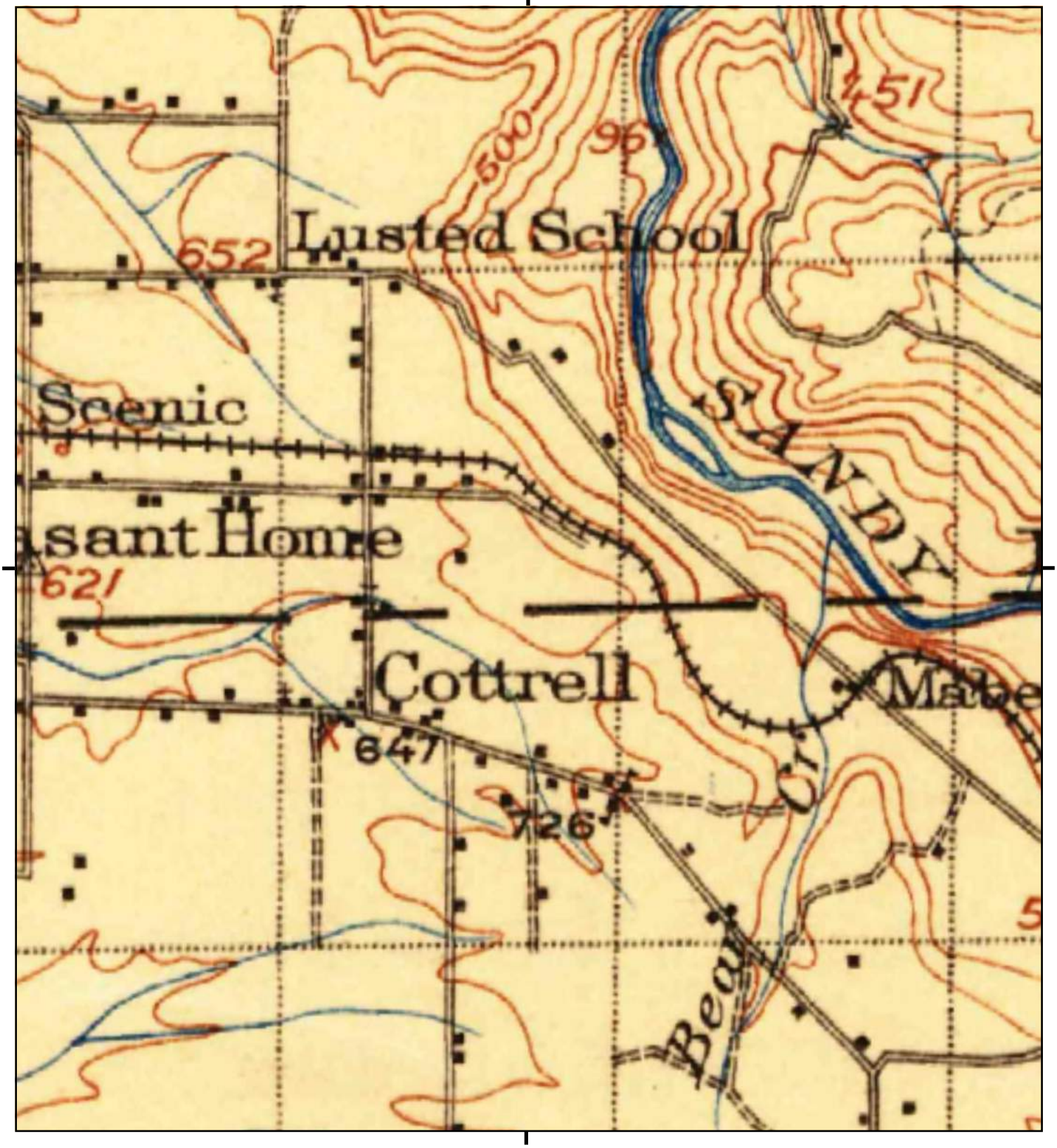
TP, BORING, 1939, 15-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1916



This report includes information from the following map sheet(s).

0 Miles 0.25 0.5 1 1.5

NW N NE
W E
SW S SE

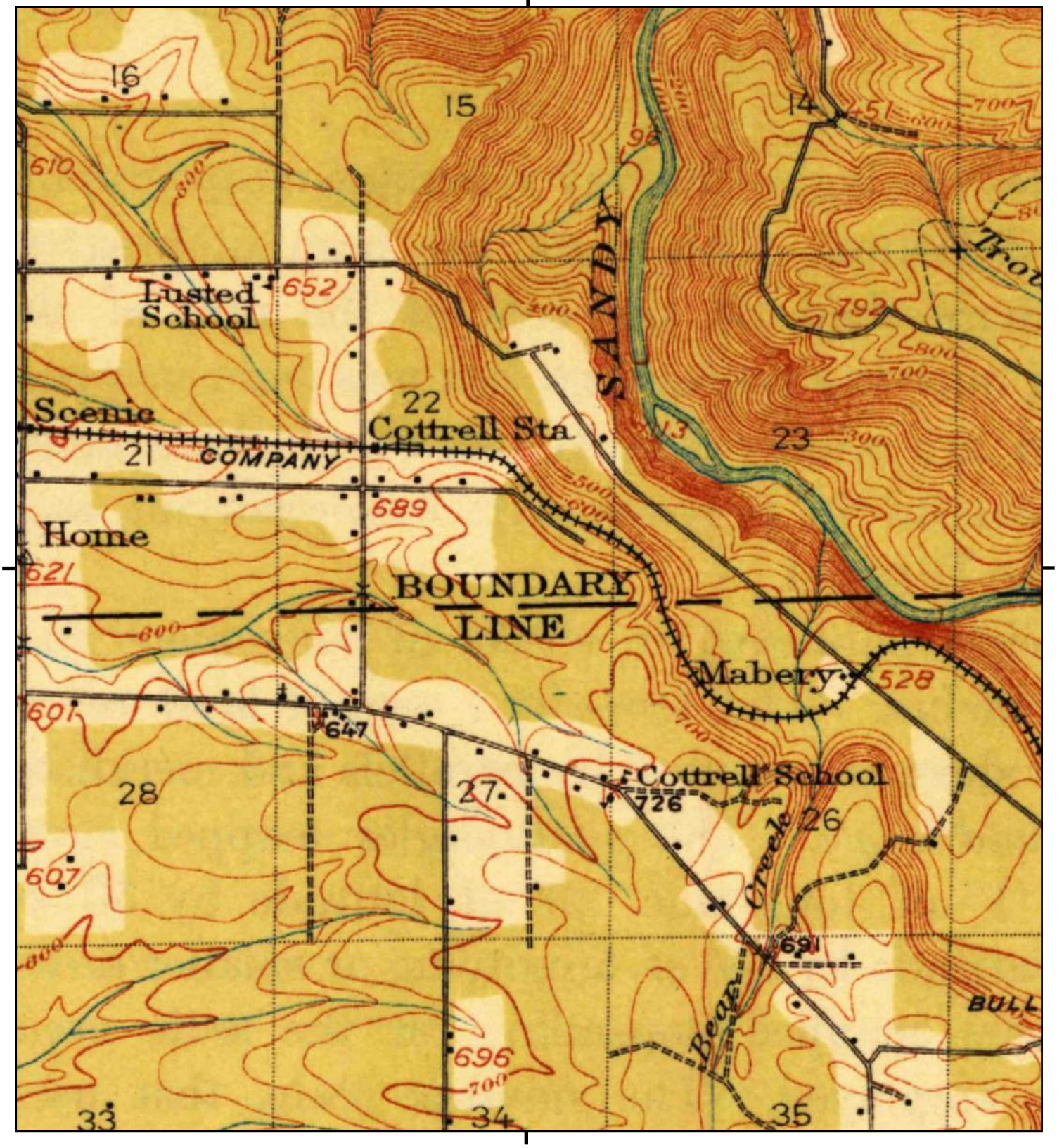
TP, Estacada, 1916, 30-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1914



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NW N NE
W E
SW S SE

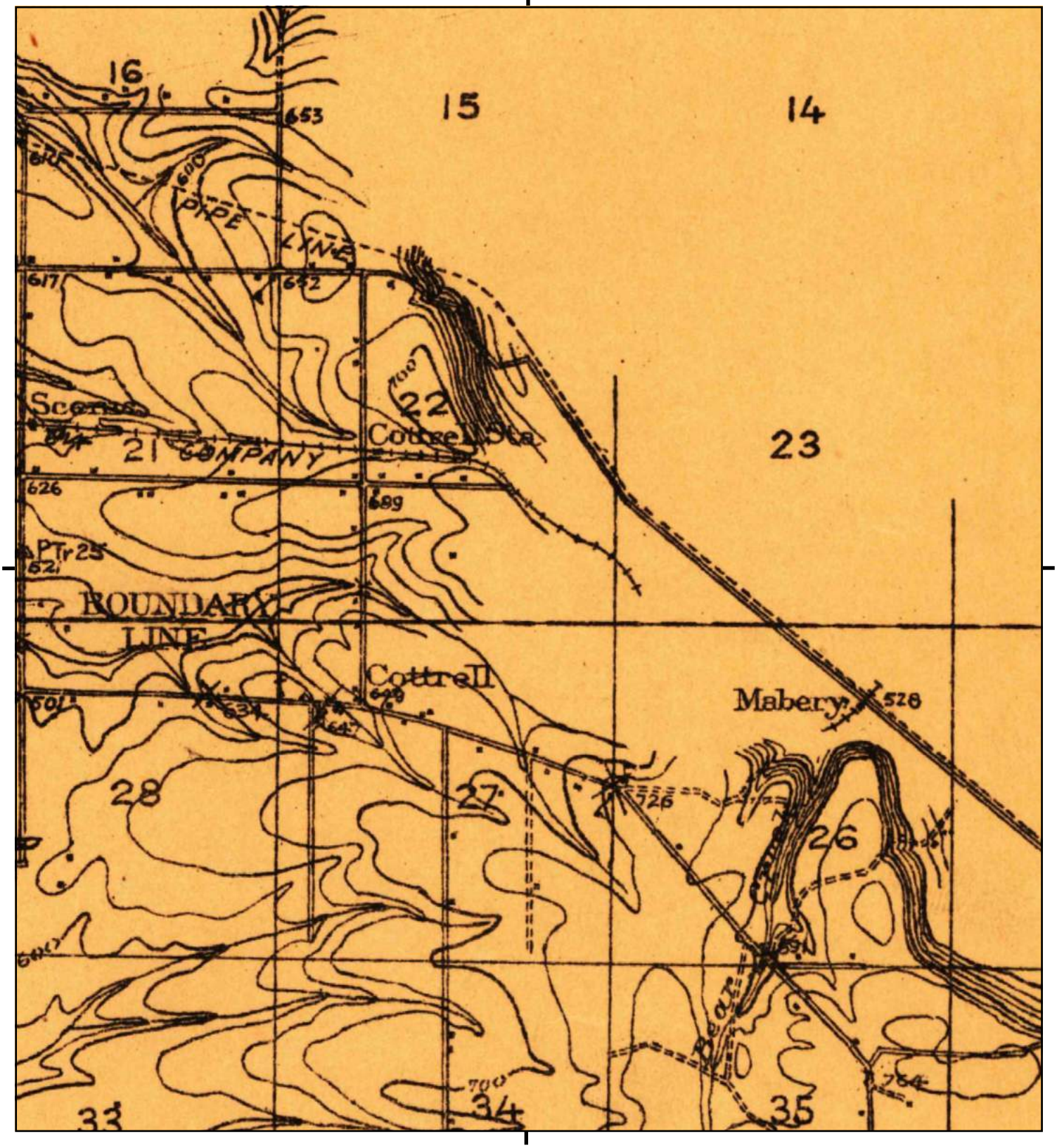
TP, Boring, 1914, 15-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

Historical Topo Map

1911



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NW N NE
W E
SW S SE

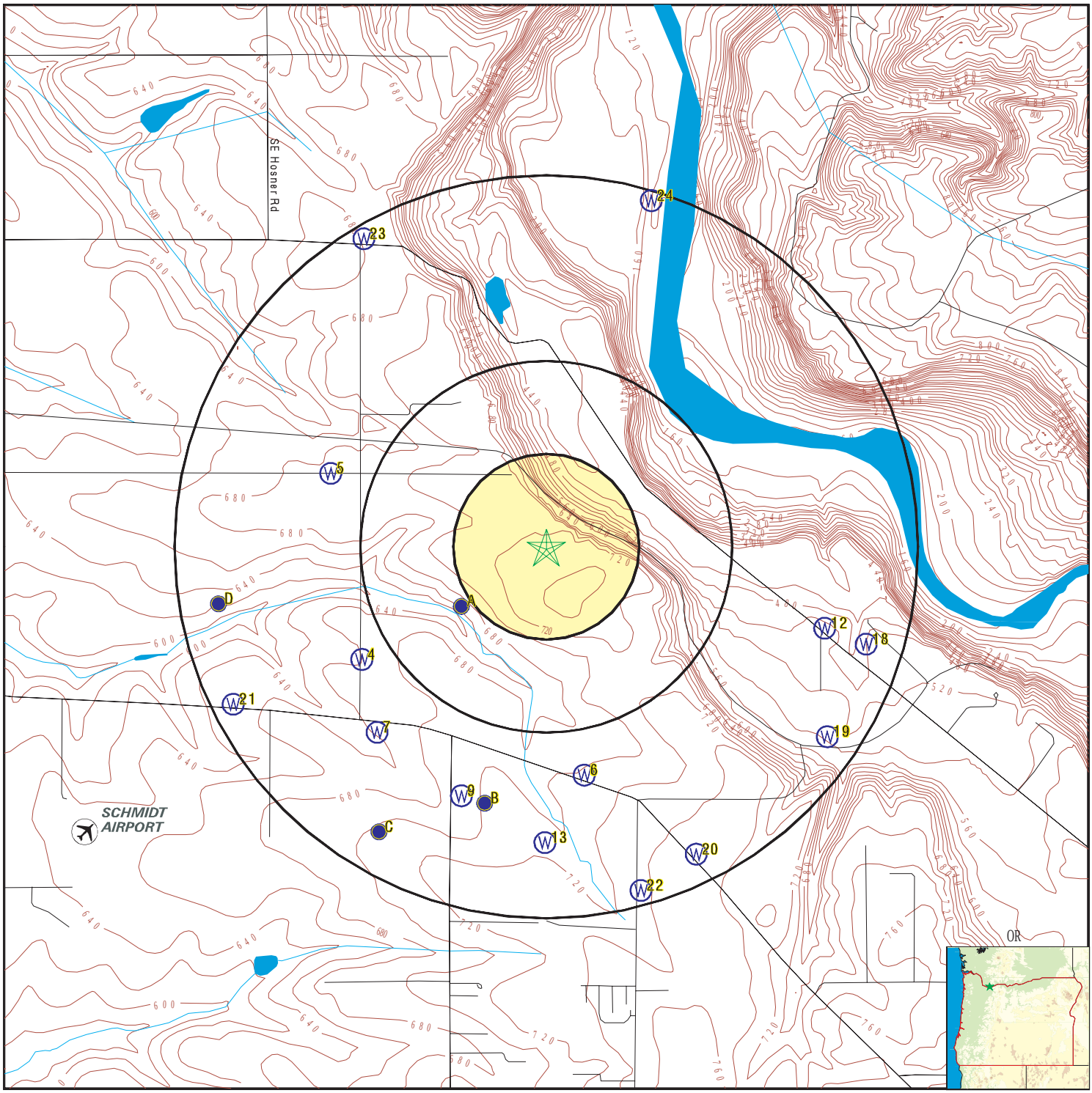
TP, Boring, 1911, 15-minute

SITE NAME: PWB Carpenter Lane Site
ADDRESS: SE Carpenter Lane
Gresham, OR 97080
CLIENT: Cooper Zietz Engineers, Inc DBA Akana.

N

APPENDIX C
EDR PHYSICAL SETTINGS MAPS

PHYSICAL SETTING SOURCE MAP - 5165381.2s



County Boundary
Major Roads
Contour Lines
Airports
Earthquake epicenter, Richter 5 or greater
Water Wells
Public Water Supply Wells
Cluster of Multiple Icons

0 1/4 1/2 1 Miles

Groundwater Flow Direction
Indeterminate Groundwater Flow at Location
Groundwater Flow Varies at Location
Oil, gas or related wells

N

SITE NAME: PWB Carpenter Lane Site	CLIENT: Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS: SE Carpenter Lane Gresham OR 97080	CONTACT: Tim Norman
LAT/LONG: 45.464009 / -122.295549	INQUIRY #: 5165381.2s
	DATE: January 22, 2018 6:10 pm

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APPENDIX D
EDR HISTORICAL AERIAL PHOTOS PACKAGE

PWB Carpenter Lane Site

SE Carpenter Lane

Gresham, OR 97080

Inquiry Number: 5165381.9

January 23, 2018

The EDR Aerial Photo Decade Package

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

01/23/18

Site Name:

PWB Carpenter Lane Site
SE Carpenter Lane
Gresham, OR 97080
EDR Inquiry # 5165381.9

Client Name:

Cooper Zietz Engineers, Inc DBA Akana
6400 SE Lake rd Suite 270
Portland, OR 97222
Contact: Tim Norman

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

Search Results:

Year	*Scale*	*Details*	*Source*
2012	1"=500'	Flight Year: 2012	USDA/NAIP
2011	1"=500'	Flight Year: 2011	USDA/NAIP
2009	1"=500'	Flight Year: 2009	USDA/NAIP
2006	1"=500'	Flight Year: 2006	USDA/NAIP
2005	1"=500'	Flight Year: 2005	USDA/NAIP
1995	1"=500'	Acquisition Date: June 29, 1995	USGS/DOQQ
1994	1"=500'	Flight Date: July 07, 1994	USGS
1991	1"=1000'	Flight Date: February 28, 1991	USGS
1982	1"=500'	Flight Date: August 06, 1982	USDA
1975	1"=500'	Flight Date: September 13, 1975	USGS
1970	1"=500'	Flight Date: July 08, 1970	USGS
1963	1"=500'	Flight Date: August 17, 1963	USGS
1960	1"=500'	Flight Date: July 18, 1960	USGS
1955	1"=500'	Flight Date: July 22, 1955	USDA
1952	1"=500'	Flight Date: July 02, 1952	USGS
1948	1"=500'	Flight Date: July 14, 1948	USDA

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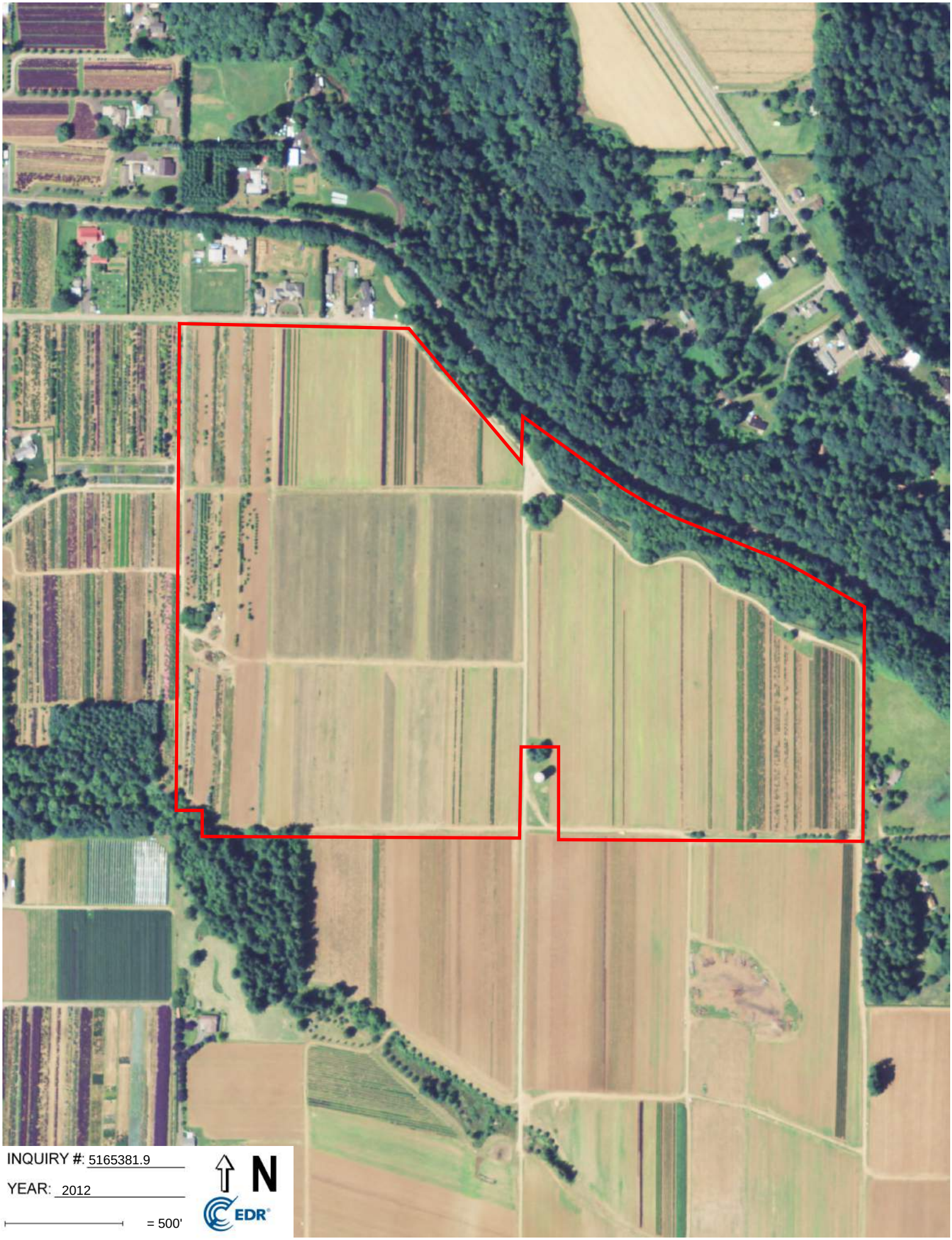
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YEAR: 2012
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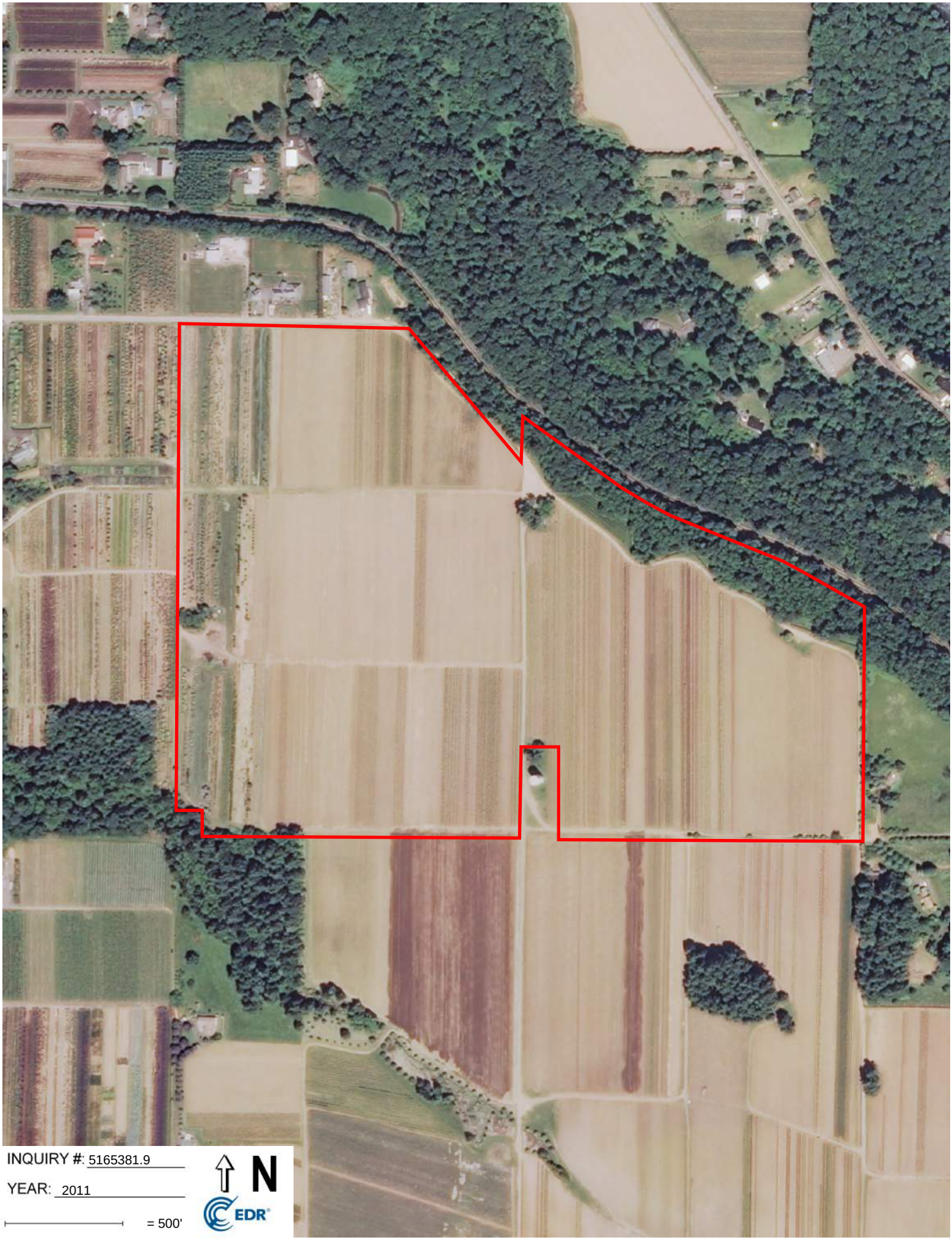
EDR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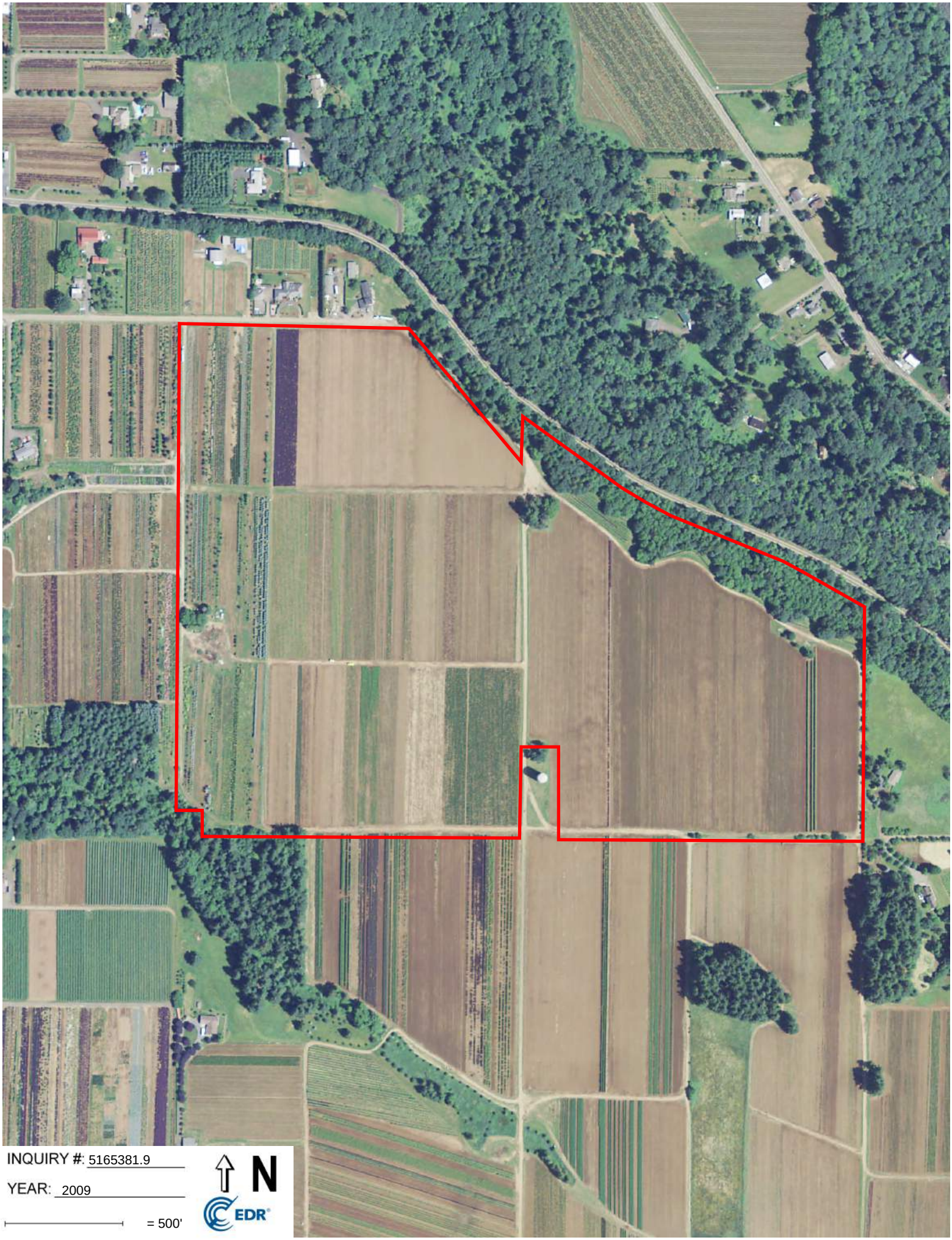
EDR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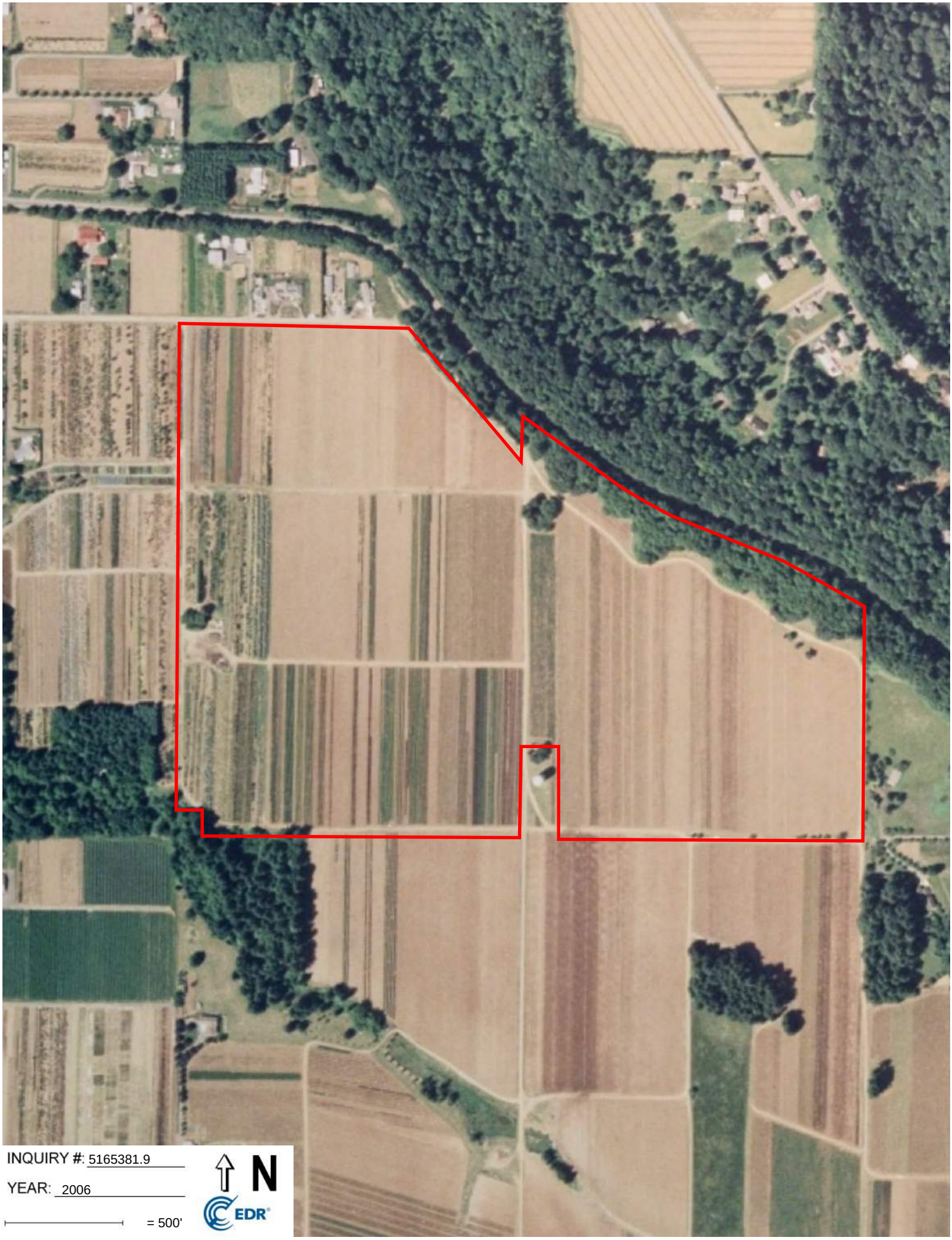
EDR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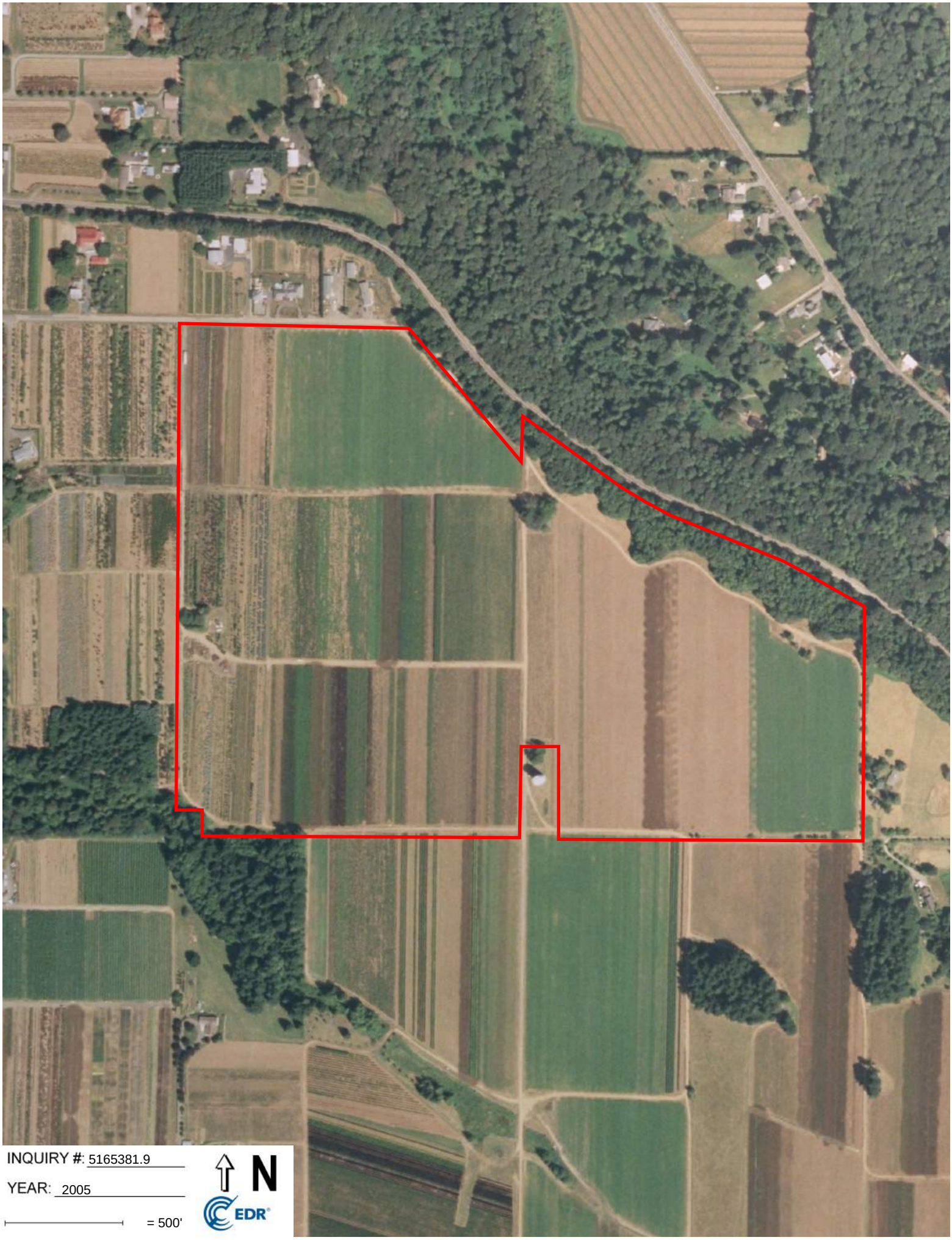
EDR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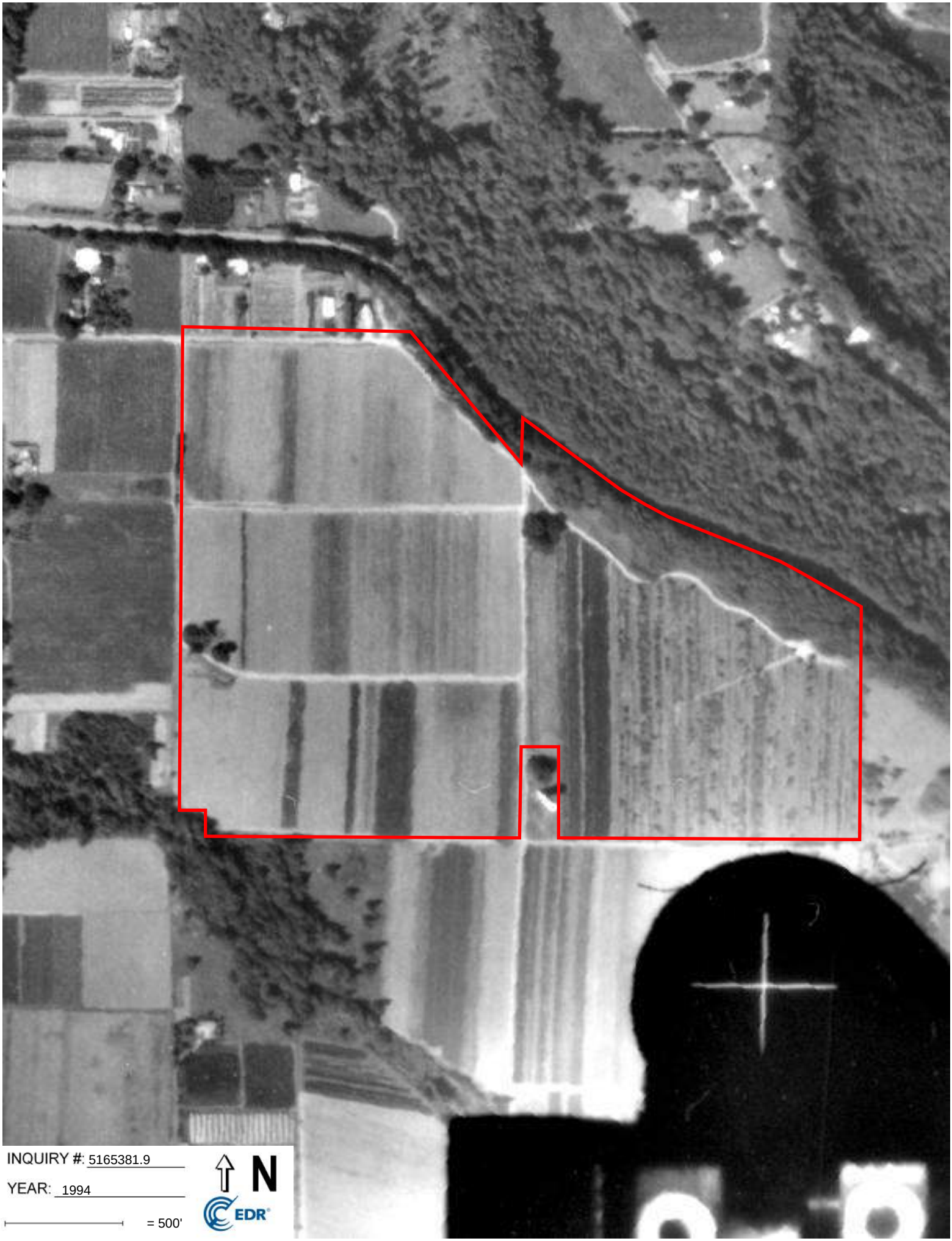
EDR

INQUIRY #: 5165381.9
YEAR: 1995
= 500'
N
EDR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YEAR: 1994
= 500'
N
EDR

INQUIRY #: 5165381.9

YEAR: 1991

= 1000'

N

EDR

Subject boundary not shown because it exceeds image extent or image is not georeferenced.

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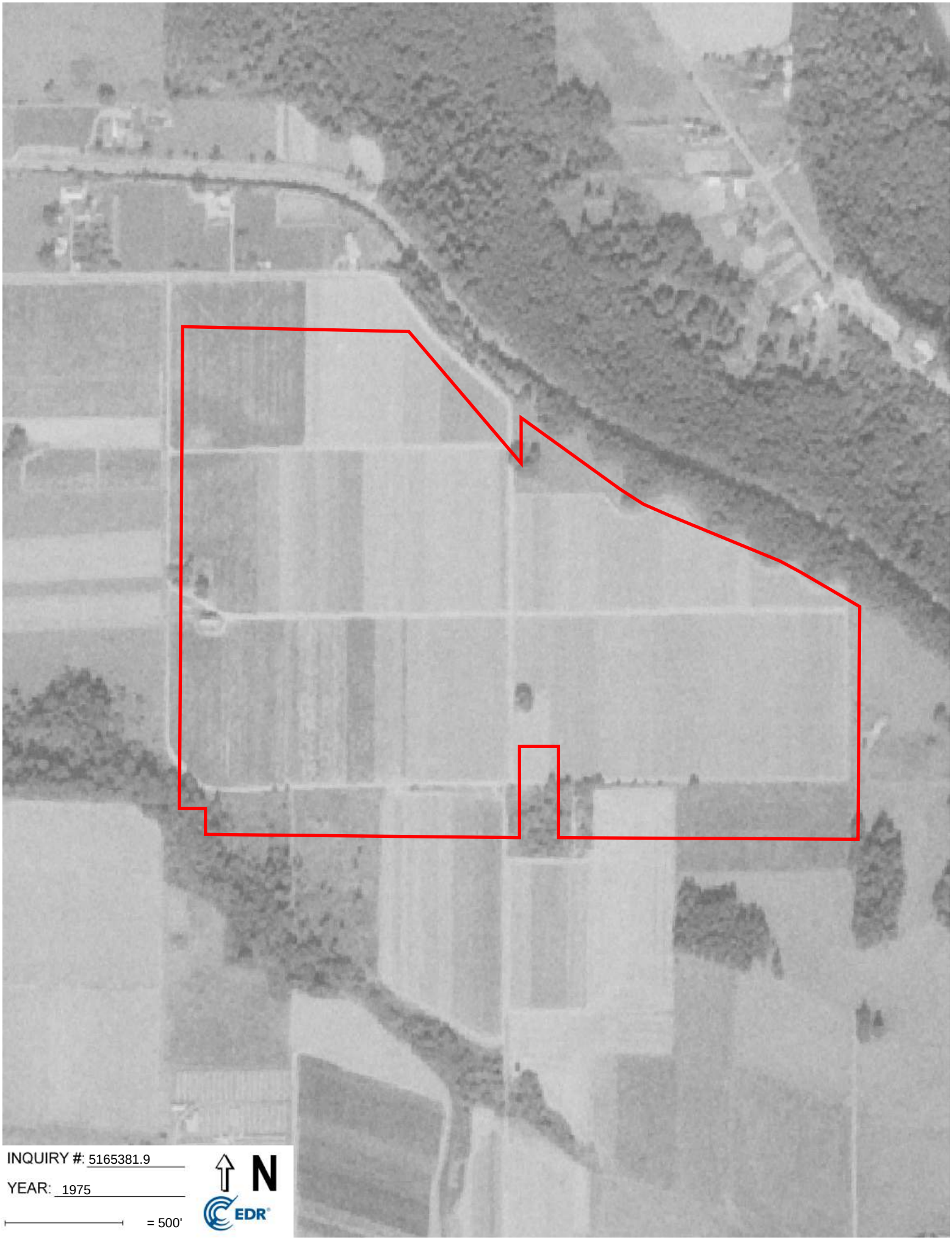
YEAR: 1982
= 500'
N
EDR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YEAR: 1975
= 500'
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EDR

INQUIRY #: 5165381.9
YEAR: 1970
= 500'
N
EDR

INQUIRY #: 5165381.9
YEAR: 1963
= 500'
N
EDR

INQUIRY #: 5165381.9
YEAR: 1960
= 500'
N
EDR

INQUIRY #: 5165381.9
YEAR: 1955
= 500'
N
EDR

INQUIRY #: 5165381.9
YEAR: 1952
= 500'
N
EDR

INQUIRY #: 5165381.9
YEAR: 1948
= 500'
N
EDR

APPENDIX E
EDR CITY DIRECTORIES

PWB Carpenter Lane Site
SE Carpenter Lane
Gresham, OR 97080

Inquiry Number: 5165381.5
January 23, 2018

The EDR-City Directory Abstract

Environmental Data Resources Inc

6 Armstrong Road
Shelton, CT 06484
800.352.0050
www.edrnet.com

TABLE OF CONTENTS

SECTION

Executive Summary

Findings

City Directory Images

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

DESCRIPTION

Environmental Data Resources, Inc.'s (EDR) City Directory Abstract is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's City Directory Abstract includes a search and abstract of available city directory data. For each address, the directory lists the name of the corresponding occupant at five year intervals.

Business directories including city, cross reference and telephone directories were reviewed, if available, at approximately five year intervals for the years spanning 1924 through 2014. This report compiles information gathered in this review by geocoding the latitude and longitude of properties identified and gathering information about properties within 1320 feet of the target property.

A summary of the information obtained is provided in the text of this report.

RECORD SOURCES

EDR's Digital Archive combines historical directory listings from sources such as Cole Information and Dun & Bradstreet. These standard sources of property information complement and enhance each other to provide a more comprehensive report.

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RESEARCH SUMMARY

The following research sources were consulted in the preparation of this report. An "X" indicates where information was identified in the source and provided in this report.

Year	Source	TP	Adjoining	Text Abstract	Source Image
2014	EDR Digital Archive	-	-	-	-
2010	EDR Digital Archive	-	-	-	-
2005	EDR Digital Archive	-	-	-	-
2000	EDR Digital Archive	-	-	-	-
1995	EDR Digital Archive	-	-	-	-
1990	EDR Digital Archive	-	-	-	-
1985	R. L. Polk and Co. Publishers	-	-	-	-
1981	R.L. Polk Co. Publishers	-	-	-	-
1980	R.L. Polk Co. Publishers	-	-	-	-
1977	R.L. Polk Co. Publishers	-	-	-	-
1975	R. L. Polk and Co. Publishers	-	-	-	-
1970	R.L.Polk Co.	-	-	-	-

EXECUTIVE SUMMARY

Year	Source	TP	Adjoining	Text Abstract	Source Image
1967	R.L.Polk Co.	-	-	-	-
1965	R.L.Polk Co.	-	-	-	-
1960	R. L. Polk Co. Publishers	-	-	-	-
1955	R. L. Polk Co. Publishers	-	-	-	-
1950	R. L. Polk Co. Publisher	-	-	-	-
1946	The Pacific Telephone and Telegraph Company	-	-	-	-
1940	R.L. Polk Co., Inc.	-	-	-	-
1935	R.L. Polk Co., Inc.	-	-	-	-
1930	R.L. Polk Co., Inc.	-	-	-	-
1924	R.L. Polk Co., Inc.	-	-	-	-

EXECUTIVE SUMMARY

SELECTED ADDRESSES

The following addresses were selected by the client, for EDR to research. An "X" indicates where information was identified.

Address	***Type***	***Findings***
35050 SE Carpenter Lane	Client Entered	
35321 SE Carpenter Lane	Client Entered	
36322 SE Dodge Park Blvd	Client Entered	

FINDINGS

TARGET PROPERTY INFORMATION

ADDRESS

SE Carpenter Lane
Gresham, OR 97080

FINDINGS DETAIL

Target Property research detail.

FINDINGS

ADJOINING PROPERTY DETAIL

The following Adjoining Property addresses were researched for this report. Detailed findings are provided for each address.

No Addresses Found

FINDINGS

TARGET PROPERTY: ADDRESS NOT IDENTIFIED IN RESEARCH SOURCE

The following Target Property addresses were researched for this report, and the addresses were not identified in the research source.

Address Researched	Address Not Identified in Research Source
SE Carpenter Lane	2014, 2010, 2005, 2000, 1995, 1990, 1985, 1981, 1980, 1977, 1975, 1970, 1967, 1965, 1960, 1955, 1950, 1946, 1940, 1935, 1930, 1924

ADJOINING PROPERTY: ADDRESSES NOT IDENTIFIED IN RESEARCH SOURCE

The following Adjoining Property addresses were researched for this report, and the addresses were not identified in research source.

Address Researched	Address Not Identified in Research Source
35050 SE Carpenter Lane	2014, 2010, 2005, 2000, 1995, 1990, 1985, 1981, 1980, 1977, 1975, 1970, 1967, 1965, 1960, 1955, 1950, 1946, 1940, 1935, 1930, 1924
35321 SE Carpenter Lane	2014, 2010, 2005, 2000, 1995, 1990, 1985, 1981, 1980, 1977, 1975, 1970, 1967, 1965, 1960, 1955, 1950, 1946, 1940, 1935, 1930, 1924
36322 SE Dodge Park Blvd	2014, 2010, 2005, 2000, 1995, 1990, 1985, 1981, 1980, 1977, 1975, 1970, 1967, 1965, 1960, 1955, 1950, 1946, 1940, 1935, 1930, 1924

APPENDIX F
EDR SANBORN FIRE INSURANCE MAPS

PWB Carpenter Lane Site

SE Carpenter Lane

Gresham, OR 97080

Inquiry Number: 5165381.3

January 22, 2018

Certified Sanborn® Map Report

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

Certified Sanborn® Map Report

01/22/18

Site Name:	Client Name:
PWB Carpenter Lane Site	Cooper Zietz Engineers, Inc DBA Akana.
SE Carpenter Lane	6400 SE Lake rd Suite 270
Gresham, OR 97080	Portland, OR 97222
EDR Inquiry # 5165381.3	Contact: Tim Norman

The Sanborn Library has been searched by EDR and maps covering the target property location as provided by Cooper Zietz Engineers, Inc DBA Akana. were identified for the years listed below. The Sanborn Library is the largest, most complete collection of fire insurance maps. The collection includes maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow, and others. Only Environmental Data Resources Inc. (EDR) is authorized to grant rights for commercial reproduction of maps by the Sanborn Library LLC, the copyright holder for the collection. Results can be authenticated by visiting www.edrnet.com/sanborn.

The Sanborn Library is continually enhanced with newly identified map archives. This report accesses all maps in the collection as of the day this report was generated.

Certified Sanborn Results:

Certification # C589-4098-BE67

PO # NA

Project 18-003

UNMAPPED PROPERTY

This report certifies that the complete holdings of the Sanborn Library, LLC collection have been searched based on client supplied target property information, and fire insurance maps covering the target property were not found.

Sanborn® Library search results

Certification #: C589-4098-BE67

The Sanborn Library includes more than 1.2 million fire insurance maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow and others which track historical property usage in approximately 12,000 American cities and towns. Collections searched:

- ✔ Library of Congress
- ✔ University Publications of America
- ✔ EDR Private Collection

The Sanborn Library LLC Since 1866™

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APPENDIX G
EDR RADIUS REPORT PACKAGE

PWB Carpenter Lane Site
SE Carpenter Lane
Gresham, OR 97080

Inquiry Number: 5165381.2s
January 22, 2018

The EDR Radius Map™ Report with GeoCheck®

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

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Executive Summary	ES1
Overview Map	2
Detail Map	3
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Government Records Searched/Data Currency Tracking	GR-1

GEOCHECK ADDENDUM

Physical Setting Source Addendum	A-1
Physical Setting Source Summary	A-2
Physical Setting SSURGO Soil Map	A-5
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Physical Setting Source Map Findings	A-13
Physical Setting Source Records Searched	PSGR-1

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13), the ASTM Standard Practice for Environmental Site Assessments for Forestland or Rural Property (E 2247-16), the ASTM Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process (E 1528-14) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

SE CARPENTER LANE
GRESHAM, OR 97080

COORDINATES

Latitude (North):	45.4640090 - 45˚ 27' 50.43''
Longitude (West):	122.2955490 - 122˚ 17' 43.97''
Universal Tranverse Mercator:	Zone 10
UTM X (Meters):	555073.2
UTM Y (Meters):	5034522.0
Elevation:	722 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	6066512 SANDY, OR
Version Date:	2014

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	20140630
Source:	USDA

MAPPED SITES SUMMARY

Target Property Address:
SE CARPENTER LANE
GRESHAM, OR 97080

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION
1	HEATING OIL TANK	36625 SE DODGE PARK	LUST	Lower	529, 0.100, ESE
2	HEATING OIL TANK	36315 SE LUSTED RD	LUST	Lower	779, 0.148, ENE
3	HEATING OIL TANK	35638 SE LUSTED RD	LUST	Lower	1331, 0.252, NNE
4	HEATING OIL TANK	37160 SE LUSTED RD	LUST	Lower	2447, 0.463, ESE

EXECUTIVE SUMMARY

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL ..... National Priority List
Proposed NPL ..... Proposed National Priority List Sites
NPL LIENS ..... Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL ..... National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY ..... Federal Facility Site Information listing
SEMS ..... Superfund Enterprise Management System

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE ..... Superfund Enterprise Management System Archive

Federal RCRA CORRACTS facilities list

CORRACTS ..... Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF ..... RCRA - Treatment, Storage and Disposal

Federal RCRA generators list

RCRA-LQG ..... RCRA - Large Quantity Generators
RCRA-SQG ..... RCRA - Small Quantity Generators
RCRA-CESQG ..... RCRA - Conditionally Exempt Small Quantity Generator

Federal institutional controls / engineering controls registries

LUCIS ..... Land Use Control Information System
US ENG CONTROLS ..... Engineering Controls Sites List

US INST CONTROL..... Sites with Institutional Controls

Federal ERNS list

ERNS..... Emergency Response Notification System

State- and tribal - equivalent CERCLIS

CRL..... Confirmed Release List and Inventory
ECSI..... Environmental Cleanup Site Information System

State and tribal landfill and/or solid waste disposal site lists

SWF/LF..... Solid Waste Facilities List

State and tribal leaking storage tank lists

INDIAN LUST..... Leaking Underground Storage Tanks on Indian Land

State and tribal registered storage tank lists

FEMA UST..... Underground Storage Tank Listing
UST..... Underground Storage Tank Database
AST..... Aboveground Storage Tanks
INDIAN UST..... Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

ENG CONTROLS..... Engineering Controls Recorded at ESCI Sites
INST CONTROL..... Institutional Controls Recorded at ESCI Sites

State and tribal voluntary cleanup sites

VCP..... Voluntary Cleanup Program Sites
INDIAN VCP..... Voluntary Cleanup Priority Listing

State and tribal Brownfields sites

BROWNFIELDS..... Brownfields Projects

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS..... A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

SWRCY..... Recycling Facility Location Listing
HIST LF..... Old Closed SW Disposal Sites
INDIAN ODI..... Report on the Status of Open Dumps on Indian Lands
DEBRIS REGION 9..... Torres Martinez Reservation Illegal Dump Site Locations
ODI..... Open Dump Inventory
IHS OPEN DUMPS..... Open Dumps on Indian Land

EXECUTIVE SUMMARY

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL	Delisted National Clandestine Laboratory Register
AOCONCERN	Columbia Slough
CDL	Uninhabitable Drug Lab Properties
US CDL	National Clandestine Laboratory Register

Local Land Records

LIENS 2	CERCLA Lien Information

Records of Emergency Release Reports

HMIRS	Hazardous Materials Information Reporting System
SPILLS	Spill Database
OR HAZMAT	Hazmat/Incidents
SPILLS 90	SPILLS 90 data from FirstSearch

Other Ascertainable Records

RCRA NonGen / NLR	RCRA - Non Generators / No Longer Regulated
FUDS	Formerly Used Defense Sites
DOD	Department of Defense Sites
SCRD DRYCLEANERS	State Coalition for Remediation of Drycleaners Listing
US FIN ASSUR	Financial Assurance Information
EPA WATCH LIST	EPA WATCH LIST
2020 COR ACTION	2020 Corrective Action Program List
TSCA	Toxic Substances Control Act
TRIS	Toxic Chemical Release Inventory System
SSTS	Section 7 Tracking Systems
ROD	Records Of Decision
RMP	Risk Management Plans
RAATS	RCRA Administrative Action Tracking System
PRP	Potentially Responsible Parties
PADS	PCB Activity Database System
ICIS	Integrated Compliance Information System
FTTS	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
MLTS	Material Licensing Tracking System
COAL ASH DOE	Steam-Electric Plant Operation Data
COAL ASH EPA	Coal Combustion Residues Surface Impoundments List
PCB TRANSFORMER	PCB Transformer Registration Database
RADINFO	Radiation Information Database
HIST FTTS	FIFRA/TSCA Tracking System Administrative Case Listing
DOT OPS	Incident and Accident Data
CONSENT	Superfund (CERCLA) Consent Decrees
INDIAN RESERV	Indian Reservations
FUSRAP	Formerly Utilized Sites Remedial Action Program
UMTRA	Uranium Mill Tailings Sites
LEAD SMELTERS	Lead Smelter Sites
US AIRS	Aerometric Information Retrieval System Facility Subsystem
US MINES	Mines Master Index File
ABANDONED MINES	Abandoned Mines
FINDS	Facility Index System/Facility Registry System

EXECUTIVE SUMMARY

ECHO ..... Enforcement & Compliance History Information
DOCKET HWC ..... Hazardous Waste Compliance Docket Listing
UXO ..... Unexploded Ordnance Sites
FUELS PROGRAM ..... EPA Fuels Program Registered Listing
AIRS ..... Oregon Title V Facility Listing
COAL ASH ..... Coal Ash Disposal Sites Listing
DRYCLEANERS ..... Drycleaning Facilities
Financial Assurance ..... Financial Assurance Information Listing
HSIS ..... Hazardous Substance Information Survey
MANIFEST ..... Manifest Information
NPDES ..... Wastewater Permits Database
UIC ..... Underground Injection Control Program Database

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP ..... EDR Proprietary Manufactured Gas Plants
EDR Hist Auto ..... EDR Exclusive Historical Auto Stations
EDR Hist Cleaner ..... EDR Exclusive Historical Cleaners

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS ..... Recovered Government Archive State Hazardous Waste Facilities List
RGA LF ..... Recovered Government Archive Solid Waste Facilities List
RGA LUST ..... Recovered Government Archive Leaking Underground Storage Tank

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

State and tribal leaking storage tank lists

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Environmental Quality's LUST Database List.

A review of the LUST list, as provided by EDR, and dated 10/03/2017 has revealed that there are 4

EXECUTIVE SUMMARY

LUST sites within approximately 0.5 miles of the target property.

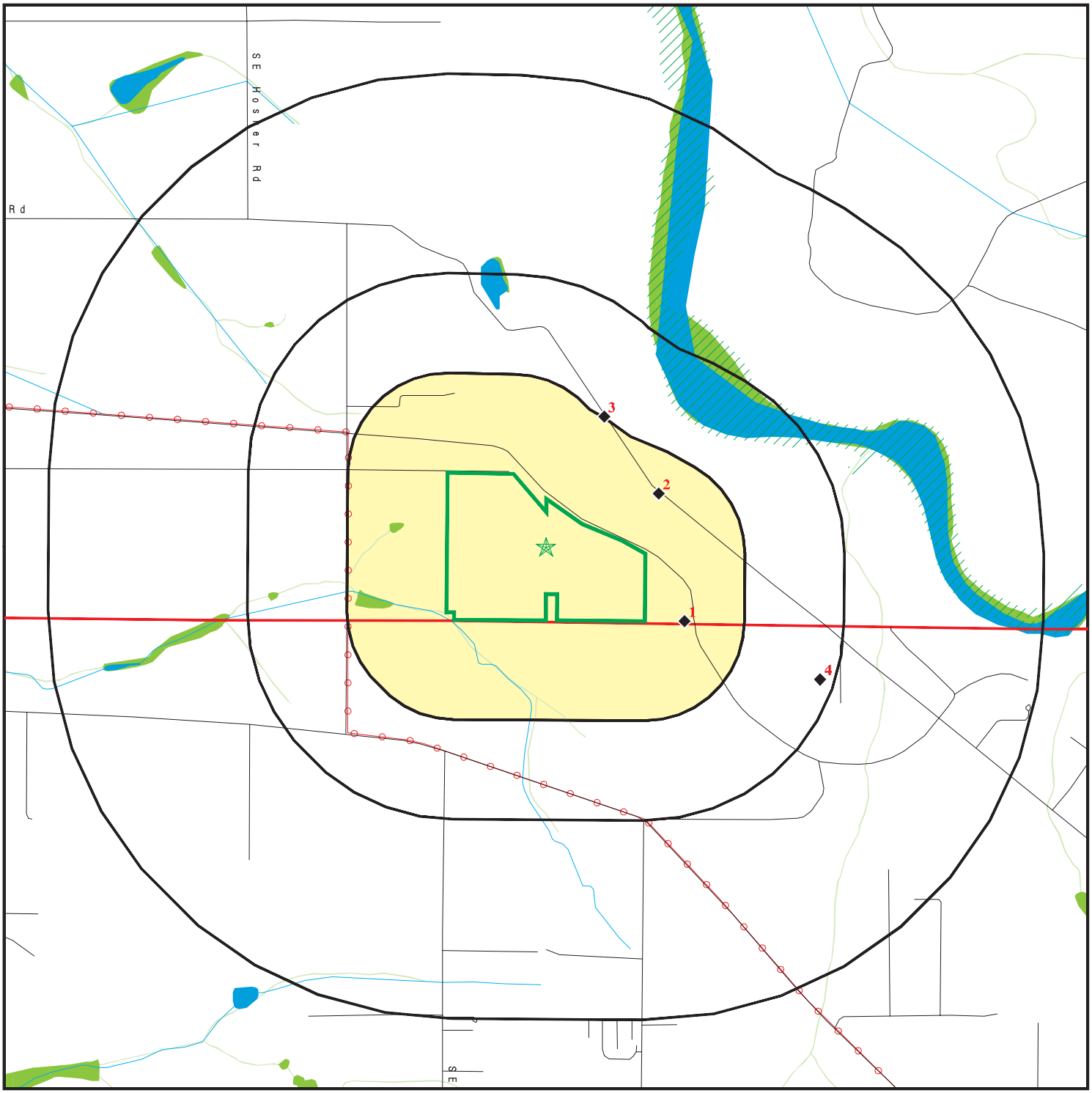
Lower Elevation	Address	Direction / Distance	Map ID	Page
HEATING OIL TANK Facility ID: 03-01-6172 Cleanup Complete: 07/12/2001	36625 SE DODGE PARK	ESE 0 - 1/8 (0.100 mi.)	1	8
HEATING OIL TANK Facility ID: 26-04-1132 Cleanup Complete: 07/28/2004	36315 SE LUSTED RD	ENE 1/8 - 1/4 (0.148 mi.)	2	8
HEATING OIL TANK Facility ID: 03-10-0238 Cleanup Complete: 02/17/2011	35638 SE LUSTED RD	NNE 1/4 - 1/2 (0.252 mi.)	3	8
HEATING OIL TANK Facility ID: 03-11-0759 Cleanup Complete: 07/23/2012	37160 SE LUSTED RD	ESE 1/4 - 1/2 (0.463 mi.)	4	8

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped. Count: 1 records.

Site Name	Database(s)
HEATING OIL TANK	LUST

OVERVIEW MAP - 5165381.2S



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- National Priority List Sites
- Dept. Defense Sites

0 1/4 1/2 1 Miles

- Indian Reservations BIA
- County Boundary
- Power transmission lines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory
- State Wetlands
- Upgradient Area
- Areas of Concern

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: PWB Carpenter Lane Site	CLIENT: Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS: SE Carpenter Lane Gresham OR 97080	CONTACT: Tim Norman
LAT/LONG: 45.464009 / -122.295549	INQUIRY #: 5165381.2s
	DATE: January 22, 2018 6:09 pm

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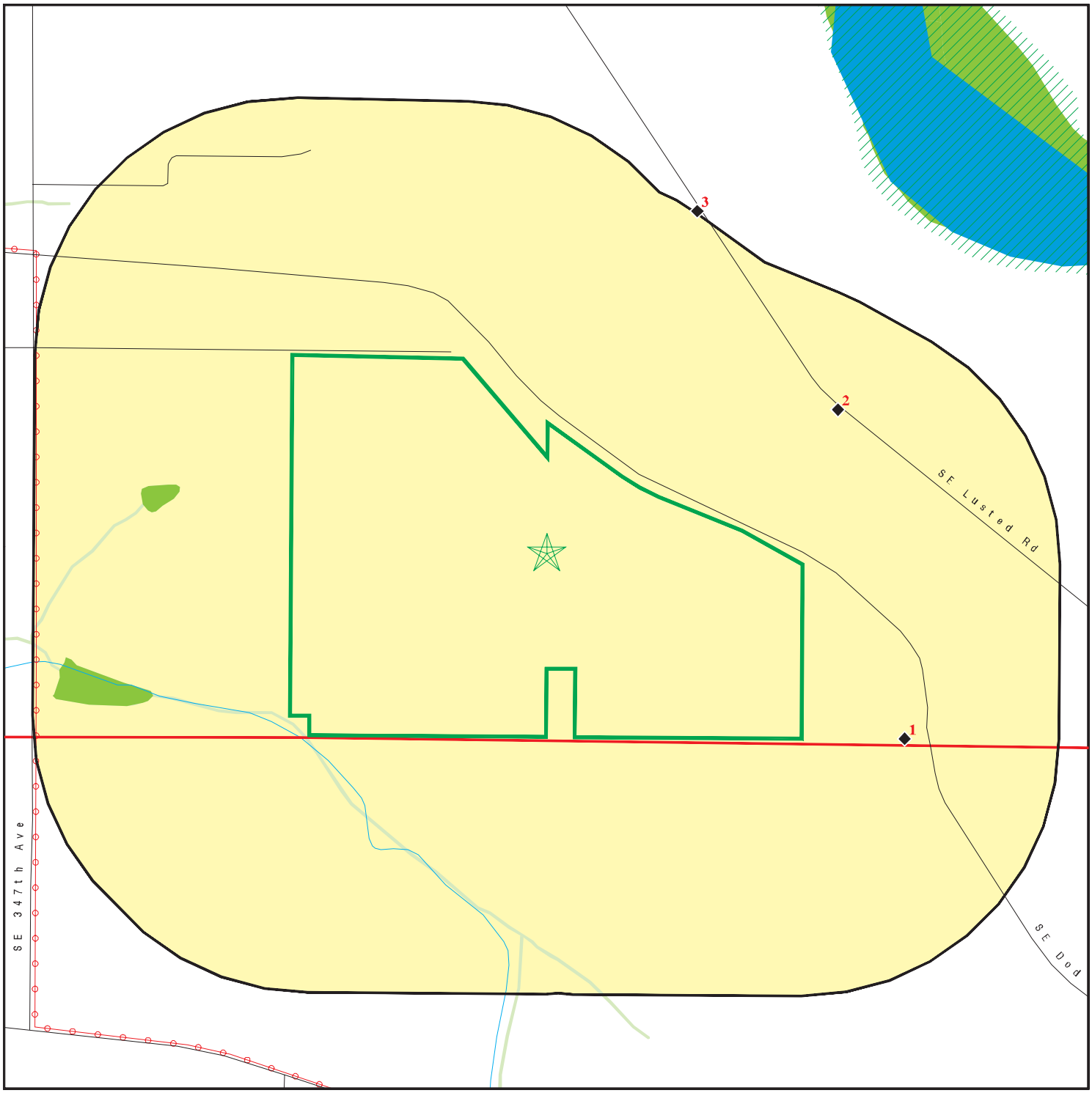
DETAIL MAP - 5165381.2S



Target Property

Sites at elevations higher than or equal to the target property

Sites at elevations lower than the target property

Manufactured Gas Plants

Sensitive Receptors

National Priority List Sites

Dept. Defense Sites

0 1/8 1/4 1/2 Miles

Indian Reservations BIA

County Boundary

Power transmission lines

100-year flood zone

500-year flood zone

National Wetland Inventory

State Wetlands

Areas of Concern

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: PWB Carpenter Lane Site	CLIENT: Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS: SE Carpenter Lane Gresham OR 97080	CONTACT: Tim Norman INQUIRY #: 5165381.2s
LAT/LONG: 45.464009 / -122.295549	DATE: January 22, 2018 6:10 pm

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MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL	1.000		0	0	0	0	NR	0
Proposed NPL	1.000		0	0	0	0	NR	0
NPL LIENS	0.001		0	NR	NR	NR	NR	0
Federal Delisted NPL site list								
Delisted NPL	1.000		0	0	0	0	NR	0
Federal CERCLIS list								
FEDERAL FACILITY	0.500		0	0	0	NR	NR	0
SEMS	0.500		0	0	0	NR	NR	0
Federal CERCLIS NFRAP site list								
SEMS-ARCHIVE	0.500		0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS	1.000		0	0	0	0	NR	0
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF	0.500		0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG	0.250		0	0	NR	NR	NR	0
RCRA-SQG	0.250		0	0	NR	NR	NR	0
RCRA-CESQG	0.250		0	0	NR	NR	NR	0
Federal institutional controls / engineering controls registries								
LUCIS	0.500		0	0	0	NR	NR	0
US ENG CONTROLS	0.500		0	0	0	NR	NR	0
US INST CONTROL	0.500		0	0	0	NR	NR	0
Federal ERNS list								
ERNS	0.001		0	NR	NR	NR	NR	0
State- and tribal - equivalent CERCLIS								
CRL	1.000		0	0	0	0	NR	0
ECSI	1.000		0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF	0.500		0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LUST	0.500		1	1	2	NR	NR	4
INDIAN LUST	0.500		0	0	0	NR	NR	0
State and tribal registered storage tank lists								
FEMA UST	0.250		0	0	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
UST	0.250		0	0	NR	NR	NR	0
AST	0.250		0	0	NR	NR	NR	0
INDIAN UST	0.250		0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
ENG CONTROLS	0.500		0	0	0	NR	NR	0
INST CONTROL	0.500		0	0	0	NR	NR	0
State and tribal voluntary cleanup sites								
VCP	0.500		0	0	0	NR	NR	0
INDIAN VCP	0.500		0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS	0.500		0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS	0.500		0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
SWRCY	0.500		0	0	0	NR	NR	0
HIST LF	0.500		0	0	0	NR	NR	0
INDIAN ODI	0.500		0	0	0	NR	NR	0
DEBRIS REGION 9	0.500		0	0	0	NR	NR	0
ODI	0.500		0	0	0	NR	NR	0
IHS OPEN DUMPS	0.500		0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US HIST CDL	0.001		0	NR	NR	NR	NR	0
AOCONCERN	1.000		0	0	0	0	NR	0
CDL	0.001		0	NR	NR	NR	NR	0
US CDL	0.001		0	NR	NR	NR	NR	0
Local Land Records								
LIENS 2	0.001		0	NR	NR	NR	NR	0
Records of Emergency Release Reports								
HMIRS	0.001		0	NR	NR	NR	NR	0
SPILLS	0.001		0	NR	NR	NR	NR	0
OR HAZMAT	0.001		0	NR	NR	NR	NR	0
SPILLS 90	0.001		0	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA NonGen / NLR	0.250		0	0	NR	NR	NR	0
FUDS	1.000		0	0	0	0	NR	0
DOD	1.000		0	0	0	0	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
SCRD DRYCLEANERS	0.500		0	0	0	NR	NR	0
US FIN ASSUR	0.001		0	NR	NR	NR	NR	0
EPA WATCH LIST	0.001		0	NR	NR	NR	NR	0
2020 COR ACTION	0.250		0	0	NR	NR	NR	0
TSCA	0.001		0	NR	NR	NR	NR	0
TRIS	0.001		0	NR	NR	NR	NR	0
SSTS	0.001		0	NR	NR	NR	NR	0
ROD	1.000		0	0	0	0	NR	0
RMP	0.001		0	NR	NR	NR	NR	0
RAATS	0.001		0	NR	NR	NR	NR	0
PRP	0.001		0	NR	NR	NR	NR	0
PADS	0.001		0	NR	NR	NR	NR	0
ICIS	0.001		0	NR	NR	NR	NR	0
FTTS	0.001		0	NR	NR	NR	NR	0
MLTS	0.001		0	NR	NR	NR	NR	0
COAL ASH DOE	0.001		0	NR	NR	NR	NR	0
COAL ASH EPA	0.500		0	0	0	NR	NR	0
PCB TRANSFORMER	0.001		0	NR	NR	NR	NR	0
RADINFO	0.001		0	NR	NR	NR	NR	0
HIST FTTS	0.001		0	NR	NR	NR	NR	0
DOT OPS	0.001		0	NR	NR	NR	NR	0
CONSENT	1.000		0	0	0	0	NR	0
INDIAN RESERV	0.001		0	NR	NR	NR	NR	0
FUSRAP	1.000		0	0	0	0	NR	0
UMTRA	0.500		0	0	0	NR	NR	0
LEAD SMELTERS	0.001		0	NR	NR	NR	NR	0
US AIRS	0.001		0	NR	NR	NR	NR	0
US MINES	0.250		0	0	NR	NR	NR	0
ABANDONED MINES	0.001		0	NR	NR	NR	NR	0
FINDS	0.001		0	NR	NR	NR	NR	0
ECHO	0.001		0	NR	NR	NR	NR	0
DOCKET HWC	0.001		0	NR	NR	NR	NR	0
UXO	1.000		0	0	0	0	NR	0
FUELS PROGRAM	0.250		0	0	NR	NR	NR	0
AIRS	0.001		0	NR	NR	NR	NR	0
COAL ASH	0.500		0	0	0	NR	NR	0
DRYCLEANERS	0.250		0	0	NR	NR	NR	0
Financial Assurance	0.001		0	NR	NR	NR	NR	0
HSIS	0.001		0	NR	NR	NR	NR	0
MANIFEST	0.250		0	0	NR	NR	NR	0
NPDES	0.001		0	NR	NR	NR	NR	0
UIC	0.001		0	NR	NR	NR	NR	0
EDR HIGH RISK HISTORICAL RECORDS								
EDR Exclusive Records								
EDR MGP	1.000		0	0	0	0	NR	0
EDR Hist Auto	0.125		0	NR	NR	NR	NR	0
EDR Hist Cleaner	0.125		0	NR	NR	NR	NR	0
EDR RECOVERED GOVERNMENT ARCHIVES								
Exclusive Recovered Govt. Archives								
RGA HWS	0.001		0	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
RGA LF	0.001		0	NR	NR	NR	NR	0
RGA LUST	0.001		0	NR	NR	NR	NR	0
- Totals --		0	1	1	2	0	0	4

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

1
ESE
< 1/8
0.100 mi.
529 ft.

HEATING OIL TANK
36625 SE DODGE PARK RD
GRESHAM, OR 97080

LUST **S105075814**
N/A

Relative:
Lower

Actual:
624 ft.

LUST:

Region:	North Western Region
Facility ID:	03-01-6172
Cleanup Received Date:	06/11/2001
Cleanup Start Date:	06/08/2001
Cleanup Complete Date:	**07/12/2001**
Decode for Region:	**North West Region**

2
ENE
1/8-1/4
0.148 mi.
779 ft.

HEATING OIL TANK
36315 SE LUSTED RD
BORING, OR 97009

LUST **S106475925**
N/A

Relative:
Lower

Actual:
446 ft.

LUST:

Region:	North Western Region
Facility ID:	26-04-1132
Cleanup Received Date:	06/11/2004
Cleanup Start Date:	06/18/2004
Cleanup Complete Date:	**07/28/2004**
Decode for Region:	**North West Region**

3
NNE
1/4-1/2
0.252 mi.
1331 ft.

HEATING OIL TANK
35638 SE LUSTED RD
BORING, OR 97009

LUST **S110292513**
N/A

Relative:
Lower

Actual:
445 ft.

LUST:

Region:	North Western Region
Facility ID:	03-10-0238
Cleanup Received Date:	03/23/2010
Cleanup Start Date:	Not reported
Cleanup Complete Date:	**02/17/2011**
Decode for Region:	**North West Region**

4
ESE
1/4-1/2
0.463 mi.
2447 ft.

HEATING OIL TANK
37160 SE LUSTED RD
BORING, OR 97009

LUST **S111332384**
N/A

Relative:
Lower

Actual:
510 ft.

LUST:

Region:	North Western Region
Facility ID:	03-11-0759
Cleanup Received Date:	07/28/2011
Cleanup Start Date:	Not reported
Cleanup Complete Date:	**07/23/2012**
Decode for Region:	**North West Region**

Count: 1 records.

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
BORING	S107595913	HEATING OIL TANK	8344 SE COTTRELL RD	97009	LUST

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Number of Days to Update: Provides confirmation that EDR is reporting records that have been updated within 90 days from the date the government agency made the information available to the public.

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL: National Priority List

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 12/11/2017
Date Data Arrived at EDR: 12/22/2017
Date Made Active in Reports: 01/05/2018
Number of Days to Update: 14

Source: EPA
Telephone: N/A
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 6
Telephone: 214-655-6659

EPA Region 3
Telephone 215-814-5418

EPA Region 7
Telephone: 913-551-7247

EPA Region 4
Telephone 404-562-8033

EPA Region 8
Telephone: 303-312-6774

EPA Region 5
Telephone 312-886-6686

EPA Region 9
Telephone: 415-947-4246

EPA Region 10
Telephone 206-553-8665

Proposed NPL: Proposed National Priority List Sites

A site that has been proposed for listing on the National Priorities List through the issuance of a proposed rule in the Federal Register. EPA then accepts public comments on the site, responds to the comments, and places on the NPL those sites that continue to meet the requirements for listing.

Date of Government Version: 12/11/2017
Date Data Arrived at EDR: 12/22/2017
Date Made Active in Reports: 01/05/2018
Number of Days to Update: 14

Source: EPA
Telephone: N/A
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

NPL LIENS: Federal Superfund Liens

Federal Superfund Liens. Under the authority granted the USEPA by CERCLA of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner received notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/1991
Date Data Arrived at EDR: 02/02/1994
Date Made Active in Reports: 03/30/1994
Number of Days to Update: 56

Source: EPA
Telephone: 202-564-4267
Last EDR Contact: 08/15/2011
Next Scheduled EDR Contact: 11/28/2011
Data Release Frequency: No Update Planned

Federal Delisted NPL site list

Delisted NPL: National Priority List Deletions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 12/11/2017	Source: EPA
Date Data Arrived at EDR: 12/22/2017	Telephone: N/A
Date Made Active in Reports: 01/05/2018	Last EDR Contact: 12/22/2017
Number of Days to Update: 14	Next Scheduled EDR Contact: 04/16/2018
	Data Release Frequency: Quarterly

Federal CERCLIS list

FEDERAL FACILITY: Federal Facility Site Information listing

A listing of National Priority List (NPL) and Base Realignment and Closure (BRAC) sites found in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Database where EPA Federal Facilities Restoration and Reuse Office is involved in cleanup activities.

Date of Government Version: 11/07/2016	Source: Environmental Protection Agency
Date Data Arrived at EDR: 01/05/2017	Telephone: 703-603-8704
Date Made Active in Reports: 04/07/2017	Last EDR Contact: 01/05/2018
Number of Days to Update: 92	Next Scheduled EDR Contact: 04/16/2018
	Data Release Frequency: Varies

SEMS: Superfund Enterprise Management System

SEMS (Superfund Enterprise Management System) tracks hazardous waste sites, potentially hazardous waste sites, and remedial activities performed in support of EPA's Superfund Program across the United States. The list was formerly know as CERCLIS, renamed to SEMS by the EPA in 2015. The list contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This dataset also contains sites which are either proposed to or on the National Priorities List (NPL) and the sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 12/11/2017	Source: EPA
Date Data Arrived at EDR: 12/22/2017	Telephone: 800-424-9346
Date Made Active in Reports: 01/12/2018	Last EDR Contact: 01/17/2018
Number of Days to Update: 21	Next Scheduled EDR Contact: 04/30/2018
	Data Release Frequency: Quarterly

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE: Superfund Enterprise Management System Archive

SEMS-ARCHIVE (Superfund Enterprise Management System Archive) tracks sites that have no further interest under the Federal Superfund Program based on available information. The list was formerly known as the CERCLIS-NFRAP, renamed to SEMS ARCHIVE by the EPA in 2015. EPA may perform a minimal level of assessment work at a site while it is archived if site conditions change and/or new information becomes available. Archived sites have been removed and archived from the inventory of SEMS sites. Archived status indicates that, to the best of EPA's knowledge, assessment at a site has been completed and that EPA has determined no further steps will be taken to list the site on the National Priorities List (NPL), unless information indicates this decision was not appropriate or other considerations require a recommendation for listing at a later time. The decision does not necessarily mean that there is no hazard associated with a given site; it only means that. based upon available information, the location is not judged to be potential NPL site.

Date of Government Version: 12/11/2017
Date Data Arrived at EDR: 12/22/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 21

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 01/17/2018
Next Scheduled EDR Contact: 04/30/2018
Data Release Frequency: Quarterly

Federal RCRA CORRACTS facilities list

CORRACTS: Corrective Action Report
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 09/13/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 10

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF: RCRA - Treatment, Storage and Disposal
RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Transporters are individuals or entities that move hazardous waste from the generator offsite to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 09/13/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 10

Source: Environmental Protection Agency
Telephone: (206) 553-1200
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

Federal RCRA generators list

RCRA-LQG: RCRA - Large Quantity Generators
RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

Date of Government Version: 09/13/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 10

Source: Environmental Protection Agency
Telephone: (206) 553-1200
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

RCRA-SQG: RCRA - Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

Date of Government Version: 09/13/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 10

Source: Environmental Protection Agency
Telephone: (206) 553-1200
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

RCRA-CESQG: RCRA - Conditionally Exempt Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

Date of Government Version: 09/13/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 10

Source: Environmental Protection Agency
Telephone: (206) 553-1200
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

Federal institutional controls / engineering controls registries

LUCIS: Land Use Control Information System

LUCIS contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.

Date of Government Version: 05/22/2017
Date Data Arrived at EDR: 06/13/2017
Date Made Active in Reports: 09/15/2017
Number of Days to Update: 94

Source: Department of the Navy
Telephone: 843-820-7326
Last EDR Contact: 11/08/2017
Next Scheduled EDR Contact: 02/26/2018
Data Release Frequency: Varies

US ENG CONTROLS: Engineering Controls Sites List

A listing of sites with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Date of Government Version: 08/10/2017
Date Data Arrived at EDR: 08/30/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 44

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Varies

US INST CONTROL: Sites with Institutional Controls

A listing of sites with institutional controls in place. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Date of Government Version: 08/10/2017
Date Data Arrived at EDR: 08/30/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 44

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Varies

Federal ERNS list

ERNS: Emergency Response Notification System
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 09/18/2017
Date Data Arrived at EDR: 09/21/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 22

Source: National Response Center, United States Coast Guard
Telephone: 202-267-2180
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

State- and tribal - equivalent CERCLIS

CRL: Confirmed Release List and Inventory
All facilities with a confirmed release.

Date of Government Version: 11/01/2017
Date Data Arrived at EDR: 11/16/2017
Date Made Active in Reports: 01/09/2018
Number of Days to Update: 54

Source: Department of Environmental Quality
Telephone: 503-229-6170
Last EDR Contact: 11/16/2017
Next Scheduled EDR Contact: 02/26/2018
Data Release Frequency: Quarterly

ECSI: Environmental Cleanup Site Information System
Sites that are or may be contaminated and may require cleanup.

Date of Government Version: 10/01/2017
Date Data Arrived at EDR: 10/06/2017
Date Made Active in Reports: 12/04/2017
Number of Days to Update: 59

Source: Department of Environmental Quality
Telephone: 503-229-6629
Last EDR Contact: 01/04/2018
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

State and tribal landfill and/or solid waste disposal site lists

SWF/LF: Solid Waste Facilities List
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 10/18/2017
Date Data Arrived at EDR: 10/19/2017
Date Made Active in Reports: 12/11/2017
Number of Days to Update: 53

Source: Department of Environmental Quality
Telephone: 503-229-6299
Last EDR Contact: 01/16/2018
Next Scheduled EDR Contact: 04/30/2018
Data Release Frequency: Semi-Annually

State and tribal leaking storage tank lists

LUST: Leaking Underground Storage Tank Database
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 10/03/2017
Date Data Arrived at EDR: 11/16/2017
Date Made Active in Reports: 01/10/2018
Number of Days to Update: 55

Source: Department of Environmental Quality
Telephone: 503-229-5790
Last EDR Contact: 11/16/2017
Next Scheduled EDR Contact: 02/26/2018
Data Release Frequency: Quarterly

INDIAN LUST R7: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Iowa, Kansas, and Nebraska

Date of Government Version: 04/14/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 71

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN LUST R8: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Date of Government Version: 05/01/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 78

Source: EPA Region 8
Telephone: 303-312-6271
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN LUST R9: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Arizona, California, New Mexico and Nevada

Date of Government Version: 04/13/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 78

Source: Environmental Protection Agency
Telephone: 415-972-3372
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN LUST R1: Leaking Underground Storage Tanks on Indian Land
A listing of leaking underground storage tank locations on Indian Land.

Date of Government Version: 04/14/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 71

Source: EPA Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN LUST R6: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in New Mexico and Oklahoma.

Date of Government Version: 04/24/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 71

Source: EPA Region 6
Telephone: 214-665-6597
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN LUST R10: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Alaska, Idaho, Oregon and Washington.

Date of Government Version: 04/25/2017
Date Data Arrived at EDR: 11/07/2017
Date Made Active in Reports: 12/08/2017
Number of Days to Update: 31

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 11/07/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN LUST R4: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Florida, Mississippi and North Carolina.

Date of Government Version: 10/14/2016
Date Data Arrived at EDR: 01/27/2017
Date Made Active in Reports: 05/05/2017
Number of Days to Update: 98

Source: EPA Region 4
Telephone: 404-562-8677
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Semi-Annually

INDIAN LUST R5: Leaking Underground Storage Tanks on Indian Land
Leaking underground storage tanks located on Indian Land in Michigan, Minnesota and Wisconsin.

Date of Government Version: 04/26/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 78

Source: EPA, Region 5
Telephone: 312-886-7439
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

State and tribal registered storage tank lists

FEMA UST: Underground Storage Tank Listing
A listing of all FEMA owned underground storage tanks.

Date of Government Version: 05/15/2017
Date Data Arrived at EDR: 05/30/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 136

Source: FEMA
Telephone: 202-646-5797
Last EDR Contact: 01/09/2018
Next Scheduled EDR Contact: 04/23/2018
Data Release Frequency: Varies

UST: Underground Storage Tank Database
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 10/03/2017
Date Data Arrived at EDR: 11/16/2017
Date Made Active in Reports: 01/10/2018
Number of Days to Update: 55

Source: Department of Environmental Quality
Telephone: 503-229-5815
Last EDR Contact: 11/16/2017
Next Scheduled EDR Contact: 02/26/2018
Data Release Frequency: Quarterly

AST: Aboveground Storage Tanks
Aboveground storage tank locations reported to the Office of State Fire Marshal.

Date of Government Version: 09/05/2017
Date Data Arrived at EDR: 11/16/2017
Date Made Active in Reports: 01/09/2018
Number of Days to Update: 54

Source: Office of State Fire Marshal
Telephone: 503-378-3473
Last EDR Contact: 11/13/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Semi-Annually

INDIAN UST R10: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 10 (Alaska, Idaho, Oregon, Washington, and Tribal Nations).

Date of Government Version: 04/25/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 78

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN UST R5: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 5 (Michigan, Minnesota and Wisconsin and Tribal Nations).

Date of Government Version: 04/26/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 71

Source: EPA Region 5
Telephone: 312-886-6136
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN UST R6: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 6 (Louisiana, Arkansas, Oklahoma, New Mexico, Texas and 65 Tribes).

Date of Government Version: 04/24/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 12/08/2017
Number of Days to Update: 134

Source: EPA Region 6
Telephone: 214-665-7591
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN UST R7: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 7 (Iowa, Kansas, Missouri, Nebraska, and 9 Tribal Nations).

Date of Government Version: 05/02/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 71

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN UST R4: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Tribal Nations)

Date of Government Version: 10/14/2016
Date Data Arrived at EDR: 01/27/2017
Date Made Active in Reports: 05/05/2017
Number of Days to Update: 98

Source: EPA Region 4
Telephone: 404-562-9424
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Semi-Annually

INDIAN UST R1: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont and ten Tribal Nations).

Date of Government Version: 04/14/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 71

Source: EPA, Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN UST R8: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming and 27 Tribal Nations).

Date of Government Version: 05/01/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 78

Source: EPA Region 8
Telephone: 303-312-6137
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

INDIAN UST R9: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 9 (Arizona, California, Hawaii, Nevada, the Pacific Islands, and Tribal Nations).

Date of Government Version: 04/13/2017
Date Data Arrived at EDR: 07/27/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 78

Source: EPA Region 9
Telephone: 415-972-3368
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

State and tribal institutional control / engineering control registries

ENG CONTROLS: Engineering Controls Recorded at ESCI Sites
Engineering controls are physical measures selected or approved by the Director for the purpose of preventing or minimizing exposure to hazardous substances. Engineering controls may include, but are not limited to, fencing, capping, horizontal or vertical barriers, hydraulic controls, and alternative water supplies.

Date of Government Version: 10/01/2017
Date Data Arrived at EDR: 10/06/2017
Date Made Active in Reports: 12/04/2017
Number of Days to Update: 59

Source: Department of Environmental Quality
Telephone: 503-229-5193
Last EDR Contact: 01/04/2018
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

INST CONTROL: Institutional Controls Recorded at ESCI Sites
An institutional control is a legal or administrative tool or action taken to reduce the potential for exposure to hazardous substances. Institutional controls may include, but are not limited to, use restrictions, environmental monitoring requirements, and site access and security measures.

Date of Government Version: 10/01/2017
Date Data Arrived at EDR: 10/06/2017
Date Made Active in Reports: 12/04/2017
Number of Days to Update: 59

Source: Department of Environmental Quality
Telephone: 503-229-5193
Last EDR Contact: 01/04/2018
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

State and tribal voluntary cleanup sites

VCS: Voluntary Cleanup Program Sites
Responsible parties have entered into an agreement with DEQ to voluntarily address contamination associated with their property.

Date of Government Version: 10/02/2017
Date Data Arrived at EDR: 10/31/2017
Date Made Active in Reports: 12/04/2017
Number of Days to Update: 34

Source: DEQ
Telephone: 503-229-5256
Last EDR Contact: 12/28/2017
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

INDIAN VCP R1: Voluntary Cleanup Priority Listing
A listing of voluntary cleanup priority sites located on Indian Land located in Region 1.

Date of Government Version: 07/27/2015
Date Data Arrived at EDR: 09/29/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 142

Source: EPA, Region 1
Telephone: 617-918-1102
Last EDR Contact: 12/20/2017
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Varies

INDIAN VCP R7: Voluntary Cleanup Priority Lisitng
A listing of voluntary cleanup priority sites located on Indian Land located in Region 7.

Date of Government Version: 03/20/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 7
Telephone: 913-551-7365
Last EDR Contact: 04/20/2009
Next Scheduled EDR Contact: 07/20/2009
Data Release Frequency: Varies

State and tribal Brownfields sites

BROWNFIELDS: Brownfields Projects
Brownfields investigations and/or cleanups that have been conducted in Oregon.

Date of Government Version: 11/01/2017
Date Data Arrived at EDR: 11/16/2017
Date Made Active in Reports: 01/09/2018
Number of Days to Update: 54

Source: Department of Environmental Quality
Telephone: 503-229-6801
Last EDR Contact: 11/16/2017
Next Scheduled EDR Contact: 02/26/2018
Data Release Frequency: Annually

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS: A Listing of Brownfields Sites
Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. Assessment, Cleanup and Redevelopment Exchange System (ACRES) stores information reported by EPA Brownfields grant recipients on brownfields properties assessed or cleaned up with grant funding as well as information on Targeted Brownfields Assessments performed by EPA Regions. A listing of ACRES Brownfield sites is obtained from Cleanups in My Community. Cleanups in My Community provides information on Brownfields properties for which information is reported back to EPA, as well as areas served by Brownfields grant programs.

Date of Government Version: 08/21/2017
Date Data Arrived at EDR: 09/20/2017
Date Made Active in Reports: 12/08/2017
Number of Days to Update: 79

Source: Environmental Protection Agency
Telephone: 202-566-2777
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/02/2018
Data Release Frequency: Semi-Annually

Local Lists of Landfill / Solid Waste Disposal Sites

HIST LF: Old Closed SW Disposal Sites
A list of solid waste disposal sites that have been closed for a long while.

Date of Government Version: 04/01/2000
Date Data Arrived at EDR: 07/08/2003
Date Made Active in Reports: 07/18/2003
Number of Days to Update: 10

Source: Department of Environmental Quality
Telephone: 503-229-5409
Last EDR Contact: 07/08/2003
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

SWRCY: Recycling Facility Location Listing
A listing of recycling facility locations.

Date of Government Version: 11/28/2017
Date Data Arrived at EDR: 11/29/2017
Date Made Active in Reports: 01/10/2018
Number of Days to Update: 42

Source: Department of Environmental Quality
Telephone: 503-229-5353
Last EDR Contact: 11/29/2017
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Quarterly

INDIAN ODI: Report on the Status of Open Dumps on Indian Lands
Location of open dumps on Indian land.

Date of Government Version: 12/31/1998
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 703-308-8245
Last EDR Contact: 10/30/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Varies

ODI: Open Dump Inventory
An open dump is defined as a disposal facility that does not comply with one or more of the Part 257 or Part 258 Subtitle D Criteria.

Date of Government Version: 06/30/1985
Date Data Arrived at EDR: 08/09/2004
Date Made Active in Reports: 09/17/2004
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 800-424-9346
Last EDR Contact: 06/09/2004
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

DEBRIS REGION 9: Torres Martinez Reservation Illegal Dump Site Locations
A listing of illegal dump sites location on the Torres Martinez Indian Reservation located in eastern Riverside County and northern Imperial County, California.

Date of Government Version: 01/12/2009
Date Data Arrived at EDR: 05/07/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 137

Source: EPA, Region 9
Telephone: 415-947-4219
Last EDR Contact: 10/20/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: No Update Planned

IHS OPEN DUMPS: Open Dumps on Indian Land
A listing of all open dumps located on Indian Land in the United States.

Date of Government Version: 04/01/2014
Date Data Arrived at EDR: 08/06/2014
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 176

Source: Department of Health & Human Serivces, Indian Health Service
Telephone: 301-443-1452
Last EDR Contact: 11/03/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Varies

Local Lists of Hazardous waste / Contaminated Sites

AOC COL: Columbia Slough
Columbia Slough waterway boundaries.

Date of Government Version: 08/10/2005
Date Data Arrived at EDR: 05/17/2006
Date Made Active in Reports: 06/16/2006
Number of Days to Update: 30

Source: City of Portland Environmental Services
Telephone: 503-823-5310
Last EDR Contact: 03/13/2007
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

AOC MU: East Multnomah County Area
Approximate extent of TSA VOC plume February , 2002

Date of Government Version: N/A
Date Data Arrived at EDR: 10/07/2002
Date Made Active in Reports: 10/22/2002
Number of Days to Update: 15

Source: City of Portland Environmental Services
Telephone: 503-823-5310
Last EDR Contact: 03/13/2007
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

US HIST CDL: National Clandestine Laboratory Register
A listing of clandestine drug lab locations that have been removed from the DEAs National Clandestine Laboratory Register.

Date of Government Version: 07/13/2017
Date Data Arrived at EDR: 09/06/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 30

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 11/28/2017
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: No Update Planned

CDL: Uninhabitable Drug Lab Properties
The properties listed on these county pages have been declared by a law enforcement agency to be unfit for use due to meth lab and/or storage activities. The properties are considered uninhabitable until cleaned up by a state certified decontamination contractor and a certificate of fitness is issued by the Oregon Health Division.

Date of Government Version: 11/08/2017
Date Data Arrived at EDR: 11/10/2017
Date Made Active in Reports: 01/09/2018
Number of Days to Update: 60

Source: Department of Consumer & Business Services
Telephone: 503-378-4133
Last EDR Contact: 11/07/2017
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Quarterly

CDL 2: Clandestine Drug Lab Site Listing
A listing of clandestine drug lab site locations included in the Incident database.

Date of Government Version: 10/02/2017
Date Data Arrived at EDR: 11/01/2017
Date Made Active in Reports: 12/01/2017
Number of Days to Update: 30

Source: Oregon State Police
Telephone: 503-373-1540
Last EDR Contact: 11/01/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Varies

US CDL: Clandestine Drug Labs
A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 07/13/2017
Date Data Arrived at EDR: 09/06/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 30

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Quarterly

Local Land Records

LIENS 2: CERCLA Lien Information
A Federal CERCLA ('Superfund') lien can exist by operation of law at any site or property at which EPA has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties.

Date of Government Version: 12/11/2017
Date Data Arrived at EDR: 12/22/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 21

Source: Environmental Protection Agency
Telephone: 202-564-6023
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Semi-Annually

Records of Emergency Release Reports

HMIRS: Hazardous Materials Information Reporting System
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 09/21/2017
Date Data Arrived at EDR: 09/21/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 22

Source: U.S. Department of Transportation
Telephone: 202-366-4555
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

SPILLS: Spill Data
Oil and hazardous material spills reported to the Environmental Response Program.

Date of Government Version: 09/28/2017
Date Data Arrived at EDR: 10/02/2017
Date Made Active in Reports: 12/04/2017
Number of Days to Update: 63

Source: Department of Environmental Quality
Telephone: 503-229-5815
Last EDR Contact: 01/02/2018
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Semi-Annually

HAZMAT: Hazmat/Incidents
Hazardous material incidents reported to the State Fire Marshal by emergency responders. The hazardous material may or may not have been released.

Date of Government Version: 07/03/2017
Date Data Arrived at EDR: 08/03/2017
Date Made Active in Reports: 09/26/2017
Number of Days to Update: 54

Source: State Fire Marshal's Office
Telephone: 503-373-1540
Last EDR Contact: 11/01/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Semi-Annually

SPILLS 90: SPILLS90 data from FirstSearch

Spills 90 includes those spill and release records available exclusively from FirstSearch databases. Typically, they may include chemical, oil and/or hazardous substance spills recorded after 1990. Duplicate records that are already included in EDR incident and release records are not included in Spills 90.

Date of Government Version: 05/01/2006
Date Data Arrived at EDR: 01/03/2013
Date Made Active in Reports: 02/22/2013
Number of Days to Update: 50

Source: FirstSearch
Telephone: N/A
Last EDR Contact: 01/03/2013
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

Other Ascertainable Records

RCRA NonGen / NLR: RCRA - Non Generators / No Longer Regulated

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

Date of Government Version: 09/13/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/06/2017
Number of Days to Update: 10

Source: Environmental Protection Agency
Telephone: (206) 553-1200
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

FUDS: Formerly Used Defense Sites

The listing includes locations of Formerly Used Defense Sites properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions.

Date of Government Version: 01/31/2015
Date Data Arrived at EDR: 07/08/2015
Date Made Active in Reports: 10/13/2015
Number of Days to Update: 97

Source: U.S. Army Corps of Engineers
Telephone: 202-528-4285
Last EDR Contact: 11/22/2017
Next Scheduled EDR Contact: 03/05/2018
Data Release Frequency: Varies

DOD: Department of Defense Sites

This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 11/10/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 62

Source: USGS
Telephone: 888-275-8747
Last EDR Contact: 10/13/2017
Next Scheduled EDR Contact: 01/22/2018
Data Release Frequency: Semi-Annually

FEDLAND: Federal and Indian Lands

Federally and Indian administrated lands of the United States. Lands included are administrated by: Army Corps of Engineers, Bureau of Reclamation, National Wild and Scenic River, National Wildlife Refuge, Public Domain Land, Wilderness, Wilderness Study Area, Wildlife Management Area, Bureau of Indian Affairs, Bureau of Land Management, Department of Justice, Forest Service, Fish and Wildlife Service, National Park Service.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 02/06/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 339

Source: U.S. Geological Survey
Telephone: 888-275-8747
Last EDR Contact: 10/11/2017
Next Scheduled EDR Contact: 01/22/2018
Data Release Frequency: N/A

SCRD DRYCLEANERS: State Coalition for Remediation of Drycleaners Listing

The State Coalition for Remediation of Drycleaners was established in 1998, with support from the U.S. EPA Office of Superfund Remediation and Technology Innovation. It is comprised of representatives of states with established drycleaner remediation programs. Currently the member states are Alabama, Connecticut, Florida, Illinois, Kansas, Minnesota, Missouri, North Carolina, Oregon, South Carolina, Tennessee, Texas, and Wisconsin.

Date of Government Version: 01/01/2017
Date Data Arrived at EDR: 02/03/2017
Date Made Active in Reports: 04/07/2017
Number of Days to Update: 63

Source: Environmental Protection Agency
Telephone: 615-532-8599
Last EDR Contact: 11/17/2017
Next Scheduled EDR Contact: 02/26/2018
Data Release Frequency: Varies

US FIN ASSUR: Financial Assurance Information

All owners and operators of facilities that treat, store, or dispose of hazardous waste are required to provide proof that they will have sufficient funds to pay for the clean up, closure, and post-closure care of their facilities.

Date of Government Version: 10/17/2017
Date Data Arrived at EDR: 11/01/2017
Date Made Active in Reports: 12/08/2017
Number of Days to Update: 37

Source: Environmental Protection Agency
Telephone: 202-566-1917
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

EPA WATCH LIST: EPA WATCH LIST

EPA maintains a "Watch List" to facilitate dialogue between EPA, state and local environmental agencies on enforcement matters relating to facilities with alleged violations identified as either significant or high priority. Being on the Watch List does not mean that the facility has actually violated the law only that an investigation by EPA or a state or local environmental agency has led those organizations to allege that an unproven violation has in fact occurred. Being on the Watch List does not represent a higher level of concern regarding the alleged violations that were detected, but instead indicates cases requiring additional dialogue between EPA, state and local agencies - primarily because of the length of time the alleged violation has gone unaddressed or unresolved.

Date of Government Version: 08/30/2013
Date Data Arrived at EDR: 03/21/2014
Date Made Active in Reports: 06/17/2014
Number of Days to Update: 88

Source: Environmental Protection Agency
Telephone: 617-520-3000
Last EDR Contact: 11/06/2017
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Quarterly

2020 COR ACTION: 2020 Corrective Action Program List

The EPA has set ambitious goals for the RCRA Corrective Action program by creating the 2020 Corrective Action Universe. This RCRA cleanup baseline includes facilities expected to need corrective action. The 2020 universe contains a wide variety of sites. Some properties are heavily contaminated while others were contaminated but have since been cleaned up. Still others have not been fully investigated yet, and may require little or no remediation. Inclusion in the 2020 Universe does not necessarily imply failure on the part of a facility to meet its RCRA obligations.

Date of Government Version: 04/22/2013
Date Data Arrived at EDR: 03/03/2015
Date Made Active in Reports: 03/09/2015
Number of Days to Update: 6

Source: Environmental Protection Agency
Telephone: 703-308-4044
Last EDR Contact: 11/09/2017
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Varies

TSCA: Toxic Substances Control Act

Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 06/21/2017
Date Made Active in Reports: 01/05/2018
Number of Days to Update: 198

Source: EPA
Telephone: 202-260-5521
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 04/02/2018
Data Release Frequency: Every 4 Years

TRIS: Toxic Chemical Release Inventory System

Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 01/10/2018
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 2

Source: EPA
Telephone: 202-566-0250
Last EDR Contact: 01/10/2018
Next Scheduled EDR Contact: 03/05/2018
Data Release Frequency: Annually

SSTS: Section 7 Tracking Systems

Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/2009
Date Data Arrived at EDR: 12/10/2010
Date Made Active in Reports: 02/25/2011
Number of Days to Update: 77

Source: EPA
Telephone: 202-564-4203
Last EDR Contact: 10/27/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Annually

ROD: Records Of Decision

Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 12/11/2017
Date Data Arrived at EDR: 12/22/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 21

Source: EPA
Telephone: 703-416-0223
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Annually

RMP: Risk Management Plans

When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n): Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases; Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g the fire department) should an accident occur.

Date of Government Version: 11/02/2017
Date Data Arrived at EDR: 11/17/2017
Date Made Active in Reports: 12/08/2017
Number of Days to Update: 21

Source: Environmental Protection Agency
Telephone: 202-564-8600
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

RAATS: RCRA Administrative Action Tracking System

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/1995
Date Data Arrived at EDR: 07/03/1995
Date Made Active in Reports: 08/07/1995
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4104
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: No Update Planned

PRP: Potentially Responsible Parties
A listing of verified Potentially Responsible Parties

Date of Government Version: 10/25/2013
Date Data Arrived at EDR: 10/17/2014
Date Made Active in Reports: 10/20/2014
Number of Days to Update: 3

Source: EPA
Telephone: 202-564-6023
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Quarterly

PADS: PCB Activity Database System
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 06/01/2017
Date Data Arrived at EDR: 06/09/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 126

Source: EPA
Telephone: 202-566-0500
Last EDR Contact: 01/12/2018
Next Scheduled EDR Contact: 04/23/2018
Data Release Frequency: Annually

ICIS: Integrated Compliance Information System
The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.

Date of Government Version: 11/18/2016
Date Data Arrived at EDR: 11/23/2016
Date Made Active in Reports: 02/10/2017
Number of Days to Update: 79

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 01/09/2018
Next Scheduled EDR Contact: 04/23/2018
Data Release Frequency: Quarterly

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-566-1667
Last EDR Contact: 08/18/2017
Next Scheduled EDR Contact: 12/04/2017
Data Release Frequency: Quarterly

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
A listing of FIFRA/TSCA Tracking System (FTTS) inspections and enforcements.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA
Telephone: 202-566-1667
Last EDR Contact: 08/18/2017
Next Scheduled EDR Contact: 12/04/2017
Data Release Frequency: Quarterly

MLTS: Material Licensing Tracking System
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 08/30/2016
Date Data Arrived at EDR: 09/08/2016
Date Made Active in Reports: 10/21/2016
Number of Days to Update: 43

Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 11/20/2017
Data Release Frequency: Quarterly

COAL ASH DOE: Steam-Electric Plant Operation Data
A listing of power plants that store ash in surface ponds.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 08/07/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 76

Source: Department of Energy
Telephone: 202-586-8719
Last EDR Contact: 12/05/2017
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Varies

COAL ASH EPA: Coal Combustion Residues Surface Impoundments List
A listing of coal combustion residues surface impoundments with high hazard potential ratings.

Date of Government Version: 07/01/2014
Date Data Arrived at EDR: 09/10/2014
Date Made Active in Reports: 10/20/2014
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: N/A
Last EDR Contact: 12/08/2017
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Varies

PCB TRANSFORMER: PCB Transformer Registration Database
The database of PCB transformer registrations that includes all PCB registration submittals.

Date of Government Version: 05/24/2017
Date Data Arrived at EDR: 11/30/2017
Date Made Active in Reports: 12/15/2017
Number of Days to Update: 15

Source: Environmental Protection Agency
Telephone: 202-566-0517
Last EDR Contact: 10/26/2017
Next Scheduled EDR Contact: 02/05/2018
Data Release Frequency: Varies

RADINFO: Radiation Information Database
The Radiation Information Database (RADINFO) contains information about facilities that are regulated by U.S. Environmental Protection Agency (EPA) regulations for radiation and radioactivity.

Date of Government Version: 10/02/2017
Date Data Arrived at EDR: 10/05/2017
Date Made Active in Reports: 10/13/2017
Number of Days to Update: 8

Source: Environmental Protection Agency
Telephone: 202-343-9775
Last EDR Contact: 01/04/2018
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Quarterly

HIST FTTS: FIFRA/TSCA Tracking System Administrative Case Listing
A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2007
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

HIST FTTS INSP: FIFRA/TSCA Tracking System Inspection & Enforcement Case Listing
A complete inspection and enforcement case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2008
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

DOT OPS: Incident and Accident Data

Department of Transporation, Office of Pipeline Safety Incident and Accident data.

Date of Government Version: 07/31/2012
Date Data Arrived at EDR: 08/07/2012
Date Made Active in Reports: 09/18/2012
Number of Days to Update: 42

Source: Department of Transporation, Office of Pipeline Safety
Telephone: 202-366-4595
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Varies

CONSENT: Superfund (CERCLA) Consent Decrees

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: 09/30/2017
Date Data Arrived at EDR: 11/10/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 63

Source: Department of Justice, Consent Decree Library
Telephone: Varies
Last EDR Contact: 01/04/2018
Next Scheduled EDR Contact: 04/02/2018
Data Release Frequency: Varies

BRS: Biennial Reporting System

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/2015
Date Data Arrived at EDR: 02/22/2017
Date Made Active in Reports: 09/28/2017
Number of Days to Update: 218

Source: EPA/NTIS
Telephone: 800-424-9346
Last EDR Contact: 11/20/2017
Next Scheduled EDR Contact: 03/05/2018
Data Release Frequency: Biennially

INDIAN RESERV: Indian Reservations

This map layer portrays Indian administered lands of the United States that have any area equal to or greater than 640 acres.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 07/14/2015
Date Made Active in Reports: 01/10/2017
Number of Days to Update: 546

Source: USGS
Telephone: 202-208-3710
Last EDR Contact: 01/09/2018
Next Scheduled EDR Contact: 04/23/2018
Data Release Frequency: Semi-Annually

FUSRAP: Formerly Utilized Sites Remedial Action Program

DOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to remediate sites where radioactive contamination remained from Manhattan Project and early U.S. Atomic Energy Commission (AEC) operations.

Date of Government Version: 12/23/2016
Date Data Arrived at EDR: 12/27/2016
Date Made Active in Reports: 02/17/2017
Number of Days to Update: 52

Source: Department of Energy
Telephone: 202-586-3559
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Varies

UMTRA: Uranium Mill Tailings Sites

Uranium ore was mined by private companies for federal government use in national defense programs. When the mills shut down, large piles of the sand-like material (mill tailings) remain after uranium has been extracted from the ore. Levels of human exposure to radioactive materials from the piles are low; however, in some cases tailings were used as construction materials before the potential health hazards of the tailings were recognized.

Date of Government Version: 06/23/2017
Date Data Arrived at EDR: 10/11/2017
Date Made Active in Reports: 11/03/2017
Number of Days to Update: 23

Source: Department of Energy
Telephone: 505-845-0011
Last EDR Contact: 11/22/2017
Next Scheduled EDR Contact: 03/05/2018
Data Release Frequency: Varies

LEAD SMELTER 1: Lead Smelter Sites
A listing of former lead smelter site locations.

Date of Government Version: 10/10/2017
Date Data Arrived at EDR: 11/03/2017
Date Made Active in Reports: 12/15/2017
Number of Days to Update: 42

Source: Environmental Protection Agency
Telephone: 703-603-8787
Last EDR Contact: 12/22/2017
Next Scheduled EDR Contact: 04/16/2018
Data Release Frequency: Varies

LEAD SMELTER 2: Lead Smelter Sites
A list of several hundred sites in the U.S. where secondary lead smelting was done from 1931and 1964. These sites may pose a threat to public health through ingestion or inhalation of contaminated soil or dust

Date of Government Version: 04/05/2001
Date Data Arrived at EDR: 10/27/2010
Date Made Active in Reports: 12/02/2010
Number of Days to Update: 36

Source: American Journal of Public Health
Telephone: 703-305-6451
Last EDR Contact: 12/02/2009
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

US AIRS (AFS): Aerometric Information Retrieval System Facility Subsystem (AFS)
The database is a sub-system of Aerometric Information Retrieval System (AIRS). AFS contains compliance data on air pollution point sources regulated by the U.S. EPA and/or state and local air regulatory agencies. This information comes from source reports by various stationary sources of air pollution, such as electric power plants, steel mills, factories, and universities, and provides information about the air pollutants they produce. Action, air program, air program pollutant, and general level plant data. It is used to track emissions and compliance data from industrial plants.

Date of Government Version: 10/12/2016
Date Data Arrived at EDR: 10/26/2016
Date Made Active in Reports: 02/03/2017
Number of Days to Update: 100

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 09/26/2017
Next Scheduled EDR Contact: 01/08/2018
Data Release Frequency: Annually

US AIRS MINOR: Air Facility System Data
A listing of minor source facilities.

Date of Government Version: 10/12/2016
Date Data Arrived at EDR: 10/26/2016
Date Made Active in Reports: 02/03/2017
Number of Days to Update: 100

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 09/26/2017
Next Scheduled EDR Contact: 01/08/2018
Data Release Frequency: Annually

US MINES: Mines Master Index File
Contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information.

Date of Government Version: 10/29/2017
Date Data Arrived at EDR: 11/28/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 45

Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959
Last EDR Contact: 11/28/2017
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Semi-Annually

US MINES 2: Ferrous and Nonferrous Metal Mines Database Listing
This map layer includes ferrous (ferrous metal mines are facilities that extract ferrous metals, such as iron ore or molybdenum) and nonferrous (Nonferrous metal mines are facilities that extract nonferrous metals, such as gold, silver, copper, zinc, and lead) metal mines in the United States.

Date of Government Version: 12/05/2005
Date Data Arrived at EDR: 02/29/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 49

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 12/01/2017
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Varies

US MINES 3: Active Mines & Mineral Plants Database Listing

Active Mines and Mineral Processing Plant operations for commodities monitored by the Minerals Information Team of the USGS.

Date of Government Version: 04/14/2011
Date Data Arrived at EDR: 06/08/2011
Date Made Active in Reports: 09/13/2011
Number of Days to Update: 97

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 12/01/2017
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Varies

ABANDONED MINES: Abandoned Mines

An inventory of land and water impacted by past mining (primarily coal mining) is maintained by OSMRE to provide information needed to implement the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The inventory contains information on the location, type, and extent of AML impacts, as well as, information on the cost associated with the reclamation of those problems. The inventory is based upon field surveys by State, Tribal, and OSMRE program officials. It is dynamic to the extent that it is modified as new problems are identified and existing problems are reclaimed.

Date of Government Version: 09/25/2017
Date Data Arrived at EDR: 09/26/2017
Date Made Active in Reports: 10/20/2017
Number of Days to Update: 24

Source: Department of Interior
Telephone: 202-208-2609
Last EDR Contact: 12/19/2017
Next Scheduled EDR Contact: 03/26/2018
Data Release Frequency: Quarterly

FINDS: Facility Index System/Facility Registry System

Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 07/23/2017
Date Data Arrived at EDR: 09/06/2017
Date Made Active in Reports: 09/15/2017
Number of Days to Update: 9

Source: EPA
Telephone: (206) 553-1200
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Quarterly

UXO: Unexploded Ordnance Sites

A listing of unexploded ordnance site locations

Date of Government Version: 09/30/2016
Date Data Arrived at EDR: 10/31/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 73

Source: Department of Defense
Telephone: 703-704-1564
Last EDR Contact: 01/02/2018
Next Scheduled EDR Contact: 04/30/2018
Data Release Frequency: Varies

DOCKET HWC: Hazardous Waste Compliance Docket Listing

A complete list of the Federal Agency Hazardous Waste Compliance Docket Facilities.

Date of Government Version: 06/27/2017
Date Data Arrived at EDR: 11/21/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 202-564-0527
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/12/2018
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

ECHO: Enforcement & Compliance History Information
ECHO provides integrated compliance and enforcement information for about 800,000 regulated facilities nationwide.

Date of Government Version: 09/02/2017
Date Data Arrived at EDR: 09/06/2017
Date Made Active in Reports: 10/20/2017
Number of Days to Update: 44

Source: Environmental Protection Agency
Telephone: 202-564-2280
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Quarterly

FUELS PROGRAM: EPA Fuels Program Registered Listing
This listing includes facilities that are registered under the Part 80 (Code of Federal Regulations) EPA Fuels Programs. All companies now are required to submit new and updated registrations.

Date of Government Version: 11/20/2017
Date Data Arrived at EDR: 11/20/2017
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 53

Source: EPA
Telephone: 800-385-6164
Last EDR Contact: 01/19/2018
Next Scheduled EDR Contact: 03/05/2018
Data Release Frequency: Quarterly

AIRS: Oregon Title V Facility Listing
A listing of Title V facility source and emissions information.

Date of Government Version: 12/31/2015
Date Data Arrived at EDR: 10/18/2017
Date Made Active in Reports: 10/23/2017
Number of Days to Update: 5

Source: Department of Environmental Quality
Telephone: 503-229-6459
Last EDR Contact: 01/04/2018
Next Scheduled EDR Contact: 04/17/2047
Data Release Frequency: Annually

COAL ASH: Coal Ash Disposal Sites Listing
A listing of coal ash disposal sites.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 03/03/2017
Date Made Active in Reports: 10/11/2017
Number of Days to Update: 222

Source: Department of Environmental Quality
Telephone: 541-298-7255
Last EDR Contact: 12/04/2017
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Varies

DRYCLEANERS: Drycleaning Facilities
A listing of registered drycleaning facilities in Oregon.

Date of Government Version: 11/03/2017
Date Data Arrived at EDR: 11/07/2017
Date Made Active in Reports: 12/01/2017
Number of Days to Update: 24

Source: Department of Environmental Quality
Telephone: 503-229-6783
Last EDR Contact: 10/30/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Annually

Financial Assurance 1: Financial Assurance Information Listing
Financial assurance information for hazardous waste facilities.

Date of Government Version: 09/08/2017
Date Data Arrived at EDR: 09/11/2017
Date Made Active in Reports: 10/23/2017
Number of Days to Update: 42

Source: Department of Environmental Quality
Telephone: 541-633-2011
Last EDR Contact: 12/04/2017
Next Scheduled EDR Contact: 03/19/2018
Data Release Frequency: Semi-Annually

Financial Assurance 2: Financial Assurance Information Listing
Financial assurance information for solid waste facilities. Financial assurance is intended to ensure that resources are available to pay for the cost of closure, post-closure care, and corrective measures if the owner or operator of a regulated facility is unable or unwilling to pay.

Date of Government Version: 11/20/2017
Date Data Arrived at EDR: 11/20/2017
Date Made Active in Reports: 01/10/2018
Number of Days to Update: 51

Source: Department of Environmental Quality
Telephone: 503-229-5521
Last EDR Contact: 11/15/2017
Next Scheduled EDR Contact: 03/05/2018
Data Release Frequency: Semi-Annually

HSIS: Hazardous Substance Information Survey
Companies in Oregon submitting the Hazardous Substance Information Survey and either reporting or not reporting hazardous substances.

Date of Government Version: 09/05/2017
Date Data Arrived at EDR: 11/16/2017
Date Made Active in Reports: 01/09/2018
Number of Days to Update: 54

Source: State Fire Marshal's Office
Telephone: 503-373-1540
Last EDR Contact: 11/13/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Semi-Annually

OR MANIFEST: Manifest Information
Hazardous waste manifest information.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 06/02/2017
Date Made Active in Reports: 10/11/2017
Number of Days to Update: 131

Source: Department of Environmental Quality
Telephone: N/A
Last EDR Contact: 11/06/2017
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Annually

NPDES: Wastewater Permits Database
A listing of permitted wastewater facilities.

Date of Government Version: 11/06/2017
Date Data Arrived at EDR: 11/09/2017
Date Made Active in Reports: 01/10/2018
Number of Days to Update: 62

Source: Department of Environmental Quality
Telephone: 503-229-5657
Last EDR Contact: 11/09/2017
Next Scheduled EDR Contact: 02/19/2018
Data Release Frequency: Varies

UIC: Underground Injection Control Program Database
DEQ's Underground Injection Control Program is authorized by the Environmental Protection Agency (EPA) to regulate all underground injection in Oregon to protect groundwater resources.

Date of Government Version: 09/21/2017
Date Data Arrived at EDR: 09/22/2017
Date Made Active in Reports: 10/11/2017
Number of Days to Update: 19

Source: Department of Environmental Quality
Telephone: 503-229-5945
Last EDR Contact: 12/21/2017
Next Scheduled EDR Contact: 04/09/2018
Data Release Frequency: Quarterly

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP: EDR Proprietary Manufactured Gas Plants
The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR's researchers. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

EDR Hist Auto: EDR Exclusive Historical Auto Stations

EDR has searched selected national collections of business directories and has collected listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include gas station/filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR Hist Cleaner: EDR Exclusive Historical Cleaners

EDR has searched selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS: Recovered Government Archive State Hazardous Waste Facilities List

The EDR Recovered Government Archive State Hazardous Waste database provides a list of SHWS incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Environmental Quality in Oregon.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 01/03/2014
Number of Days to Update: 186

Source: Department of Environmental Quality
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

RGA LF: Recovered Government Archive Solid Waste Facilities List

The EDR Recovered Government Archive Landfill database provides a list of landfills derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Environmental Quality in Oregon.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 01/13/2014
Number of Days to Update: 196

Source: Department of Environmental Quality
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

RGA LUST: Recovered Government Archive Leaking Underground Storage Tank

The EDR Recovered Government Archive Leaking Underground Storage Tank database provides a list of LUST incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Environmental Quality in Oregon.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 12/27/2013
Number of Days to Update: 179

Source: Department of Environmental Quality
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

NY MANIFEST: Facility and Manifest Data
Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a TSD facility.

Date of Government Version: 10/01/2017
Date Data Arrived at EDR: 11/01/2017
Date Made Active in Reports: 11/13/2017
Number of Days to Update: 12

Source: Department of Environmental Conservation
Telephone: 518-402-8651
Last EDR Contact: 11/01/2017
Next Scheduled EDR Contact: 02/12/2018
Data Release Frequency: Quarterly

WI MANIFEST: Manifest Information
Hazardous waste manifest information.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 04/13/2017
Date Made Active in Reports: 07/14/2017
Number of Days to Update: 92

Source: Department of Natural Resources
Telephone: N/A
Last EDR Contact: 12/11/2017
Next Scheduled EDR Contact: 03/26/2018
Data Release Frequency: Annually

Oil/Gas Pipelines
Source: PennWell Corporation
Petroleum Bundle (Crude Oil, Refined Products, Petrochemicals, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)) N = Natural Gas Bundle (Natural Gas, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)). This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

Electric Power Transmission Line Data
Source: PennWell Corporation
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Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

Daycare Centers: Child Care Listings
Source: Employment Department
Telephone: 503-947-1420

Flood Zone Data: This data was obtained from the Federal Emergency Management Agency (FEMA). It depicts 100-year and 500-year flood zones as defined by FEMA. It includes the National Flood Hazard Layer (NFHL) which incorporates Flood Insurance Rate Map (FIRM) data and Q3 data from FEMA in areas not covered by NFHL.
Source: FEMA
Telephone: 877-336-2627
Date of Government Version: 2003, 2015

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetlands Inventory Data
Source: Oregon Geospatial Enterprise Office
Telephone: 503-378-2166

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

STREET AND ADDRESS INFORMATION

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GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

PWB CARPENTER LANE SITE
SE CARPENTER LANE
GRESHAM, OR 97080

TARGET PROPERTY COORDINATES

Latitude (North):	45.464009 - 45˚ 27' 50.43''
Longitude (West):	122.295549 - 122˚ 17' 43.98''
Universal Tranverse Mercator:	Zone 10
UTM X (Meters):	555073.2
UTM Y (Meters):	5034522.0
Elevation:	722 ft. above sea level

USGS TOPOGRAPHIC MAP

Target Property Map:	6066512 SANDY, OR
Version Date:	2014

EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

Assessment of the impact of contaminant migration generally has two principal investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

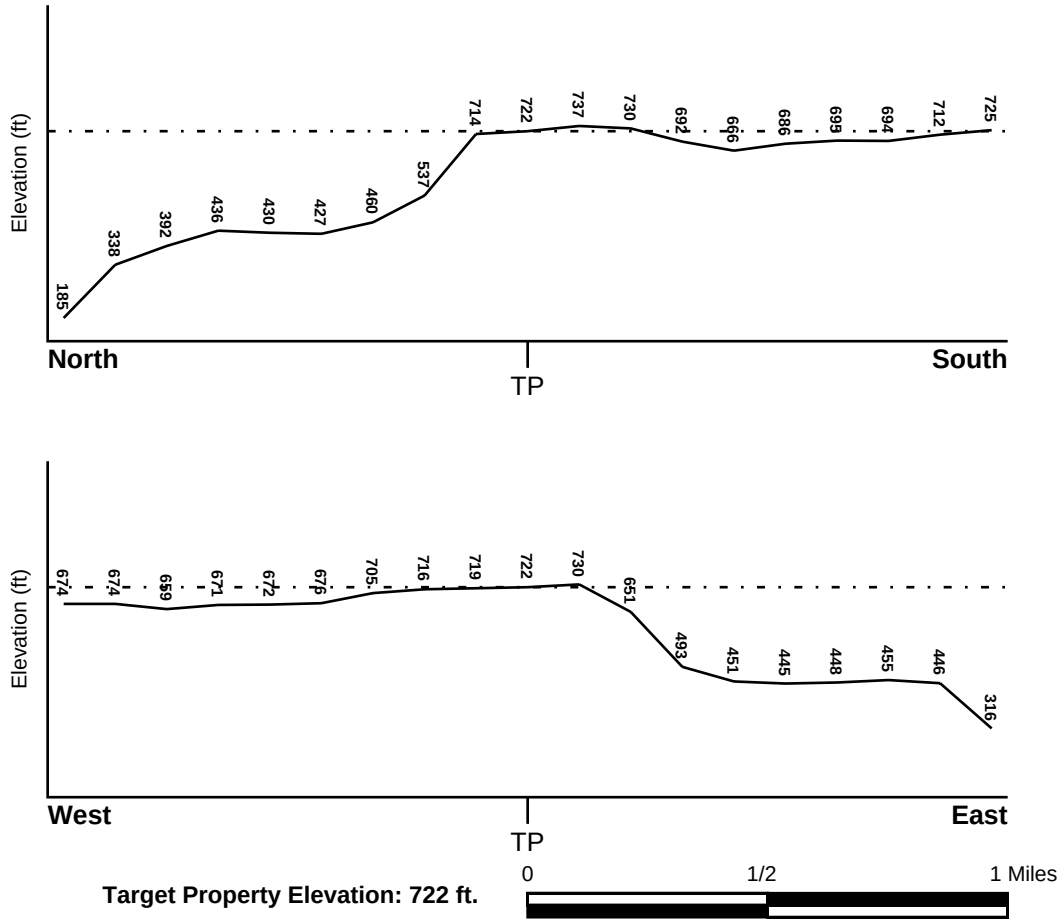
TOPOGRAPHIC INFORMATION

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

General Topographic Gradient: General NNE

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES



Target Property Elevation: 722 ft.

Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Flood Plain Panel at Target Property	FEMA Source Type
41005C0085D	FEMA FIRM Flood data

Additional Panels in search area:	FEMA Source Type
41005C0080D	FEMA FIRM Flood data

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
SANDY	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

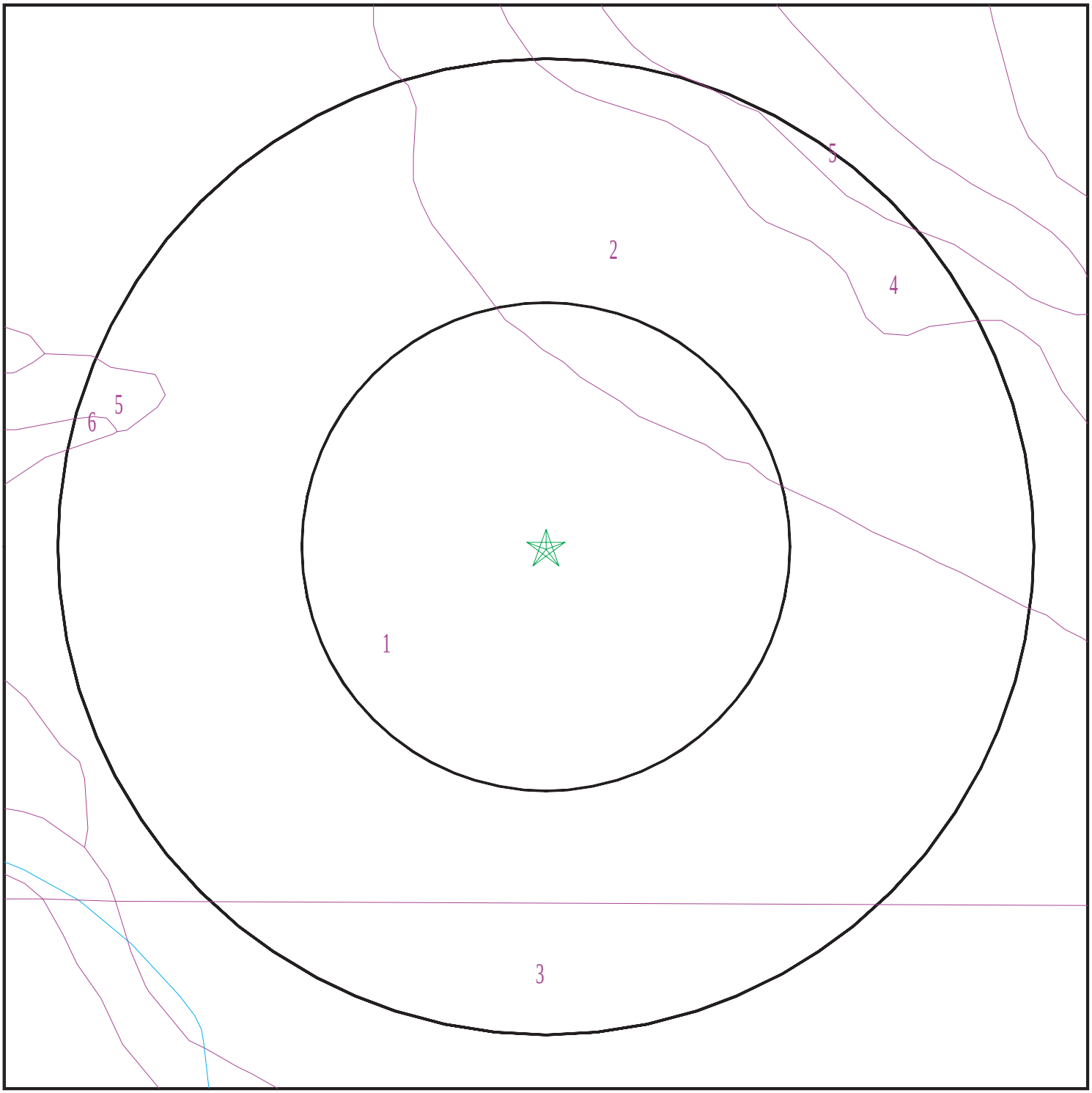
Era:	Cenozoic
System:	Tertiary
Series:	Upper Tertiary andesite
Code:	uTa *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Volcanic Rocks

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

SSURGO SOIL MAP - 5165381.2s



Target Property
SSURGO Soil
Water

0 1/16 1/8 1/4 Miles

N

SITE NAME:	PWB Carpenter Lane Site	CLIENT:	Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS:	SE Carpenter Lane Gresham OR 97080	CONTACT:	Tim Norman
		INQUIRY #:	5165381.2s
LAT/LONG:	45.464009 / -122.295549	DATE:	January 22, 2018 6:10 pm

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GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. The following information is based on Soil Conservation Service SSURGO data.

Soil Map ID: 1

Soil Component Name: Cazadero

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	16 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.1
2	16 inches	59 inches	silty clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 2

Soil Component Name: Haplumbrepts

Soil Surface Texture: silt loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Not Reported

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	14 inches	silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 1.4	Max: 6 Min: 5.1
2	14 inches	59 inches	gravelly clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Gravels, Gravels with fines, Clayey Gravel	Max: 14 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 3

Soil Component Name: Cazadero

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	20 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.1
2	20 inches	75 inches	clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 4

Soil Component Name: Haplumbrepts

Soil Surface Texture: silt loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Not Reported

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	14 inches	silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 1.4	Max: 6 Min: 5.1

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
2	14 inches	59 inches	gravelly clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Gravels, Gravels with fines, Clayey Gravel	Max: 14 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 5

Soil Component Name: Wollent

Soil Surface Texture: silt loam

Hydrologic Group: Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

Soil Drainage Class: Poorly drained

Hydric Status: All hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 15 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	9 inches	silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.6
2	9 inches	59 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.6

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Map ID: 6

Soil Component Name: Cazadero

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	16 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.1
2	16 inches	59 inches	silty clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.1

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 0.001 miles
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A2	USGS40000993363	1/4 - 1/2 Mile WSW
B10	USGS40000993306	1/2 - 1 Mile SSW
C15	USGS40000993288	1/2 - 1 Mile SSW
D17	USGS40000993364	1/2 - 1 Mile West

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

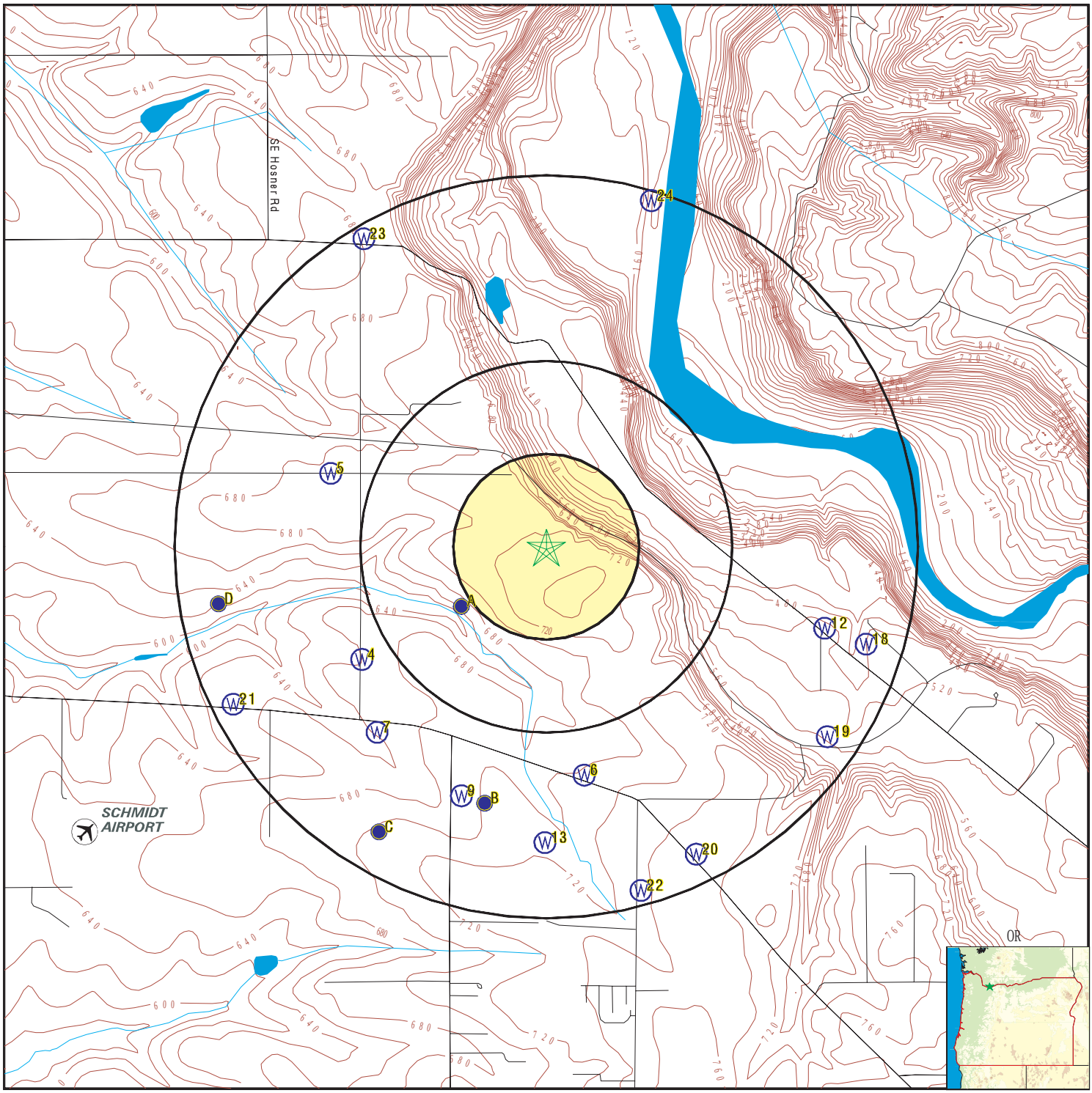
MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A1	ORW500000017320	1/4 - 1/2 Mile SW
A3	ORW500000014151	1/4 - 1/2 Mile WSW
4	ORW500000006517	1/2 - 1 Mile WSW
5	ORI500000047048	1/2 - 1 Mile WNW
6	ORW500000007737	1/2 - 1 Mile South
7	ORW500000007738	1/2 - 1 Mile SW
B8	ORW500000004700	1/2 - 1 Mile SSW
9	ORW500000004699	1/2 - 1 Mile SSW
B11	ORW500000014124	1/2 - 1 Mile SSW
12	ORW500000004585	1/2 - 1 Mile ESE
13	ORW500000003750	1/2 - 1 Mile South
C14	ORW500000003744	1/2 - 1 Mile SSW
D16	ORW500000003734	1/2 - 1 Mile West
18	ORI500000040707	1/2 - 1 Mile ESE
19	ORW500000004583	1/2 - 1 Mile SE
20	ORW500000005797	1/2 - 1 Mile SSE
21	ORW500000004588	1/2 - 1 Mile WSW
22	ORW500000004584	1/2 - 1 Mile SSE
23	ORW500000017322	1/2 - 1 Mile NNW
24	ORW500000004569	1/2 - 1 Mile NNE

PHYSICAL SETTING SOURCE MAP - 5165381.2s



County Boundary
Major Roads
Contour Lines
Airports
Earthquake epicenter, Richter 5 or greater
Water Wells
Public Water Supply Wells
Cluster of Multiple Icons

0 1/4 1/2 1 Miles

Groundwater Flow Direction
Indeterminate Groundwater Flow at Location
Groundwater Flow Varies at Location
Oil, gas or related wells

N

SITE NAME: PWB Carpenter Lane Site	CLIENT: Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS: SE Carpenter Lane Gresham OR 97080	CONTACT: Tim Norman
LAT/LONG: 45.464009 / -122.295549	INQUIRY #: 5165381.2s
	DATE: January 22, 2018 6:10 pm

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Map ID Direction Distance Elevation		Database	EDR ID Number
A1 **SW** **1/4 - 1/2 Mile** **Lower**		**OR WELLS**	**ORW500000017320**

Fid:	17319	Objectid:	0
Logid:	MULT 2594	Lstupdate:	12/30/2014
Establby:	JEN WOODY	Xysource:	APPLICATION
Horizerr:	300	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	37033		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	650		
Latitude:	45.4614974093		
Longitude:	-122.300010334		
Site id:	ORW500000017320		

A2 **WSW** **1/4 - 1/2 Mile** **Lower**		**FED USGS**	**USGS40000993363**

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452743122175701		
Monloc name:	01S/04E-22DCC		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4617873
Longitude:	-122.300367	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	650
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		
Aquifer type:	Not Reported		
Construction date:	19720326	Welldepth:	420
Welldepth units:	ft	Wellholedepth:	420
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 2

Date	Feet below Surface	Feet to Sealevel	Date	Feet below Surface	Feet to Sealevel
1972-05-01	280		1972-05	280	

Map ID Direction Distance Elevation	Database	EDR ID Number
A3 **WSW** **1/4 - 1/2 Mile** **Lower**	**OR WELLS**	**ORW500000014151**

Fid:	14150	Objectid:	14453
Logid:	MULT 9182	Lstupdate:	04/19/2011
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	100	Sourceorg:	USGS
Sourceowrd:	NWIS	Waypoint:	452743122175701
Welltag:	0		
Sownum:	0	Obswell:	Not Reported
Recwell:	Not Reported	Obsflagall:	Not Reported
Lsdelev:	0		
Latitude:	45.4617872503		
Longitude:	-122.300367001		
Site id:	ORW500000014151		

4 **WSW** **1/2 - 1 Mile** **Lower**	**OR WELLS**	**ORW500000006517**

Fid:	6516	Objectid:	6620
Logid:	CLAC 50350	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	FINAL PROOF MAP
Horizerr:	250	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	52962		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	654		
Latitude:	45.4596158042		
Longitude:	-122.305758711		
Site id:	ORW500000006517		

5 **WNW** **1/2 - 1 Mile** **Lower**	**OR WELLS**	**ORI500000047048**

Fid:	47047	Well inspe:	0
Physical l:	Not Reported	Inspection:	2008-05-14 00:00:00.000
Startcard :	189786	Wl county :	MULT
Wl nbr:	94299	Startcar00:	Not Reported
Well tag n:	Not Reported	No log:	Not Reported
Property o:	Not Reported	Inspecti00:	Not Reported
Special st:	0	Title:	Not Reported
Inspecti01:	Not Reported	Witnesses:	Not Reported
Name owner:	MALLORY, SCOTT		
Street:	Not Reported	City:	Not Reported

State:	Not Reported	Zip:	Not Reported
Phone home:	Not Reported	Phone comp:	Not Reported
Gps on wel:	Not Reported	Distance t:	Not Reported
Bearing to:	Not Reported	Drilling m:	Not Reported
Use of wel:	Not Reported	Drilling00:	Not Reported
Rough log :	Not Reported	Well tag r:	Not Reported
Monitoring:	Not Reported	Monitori00:	Not Reported
Protective:	Not Reported	Well locke:	Not Reported
Consultant:	Not Reported	Water in v:	Not Reported
Seal test :	Not Reported	Samples ta:	Not Reported
Casing dia:	Not Reported	Csg above :	Not Reported
Csg gauge:	Not Reported	Borehole d:	Not Reported
Dedicated :	Not Reported	Access por:	Not Reported
Access p00:	Not Reported	Measuring :	Not Reported
Measurin00:	Not Reported	Depth belo:	Not Reported
Depth be00:	Not Reported	Tape hold:	Not Reported
Tape missi:	Not Reported	Tape cut:	Not Reported
Water leve:	Not Reported	Water le00:	Not Reported
Cascading :	Not Reported	Pump type:	Not Reported
Pump make:	Not Reported	Pump hp:	Not Reported
Flowmeter :	Not Reported	Flowmete00:	Not Reported
Flowmete01:	Not Reported	Flowmete02:	Not Reported
Associated:	Not Reported	Nbr of hou:	Not Reported
Deficiency:	Not Reported		
Inspecti02:	GPS @ GATE TO DRIVEWAY		
Work new:	1	Work deepe:	0
Work conve:	0	Work alter:	0
Work aband:	0	Work exist:	0
Work other:	Not Reported	Drill rota:	Not Reported
Drill ro00:	Not Reported	Drill cabl:	Not Reported
Drill ca00:	Not Reported	Drill reve:	Not Reported
Drill re00:	Not Reported	Drill auge:	Not Reported
Drill push:	Not Reported	Drill hand:	Not Reported
Drill holl:	Not Reported	Drill soni:	Not Reported
Drill othe:	Not Reported	Use domest:	Not Reported
Use irriga:	Not Reported	Use commun:	Not Reported
Use indust:	Not Reported	Use livest:	Not Reported
Use dewate:	Not Reported	Use monito:	Not Reported
Use therma:	Not Reported	Use inject:	Not Reported
Use piezom:	Not Reported	Use observ:	Not Reported
Use recove:	Not Reported	Use other:	Not Reported
Bentonite :	Not Reported	Conductivi:	Not Reported
Conducti00:	Not Reported	Measuremen:	Not Reported
Well tag00:	Not Reported	Bonded lic:	1380
Unbonded l:	Not Reported	Bonded dri:	Not Reported
Unbonded d:	Not Reported	County cod:	MULT
Tax lot:	100	Township:	1
Township c:	S	Range:	4
Range char:	E	Sctn:	22
Qtr40:	Not Reported	Qtr160:	Not Reported
Latitude d:	45.46687000	Longitude :	-122.30747600
Gps horizo:	39.00000000	Year const:	2008
Date const:	Not Reported	Date con00:	Not Reported
Deficienci:	U	Previous i:	0
Inspected :	J J	Inspecte00:	113341
Wm region:	NW		
Well tag a:	Not Reported		
Well tag01:	Not Reported	Depth:	Not Reported
Static wat:	Not Reported	Status of :	Not Reported
Location r:	Not Reported	Site visit:	Not Reported

Type of lo:	W	Casing cap:	Not Reported
Pictures t:	0	Street of :	7625 SE COTTRELL
Street o00:	7625 SE COTTRELL RD, GRESHAM		
Last updt :	2008-10-24 10:18:45.547		
Last upd00:	jefferjw	Rec creati:	2009-06-01 06:51:00.000
Rec crea00:	OWRD\migrate		
Latitude:	45.46687		
Loongitude:	-122.307476		
Site id:	ORI500000047048		

6
South
1/2 - 1 Mile
Lower

OR WELLS **ORW500000007737**

Fid:	7736	Objectid:	7843
Logid:	CLAC 12302	Lstupdate:	12/23/2005
Establby:	SABRINA WHITE	Xysource:	FINAL PROOF MAP
Horizerr:	250	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	0		
Latitude:	45.4551040912		
Longitude:	-122.293440417		
Site id:	ORW500000007737		

7
SW
1/2 - 1 Mile
Lower

OR WELLS **ORW500000007738**

Fid:	7737	Objectid:	7844
Logid:	CLAC 54463	Lstupdate:	12/23/2005
Establby:	SABRINA WHITE	Xysource:	FINAL PROOF MAP
Horizerr:	250	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	14896		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	0		
Latitude:	45.4567739912		
Longitude:	-122.304913008		
Site id:	ORW500000007738		

B8
SSW
1/2 - 1 Mile
Lower

OR WELLS **ORW500000004700**

Fid:	4699	Objectid:	4721
Logid:	CLAC 942	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	695		
Latitude:	45.4540288306		
Longitude:	-122.298907152		
Site id:	ORW500000004700		

9
SSW **OR WELLS** **ORW500000004699**
1/2 - 1 Mile
Lower

Fid:	4698	Objectid:	4720
Logid:	CLAC 943	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	690		
Latitude:	45.4542980666		
Longitude:	-122.300241878		
Site id:	ORW500000004699		

B10
SSW **FED USGS** **USGS40000993306**
1/2 - 1 Mile
Lower

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452715122175201		
Monloc name:	01S/04E-27ACC1		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4540095
Longitude:	-122.298978	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	695
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		

Aquifer type:	Not Reported		
Construction date:	19800922	Welldepth:	360
Welldepth units:	ft	Wellholedepth:	365
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1980-09-22	245	

B11
SSW
1/2 - 1 Mile
Lower

OR WELLS **ORW500000014124**

Fid:	14123	Objectid:	14424
Logid:	CLAC 7119	Lstupdate:	04/19/2011
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	100	Sourceorg:	USGS
Sourceowrd:	NWIS	Waypoint:	452715122175201
Welltag:	0		
Sownum:	0	Obswell:	Not Reported
Recwell:	Not Reported	Obsflagall:	Not Reported
Lsdelev:	0		
Latitude:	45.4540094798		
Longitude:	-122.298978		
Site id:	ORW500000014124		

12
ESE
1/2 - 1 Mile
Lower

OR WELLS **ORW500000004585**

Fid:	4584	Objectid:	4606
Logid:	CLAC 896	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	500		
Latitude:	45.4608337933		
Longitude:	-122.280126233		
Site id:	ORW500000004585		

13
South
1/2 - 1 Mile
Lower

OR WELLS **ORW500000003750**

Fid:	3749	Objectid:	3765
Logid:	CLAC 936	Lstupdate:	06/26/2006
Establby:	KARL WOZNIAK	Xysource:	FINAL PROOF MAP & DOQ
Horizerr:	100	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	720		
Latitude:	45.4524746471		
Longitude:	-122.295619125		
Site id:	ORW500000003750		

C14
SSW **OR WELLS** **ORW500000003744**
1/2 - 1 Mile
Lower

Fid:	3743	Objectid:	3759
Logid:	CLAC 944	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	9
Recwell:	9	Obsflagall:	Not Reported
Lsdelev:	700		
Latitude:	45.4528993144		
Longitude:	-122.304811178		
Site id:	ORW500000003744		

C15
SSW **FED USGS** **USGS40000993288**
1/2 - 1 Mile
Lower

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452711122181301		
Monloc name:	01S/04E-27CAB1		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4528984
Longitude:	-122.3048113	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	700
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		

Aquifer type:	Not Reported		
Construction date:	19730430	Welldepth:	392
Welldepth units:	ft	Wellholedepth:	392
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 0

D16
West
1/2 - 1 Mile
Lower

OR WELLS **ORW500000003734**

Fid:	3733	Objectid:	3749
Logid:	MULT 2590	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	9
Recwell:	9	Obsflagall:	Not Reported
Lsdelev:	612		
Latitude:	45.4617879018		
Longitude:	-122.313700318		
Site id:	ORW500000003734		

D17
West
1/2 - 1 Mile
Lower

FED USGS **USGS40000993364**

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452743122184501		
Monloc name:	01S/04E-21DDC		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4617873
Longitude:	-122.3137005	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	612
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		
Aquifer type:	Not Reported		
Construction date:	19741121	Welldepth:	400
Welldepth units:	ft	Wellholedepth:	450
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation		Database	EDR ID Number
18 **ESE** **1/2 - 1 Mile** **Lower**		**OR WELLS**	**ORI500000040707**

Fid:	40706	Well inspe:	0
Physical l:	Not Reported	Inspection:	2006-01-20 00:00:00.000
Startcard :	183454	Wl county :	Not Reported
Wl nbr:	Not Reported	Startcar00:	Not Reported
Well tag n:	Not Reported	No log:	Not Reported
Property o:	Not Reported	Inspecti00:	Not Reported
Special st:	0	Title:	Not Reported
Inspecti01:	Not Reported	Witnesses:	Not Reported
Name owner:	CRUTCHER, RYAN		
Street:	Not Reported	City:	Not Reported
State:	Not Reported	Zip:	Not Reported
Phone home:	Not Reported	Phone comp:	Not Reported
Gps on wel:	Not Reported	Distance t:	Not Reported
Bearing to:	Not Reported	Drilling m:	Not Reported
Use of wel:	Not Reported	Drilling00:	Not Reported
Rough log :	Not Reported	Well tag r:	Not Reported
Monitoring:	Not Reported	Monitori00:	Not Reported
Protective:	Not Reported	Well locke:	Not Reported
Consultant:	Not Reported	Water in v:	Not Reported
Seal test :	Not Reported	Samples ta:	Not Reported
Casing dia:	Not Reported	Csg above :	Not Reported
Csg gauge:	Not Reported	Borehole d:	Not Reported
Dedicated :	Not Reported	Access por:	Not Reported
Access p00:	Not Reported	Measuring :	Not Reported
Measurin00:	Not Reported	Depth belo:	Not Reported
Depth be00:	Not Reported	Tape hold:	Not Reported
Tape missi:	Not Reported	Tape cut:	Not Reported
Water leve:	Not Reported	Water le00:	Not Reported
Cascading :	Not Reported	Pump type:	Not Reported
Pump make:	Not Reported	Pump hp:	Not Reported
Flowmeter :	Not Reported	Flowmete00:	Not Reported
Flowmete01:	Not Reported	Flowmete02:	Not Reported
Associated:	Not Reported	Nbr of hou:	Not Reported
Deficiency:	Not Reported		
Inspecti02:	Not Reported		
Work new:	0	Work deepe:	0
Work conve:	0	Work alter:	0
Work aband:	0	Work exist:	0
Work other:	Not Reported	Drill rota:	Not Reported
Drill ro00:	Not Reported	Drill cabl:	Not Reported
Drill ca00:	Not Reported	Drill reve:	Not Reported
Drill re00:	Not Reported	Drill auge:	Not Reported
Drill push:	Not Reported	Drill hand:	Not Reported
Drill holl:	Not Reported	Drill soni:	Not Reported
Drill othe:	Not Reported	Use domest:	Not Reported
Use irriga:	Not Reported	Use commun:	Not Reported
Use indust:	Not Reported	Use livest:	Not Reported
Use dewate:	Not Reported	Use monito:	Not Reported
Use therma:	Not Reported	Use inject:	Not Reported
Use piezom:	Not Reported	Use observ:	Not Reported

Use recove:	Not Reported	Use other:	Not Reported
Bentonite :	Not Reported	Conductivi:	Not Reported
Conducti00:	Not Reported	Measuremen:	Not Reported
Well tag00:	Not Reported	Bonded lic:	1592
Unbonded l:	Not Reported	Bonded dri:	Not Reported
Unbonded d:	Not Reported	County cod:	CLAC
Tax lot:	1901	Township:	1
Township c:	S	Range:	4
Range char:	E	Sctn:	26
Qtr40:	NW	Qtr160:	NE
Latitude d:	45.46021000	Longitude :	-122.27783000
Gps horizo:	16.00000000	Year const:	2006
Date const:	Not Reported	Date con00:	Not Reported
Deficienci:	U	Previous i:	0
Inspected :	J J	Inspecte00:	113341
Wm region:	NW		
Well tag a:	WELL NOT COMPLETE - NO ATTACHED ID		
Well tag01:	Not Reported	Depth:	Not Reported
Static wat:	Not Reported	Status of :	DIP
Location r:	Not Reported	Site visit:	Not Reported
Type of lo:	W	Casing cap:	Not Reported
Pictures t:	0	Street of :	Not Reported
Street o00:	8627 SE MAYBERRY LANE, BORING		
Last updt :	2010-04-01 00:00:00.000		
Last upd00:	WRD\migrate	Rec creati:	2009-06-01 06:51:00.000
Rec crea00:	OWRD\migrate		
Latitude:	45.46021		
Loongitude:	-122.27783		
Site id:	ORI500000040707		

19
SE
1/2 - 1 Mile
Lower

OR WELLS **ORW500000004583**

Fid:	4582	Objectid:	4604
Logid:	CLAC 930	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	537		
Latitude:	45.4566022719		
Longitude:	-122.279980209		
Site id:	ORW500000004583		

20
SSE
1/2 - 1 Mile
Higher

OR WELLS **ORW500000005797**

Fid:	5796	Objectid:	5876
Logid:	CLAC 20245	Lstupdate:	01/01/1990
Establby:	MARC NORTON	Xysource:	GPS
Horizerr:	4	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	r032621b.cor
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	745		
Latitude:	45.4520217707		
Longitude:	-122.287236956		
Site id:	ORW500000005797		

21
WSW **OR WELLS** **ORW500000004588**
1/2 - 1 Mile
Lower

Fid:	4587	Objectid:	4609
Logid:	CLAC 959	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	646		
Latitude:	45.457867409		
Longitude:	-122.312878945		
Site id:	ORW500000004588		

22
SSE **OR WELLS** **ORW500000004584**
1/2 - 1 Mile
Higher

Fid:	4583	Objectid:	4605
Logid:	CLAC 899	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	730		
Latitude:	45.4506091148		
Longitude:	-122.290301432		
Site id:	ORW500000004584		

23
NNW **OR WELLS** **ORW500000017322**
1/2 - 1 Mile
Lower

Fid:	17321	Objectid:	0
Logid:	MULT 56024	Lstupdate:	12/30/2014
Establby:	JEN WOODY	Xysource:	APPL MAP
Horizerr:	200	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	15836		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	675		
Latitude:	45.4760159995		
Longitude:	-122.305642671		
Site id:	ORW500000017322		

24
NNE **OR WELLS** **ORW500000004569**
1/2 - 1 Mile
Lower

Fid:	4568	Objectid:	4590
Logid:	MULT 2514	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	9
Recwell:	9	Obsflagall:	Not Reported
Lsdelev:	140		
Latitude:	45.4775013124		
Longitude:	-122.289727403		
Site id:	ORW500000004569		

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

State Database: OR Radon

Radon Test Results

Zipcode	Num Tests	Maximum	Minimum	Average	# > 4 pCi/L
97080	17	2.4	0.1	1.2	0

Federal EPA Radon Zone for MULTNOMAH County: 2

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for MULTNOMAH COUNTY, OR

Number of sites tested: 33

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area	1.530 pCi/L	91%	9%	0%
Basement	2.630 pCi/L	57%	43%	0%

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

HYDROLOGIC INFORMATION

Flood Zone Data: This data was obtained from the Federal Emergency Management Agency (FEMA). It depicts 100-year and 500-year flood zones as defined by FEMA. It includes the National Flood Hazard Layer (NFHL) which incorporates Flood Insurance Rate Map (FIRM) data and Q3 data from FEMA in areas not covered by NFHL.
Source: FEMA
Telephone: 877-336-2627
Date of Government Version: 2003, 2015

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetlands Inventory Data
Source: Oregon Geospatial Enterprise Office
Telephone: 503-378-2166

HYDROGEOLOGIC INFORMATION

AQUIFLOW[R] Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Service, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

Water Well Data
Source: Department of Water Resources
Telephone: 503-986-0843

OTHER STATE DATABASE INFORMATION

Oil and Gas Well Locations
Source: Department of Geology and Mineral Industries
Telephone: 971-673-1540
A listing of oil and gas well locations in the state.

RADON

State Database: OR Radon
Source: Oregon Health Services
Telephone: 503-731-4272
Radon Levels in Orgeon

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Earthquake Fault Lines: The fault lines displayed on EDR's Topographic map are digitized quaternary faultlines, prepared in 1975 by the United State Geological Survey

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STREET AND ADDRESS INFORMATION

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APPENDIX H
EDR WATER WELL REPORT

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 0.001 miles
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A2	USGS40000993363	1/4 - 1/2 Mile WSW
B10	USGS40000993306	1/2 - 1 Mile SSW
C15	USGS40000993288	1/2 - 1 Mile SSW
D17	USGS40000993364	1/2 - 1 Mile West

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

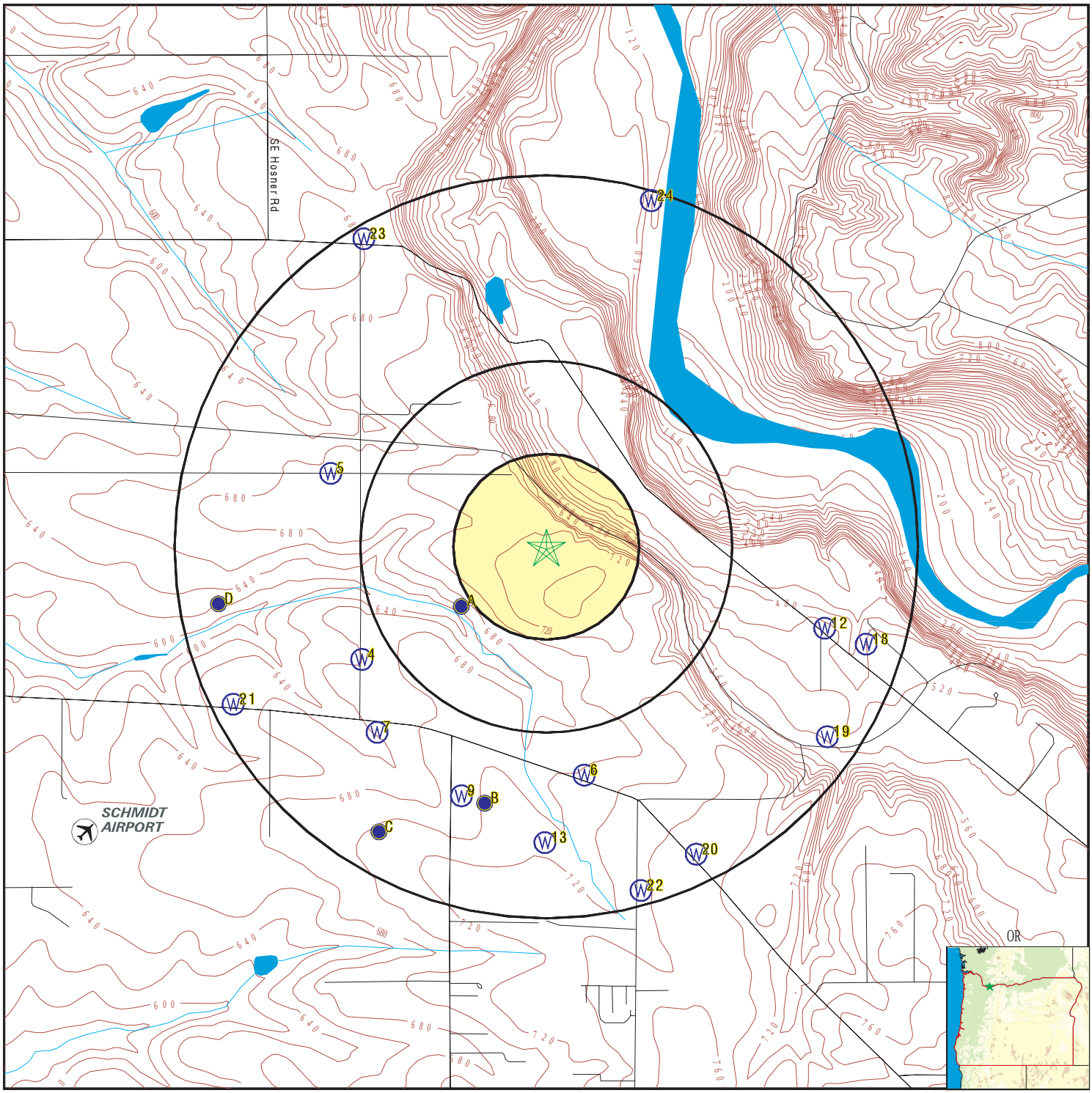
MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A1	ORW500000017320	1/4 - 1/2 Mile SW
A3	ORW500000014151	1/4 - 1/2 Mile WSW
4	ORW500000006517	1/2 - 1 Mile WSW
5	ORI500000047048	1/2 - 1 Mile WNW
6	ORW500000007737	1/2 - 1 Mile South
7	ORW500000007738	1/2 - 1 Mile SW
B8	ORW500000004700	1/2 - 1 Mile SSW
9	ORW500000004699	1/2 - 1 Mile SSW
B11	ORW500000014124	1/2 - 1 Mile SSW
12	ORW500000004585	1/2 - 1 Mile ESE
13	ORW500000003750	1/2 - 1 Mile South
C14	ORW500000003744	1/2 - 1 Mile SSW
D16	ORW500000003734	1/2 - 1 Mile West
18	ORI500000040707	1/2 - 1 Mile ESE
19	ORW500000004583	1/2 - 1 Mile SE
20	ORW500000005797	1/2 - 1 Mile SSE
21	ORW500000004588	1/2 - 1 Mile WSW
22	ORW500000004584	1/2 - 1 Mile SSE
23	ORW500000017322	1/2 - 1 Mile NNW
24	ORW500000004569	1/2 - 1 Mile NNE

PHYSICAL SETTING SOURCE MAP - 5165381.2s



County Boundary
Major Roads
Contour Lines
Airports
Earthquake epicenter, Richter 5 or greater
Water Wells
Public Water Supply Wells
Cluster of Multiple Icons

0 1/4 1/2 1 Miles

Groundwater Flow Direction
Indeterminate Groundwater Flow at Location
Groundwater Flow Varies at Location
Oil, gas or related wells

N

SITE NAME: PWB Carpenter Lane Site	CLIENT: Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS: SE Carpenter Lane Gresham OR 97080	CONTACT: Tim Norman
LAT/LONG: 45.464009 / -122.295549	INQUIRY #: 5165381.2s
	DATE: January 22, 2018 6:10 pm

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Map ID Direction Distance Elevation		Database	EDR ID Number
A1 **SW** **1/4 - 1/2 Mile** **Lower**		**OR WELLS**	**ORW500000017320**

Fid:	17319	Objectid:	0
Logid:	MULT 2594	Lstupdate:	12/30/2014
Establby:	JEN WOODY	Xysource:	APPLICATION
Horizerr:	300	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	37033		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	650		
Latitude:	45.4614974093		
Longitude:	-122.300010334		
Site id:	ORW500000017320		

A2 **WSW** **1/4 - 1/2 Mile** **Lower**		**FED USGS**	**USGS40000993363**

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452743122175701		
Monloc name:	01S/04E-22DCC		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4617873
Longitude:	-122.300367	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	650
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		
Aquifer type:	Not Reported		
Construction date:	19720326	Welldepth:	420
Welldepth units:	ft	Wellholedepth:	420
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 2

Date	Feet below Surface	Feet to Sealevel	Date	Feet below Surface	Feet to Sealevel
1972-05-01	280		1972-05	280	

Map ID Direction Distance Elevation	Database	EDR ID Number
A3 **WSW** **1/4 - 1/2 Mile** **Lower**	**OR WELLS**	**ORW500000014151**

Fid:	14150	Objectid:	14453
Logid:	MULT 9182	Lstupdate:	04/19/2011
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	100	Sourceorg:	USGS
Sourceowrd:	NWIS	Waypoint:	452743122175701
Welltag:	0		
Sownum:	0	Obswell:	Not Reported
Recwell:	Not Reported	Obsflagall:	Not Reported
Lsdelev:	0		
Latitude:	45.4617872503		
Longitude:	-122.300367001		
Site id:	ORW500000014151		

4 **WSW** **1/2 - 1 Mile** **Lower**	**OR WELLS**	**ORW500000006517**

Fid:	6516	Objectid:	6620
Logid:	CLAC 50350	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	FINAL PROOF MAP
Horizerr:	250	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	52962		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	654		
Latitude:	45.4596158042		
Longitude:	-122.305758711		
Site id:	ORW500000006517		

5 **WNW** **1/2 - 1 Mile** **Lower**	**OR WELLS**	**ORI500000047048**

Fid:	47047	Well inspe:	0
Physical l:	Not Reported	Inspection:	2008-05-14 00:00:00.000
Startcard :	189786	Wl county :	MULT
Wl nbr:	94299	Startcar00:	Not Reported
Well tag n:	Not Reported	No log:	Not Reported
Property o:	Not Reported	Inspecti00:	Not Reported
Special st:	0	Title:	Not Reported
Inspecti01:	Not Reported	Witnesses:	Not Reported
Name owner:	MALLORY, SCOTT		
Street:	Not Reported	City:	Not Reported

State:	Not Reported	Zip:	Not Reported
Phone home:	Not Reported	Phone comp:	Not Reported
Gps on wel:	Not Reported	Distance t:	Not Reported
Bearing to:	Not Reported	Drilling m:	Not Reported
Use of wel:	Not Reported	Drilling00:	Not Reported
Rough log :	Not Reported	Well tag r:	Not Reported
Monitoring:	Not Reported	Monitori00:	Not Reported
Protective:	Not Reported	Well locke:	Not Reported
Consultant:	Not Reported	Water in v:	Not Reported
Seal test :	Not Reported	Samples ta:	Not Reported
Casing dia:	Not Reported	Csg above :	Not Reported
Csg gauge:	Not Reported	Borehole d:	Not Reported
Dedicated :	Not Reported	Access por:	Not Reported
Access p00:	Not Reported	Measuring :	Not Reported
Measurin00:	Not Reported	Depth belo:	Not Reported
Depth be00:	Not Reported	Tape hold:	Not Reported
Tape missi:	Not Reported	Tape cut:	Not Reported
Water leve:	Not Reported	Water le00:	Not Reported
Cascading :	Not Reported	Pump type:	Not Reported
Pump make:	Not Reported	Pump hp:	Not Reported
Flowmeter :	Not Reported	Flowmete00:	Not Reported
Flowmete01:	Not Reported	Flowmete02:	Not Reported
Associated:	Not Reported	Nbr of hou:	Not Reported
Deficiency:	Not Reported		
Inspecti02:	GPS @ GATE TO DRIVEWAY		
Work new:	1	Work deepe:	0
Work conve:	0	Work alter:	0
Work aband:	0	Work exist:	0
Work other:	Not Reported	Drill rota:	Not Reported
Drill ro00:	Not Reported	Drill cabl:	Not Reported
Drill ca00:	Not Reported	Drill reve:	Not Reported
Drill re00:	Not Reported	Drill auge:	Not Reported
Drill push:	Not Reported	Drill hand:	Not Reported
Drill holl:	Not Reported	Drill soni:	Not Reported
Drill othe:	Not Reported	Use domest:	Not Reported
Use irriga:	Not Reported	Use commun:	Not Reported
Use indust:	Not Reported	Use livest:	Not Reported
Use dewate:	Not Reported	Use monito:	Not Reported
Use therma:	Not Reported	Use inject:	Not Reported
Use piezom:	Not Reported	Use observ:	Not Reported
Use recove:	Not Reported	Use other:	Not Reported
Bentonite :	Not Reported	Conductivi:	Not Reported
Conducti00:	Not Reported	Measuremen:	Not Reported
Well tag00:	Not Reported	Bonded lic:	1380
Unbonded l:	Not Reported	Bonded dri:	Not Reported
Unbonded d:	Not Reported	County cod:	MULT
Tax lot:	100	Township:	1
Township c:	S	Range:	4
Range char:	E	Sctn:	22
Qtr40:	Not Reported	Qtr160:	Not Reported
Latitude d:	45.46687000	Longitude :	-122.30747600
Gps horizo:	39.00000000	Year const:	2008
Date const:	Not Reported	Date con00:	Not Reported
Deficienci:	U	Previous i:	0
Inspected :	J J	Inspecte00:	113341
Wm region:	NW		
Well tag a:	Not Reported		
Well tag01:	Not Reported	Depth:	Not Reported
Static wat:	Not Reported	Status of :	Not Reported
Location r:	Not Reported	Site visit:	Not Reported

Type of lo:	W	Casing cap:	Not Reported
Pictures t:	0	Street of :	7625 SE COTTRELL
Street o00:	7625 SE COTTRELL RD, GRESHAM		
Last updt :	2008-10-24 10:18:45.547		
Last upd00:	jefferjw	Rec creati:	2009-06-01 06:51:00.000
Rec crea00:	OWRD\migrate		
Latitude:	45.46687		
Loongitude:	-122.307476		
Site id:	ORI500000047048		

6
South
1/2 - 1 Mile
Lower

OR WELLS **ORW500000007737**

Fid:	7736	Objectid:	7843
Logid:	CLAC 12302	Lstupdate:	12/23/2005
Establby:	SABRINA WHITE	Xysource:	FINAL PROOF MAP
Horizerr:	250	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	0		
Latitude:	45.4551040912		
Longitude:	-122.293440417		
Site id:	ORW500000007737		

7
SW
1/2 - 1 Mile
Lower

OR WELLS **ORW500000007738**

Fid:	7737	Objectid:	7844
Logid:	CLAC 54463	Lstupdate:	12/23/2005
Establby:	SABRINA WHITE	Xysource:	FINAL PROOF MAP
Horizerr:	250	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	14896		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	0		
Latitude:	45.4567739912		
Longitude:	-122.304913008		
Site id:	ORW500000007738		

B8
SSW
1/2 - 1 Mile
Lower

OR WELLS **ORW500000004700**

Fid:	4699	Objectid:	4721
Logid:	CLAC 942	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	695		
Latitude:	45.4540288306		
Longitude:	-122.298907152		
Site id:	ORW500000004700		

9
SSW **OR WELLS** **ORW500000004699**
1/2 - 1 Mile
Lower

Fid:	4698	Objectid:	4720
Logid:	CLAC 943	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	690		
Latitude:	45.4542980666		
Longitude:	-122.300241878		
Site id:	ORW500000004699		

B10
SSW **FED USGS** **USGS40000993306**
1/2 - 1 Mile
Lower

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452715122175201		
Monloc name:	01S/04E-27ACC1		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4540095
Longitude:	-122.298978	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	695
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		

Aquifer type:	Not Reported		
Construction date:	19800922	Welldepth:	360
Welldepth units:	ft	Wellholedepth:	365
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1980-09-22	245	

B11
SSW
1/2 - 1 Mile
Lower

OR WELLS **ORW500000014124**

Fid:	14123	Objectid:	14424
Logid:	CLAC 7119	Lstupdate:	04/19/2011
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	100	Sourceorg:	USGS
Sourceowrd:	NWIS	Waypoint:	452715122175201
Welltag:	0		
Sownum:	0	Obswell:	Not Reported
Recwell:	Not Reported	Obsflagall:	Not Reported
Lsdelev:	0		
Latitude:	45.4540094798		
Longitude:	-122.298978		
Site id:	ORW500000014124		

12
ESE
1/2 - 1 Mile
Lower

OR WELLS **ORW500000004585**

Fid:	4584	Objectid:	4606
Logid:	CLAC 896	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	500		
Latitude:	45.4608337933		
Longitude:	-122.280126233		
Site id:	ORW500000004585		

13
South
1/2 - 1 Mile
Lower

OR WELLS **ORW500000003750**

Fid:	3749	Objectid:	3765
Logid:	CLAC 936	Lstupdate:	06/26/2006
Establby:	KARL WOZNIAK	Xysource:	FINAL PROOF MAP & DOQ
Horizerr:	100	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	720		
Latitude:	45.4524746471		
Longitude:	-122.295619125		
Site id:	ORW500000003750		

C14
SSW **OR WELLS** **ORW500000003744**
1/2 - 1 Mile
Lower

Fid:	3743	Objectid:	3759
Logid:	CLAC 944	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	9
Recwell:	9	Obsflagall:	Not Reported
Lsdelev:	700		
Latitude:	45.4528993144		
Longitude:	-122.304811178		
Site id:	ORW500000003744		

C15
SSW **FED USGS** **USGS40000993288**
1/2 - 1 Mile
Lower

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452711122181301		
Monloc name:	01S/04E-27CAB1		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4528984
Longitude:	-122.3048113	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	700
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		

Aquifer type:	Not Reported		
Construction date:	19730430	Welldepth:	392
Welldepth units:	ft	Wellholedepth:	392
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 0

D16
West
1/2 - 1 Mile
Lower

OR WELLS **ORW500000003734**

Fid:	3733	Objectid:	3749
Logid:	MULT 2590	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	9
Recwell:	9	Obsflagall:	Not Reported
Lsdelev:	612		
Latitude:	45.4617879018		
Longitude:	-122.313700318		
Site id:	ORW500000003734		

D17
West
1/2 - 1 Mile
Lower

FED USGS **USGS40000993364**

Org. Identifier:	USGS-OR		
Formal name:	USGS Oregon Water Science Center		
Monloc Identifier:	USGS-452743122184501		
Monloc name:	01S/04E-21DDC		
Monloc type:	Well		
Monloc desc:	Not Reported		
Huc code:	17090012	Drainagearea value:	Not Reported
Drainagearea Units:	Not Reported	Contrib drainagearea:	Not Reported
Contrib drainagearea units:	Not Reported	Latitude:	45.4617873
Longitude:	-122.3137005	Sourcemap scale:	Not Reported
Horiz Acc measure:	1	Horiz Acc measure units:	seconds
Horiz Collection method:	Interpolated from map		
Horiz coord refsys:	NAD83	Vert measure val:	612
Vert measure units:	feet	Vertacc measure val:	20
Vert accmeasure units:	feet		
Vertcollection method:	Interpolated from topographic map		
Vert coord refsys:	NGVD29	Countrycode:	US
Aquifername:	Not Reported		
Formation type:	Not Reported		
Aquifer type:	Not Reported		
Construction date:	19741121	Welldepth:	400
Welldepth units:	ft	Wellholedepth:	450
Wellholedepth units:	ft		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation		Database	EDR ID Number
18 **ESE** **1/2 - 1 Mile** **Lower**		**OR WELLS**	**ORI500000040707**

Fid:	40706	Well inspe:	0
Physical l:	Not Reported	Inspection:	2006-01-20 00:00:00.000
Startcard :	183454	Wl county :	Not Reported
Wl nbr:	Not Reported	Startcar00:	Not Reported
Well tag n:	Not Reported	No log:	Not Reported
Property o:	Not Reported	Inspecti00:	Not Reported
Special st:	0	Title:	Not Reported
Inspecti01:	Not Reported	Witnesses:	Not Reported
Name owner:	CRUTCHER, RYAN		
Street:	Not Reported	City:	Not Reported
State:	Not Reported	Zip:	Not Reported
Phone home:	Not Reported	Phone comp:	Not Reported
Gps on wel:	Not Reported	Distance t:	Not Reported
Bearing to:	Not Reported	Drilling m:	Not Reported
Use of wel:	Not Reported	Drilling00:	Not Reported
Rough log :	Not Reported	Well tag r:	Not Reported
Monitoring:	Not Reported	Monitori00:	Not Reported
Protective:	Not Reported	Well locke:	Not Reported
Consultant:	Not Reported	Water in v:	Not Reported
Seal test :	Not Reported	Samples ta:	Not Reported
Casing dia:	Not Reported	Csg above :	Not Reported
Csg gauge:	Not Reported	Borehole d:	Not Reported
Dedicated :	Not Reported	Access por:	Not Reported
Access p00:	Not Reported	Measuring :	Not Reported
Measurin00:	Not Reported	Depth belo:	Not Reported
Depth be00:	Not Reported	Tape hold:	Not Reported
Tape missi:	Not Reported	Tape cut:	Not Reported
Water leve:	Not Reported	Water le00:	Not Reported
Cascading :	Not Reported	Pump type:	Not Reported
Pump make:	Not Reported	Pump hp:	Not Reported
Flowmeter :	Not Reported	Flowmete00:	Not Reported
Flowmete01:	Not Reported	Flowmete02:	Not Reported
Associated:	Not Reported	Nbr of hou:	Not Reported
Deficiency:	Not Reported		
Inspecti02:	Not Reported		
Work new:	0	Work deepe:	0
Work conve:	0	Work alter:	0
Work aband:	0	Work exist:	0
Work other:	Not Reported	Drill rota:	Not Reported
Drill ro00:	Not Reported	Drill cabl:	Not Reported
Drill ca00:	Not Reported	Drill reve:	Not Reported
Drill re00:	Not Reported	Drill auge:	Not Reported
Drill push:	Not Reported	Drill hand:	Not Reported
Drill holl:	Not Reported	Drill soni:	Not Reported
Drill othe:	Not Reported	Use domest:	Not Reported
Use irriga:	Not Reported	Use commun:	Not Reported
Use indust:	Not Reported	Use livest:	Not Reported
Use dewate:	Not Reported	Use monito:	Not Reported
Use therma:	Not Reported	Use inject:	Not Reported
Use piezom:	Not Reported	Use observ:	Not Reported

Use recove:	Not Reported	Use other:	Not Reported
Bentonite :	Not Reported	Conductivi:	Not Reported
Conducti00:	Not Reported	Measuremen:	Not Reported
Well tag00:	Not Reported	Bonded lic:	1592
Unbonded l:	Not Reported	Bonded dri:	Not Reported
Unbonded d:	Not Reported	County cod:	CLAC
Tax lot:	1901	Township:	1
Township c:	S	Range:	4
Range char:	E	Sctn:	26
Qtr40:	NW	Qtr160:	NE
Latitude d:	45.46021000	Longitude :	-122.27783000
Gps horizo:	16.00000000	Year const:	2006
Date const:	Not Reported	Date con00:	Not Reported
Deficienci:	U	Previous i:	0
Inspected :	J J	Inspecte00:	113341
Wm region:	NW		
Well tag a:	WELL NOT COMPLETE - NO ATTACHED ID		
Well tag01:	Not Reported	Depth:	Not Reported
Static wat:	Not Reported	Status of :	DIP
Location r:	Not Reported	Site visit:	Not Reported
Type of lo:	W	Casing cap:	Not Reported
Pictures t:	0	Street of :	Not Reported
Street o00:	8627 SE MAYBERRY LANE, BORING		
Last updt :	2010-04-01 00:00:00.000		
Last upd00:	WRD\migrate	Rec creati:	2009-06-01 06:51:00.000
Rec crea00:	OWRD\migrate		
Latitude:	45.46021		
Loongitude:	-122.27783		
Site id:	ORI500000040707		

19
SE
1/2 - 1 Mile
Lower

OR WELLS **ORW500000004583**

Fid:	4582	Objectid:	4604
Logid:	CLAC 930	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	537		
Latitude:	45.4566022719		
Longitude:	-122.279980209		
Site id:	ORW500000004583		

20
SSE
1/2 - 1 Mile
Higher

OR WELLS **ORW500000005797**

Fid:	5796	Objectid:	5876
Logid:	CLAC 20245	Lstupdate:	01/01/1990
Establby:	MARC NORTON	Xysource:	GPS
Horizerr:	4	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	r032621b.cor
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	745		
Latitude:	45.4520217707		
Longitude:	-122.287236956		
Site id:	ORW500000005797		

21
WSW **OR WELLS** **ORW500000004588**
1/2 - 1 Mile
Lower

Fid:	4587	Objectid:	4609
Logid:	CLAC 959	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	646		
Latitude:	45.457867409		
Longitude:	-122.312878945		
Site id:	ORW500000004588		

22
SSE **OR WELLS** **ORW500000004584**
1/2 - 1 Mile
Higher

Fid:	4583	Objectid:	4605
Logid:	CLAC 899	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	N
Recwell:	9	Obsflagall:	ON
Lsdelev:	730		
Latitude:	45.4506091148		
Longitude:	-122.290301432		
Site id:	ORW500000004584		

23
NNW **OR WELLS** **ORW500000017322**
1/2 - 1 Mile
Lower

Fid:	17321	Objectid:	0
Logid:	MULT 56024	Lstupdate:	12/30/2014
Establby:	JEN WOODY	Xysource:	APPL MAP
Horizerr:	200	Sourceorg:	OWRD
Sourceowrd:	GWATER	Waypoint:	Not Reported
Welltag:	15836		
Sownum:	0	Obswell:	C
Recwell:	9	Obsflagall:	OC
Lsdelev:	675		
Latitude:	45.4760159995		
Longitude:	-122.305642671		
Site id:	ORW500000017322		

24
NNE **OR WELLS** **ORW500000004569**
1/2 - 1 Mile
Lower

Fid:	4568	Objectid:	4590
Logid:	MULT 2514	Lstupdate:	01/01/1990
Establby:	KARL WOZNIAK	Xysource:	UNKNOWN
Horizerr:	1000	Sourceorg:	OWRD
Sourceowrd:	USGS WILLGW	Waypoint:	Not Reported
Welltag:	0		
Sownum:	0	Obswell:	9
Recwell:	9	Obsflagall:	Not Reported
Lsdelev:	140		
Latitude:	45.4775013124		
Longitude:	-122.289727403		
Site id:	ORW500000004569		

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

State Database: OR Radon

Radon Test Results

Zipcode	Num Tests	Maximum	Minimum	Average	# > 4 pCi/L
97080	17	2.4	0.1	1.2	0

Federal EPA Radon Zone for MULTNOMAH County: 2

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for MULTNOMAH COUNTY, OR

Number of sites tested: 33

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area	1.530 pCi/L	91%	9%	0%
Basement	2.630 pCi/L	57%	43%	0%

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

HYDROLOGIC INFORMATION

Flood Zone Data: This data was obtained from the Federal Emergency Management Agency (FEMA). It depicts 100-year and 500-year flood zones as defined by FEMA. It includes the National Flood Hazard Layer (NFHL) which incorporates Flood Insurance Rate Map (FIRM) data and Q3 data from FEMA in areas not covered by NFHL.
Source: FEMA
Telephone: 877-336-2627
Date of Government Version: 2003, 2015

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetlands Inventory Data
Source: Oregon Geospatial Enterprise Office
Telephone: 503-378-2166

HYDROGEOLOGIC INFORMATION

AQUIFLOW[R] Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Service, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

Water Well Data
Source: Department of Water Resources
Telephone: 503-986-0843

OTHER STATE DATABASE INFORMATION

Oil and Gas Well Locations
Source: Department of Geology and Mineral Industries
Telephone: 971-673-1540
A listing of oil and gas well locations in the state.

RADON

State Database: OR Radon
Source: Oregon Health Services
Telephone: 503-731-4272
Radon Levels in Orgeon

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Earthquake Fault Lines: The fault lines displayed on EDR's Topographic map are digitized quaternary faultlines, prepared in 1975 by the United State Geological Survey

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STREET AND ADDRESS INFORMATION

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APPENDIX I
EDR GEOLOGY AND SOILS REPORT

GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

PWB CARPENTER LANE SITE
SE CARPENTER LANE
GRESHAM, OR 97080

TARGET PROPERTY COORDINATES

Latitude (North):	45.464009 - 45˚ 27' 50.43''
Longitude (West):	122.295549 - 122˚ 17' 43.98''
Universal Tranverse Mercator:	Zone 10
UTM X (Meters):	555073.2
UTM Y (Meters):	5034522.0
Elevation:	722 ft. above sea level

USGS TOPOGRAPHIC MAP

Target Property Map:	6066512 SANDY, OR
Version Date:	2014

EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

Assessment of the impact of contaminant migration generally has two principal investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

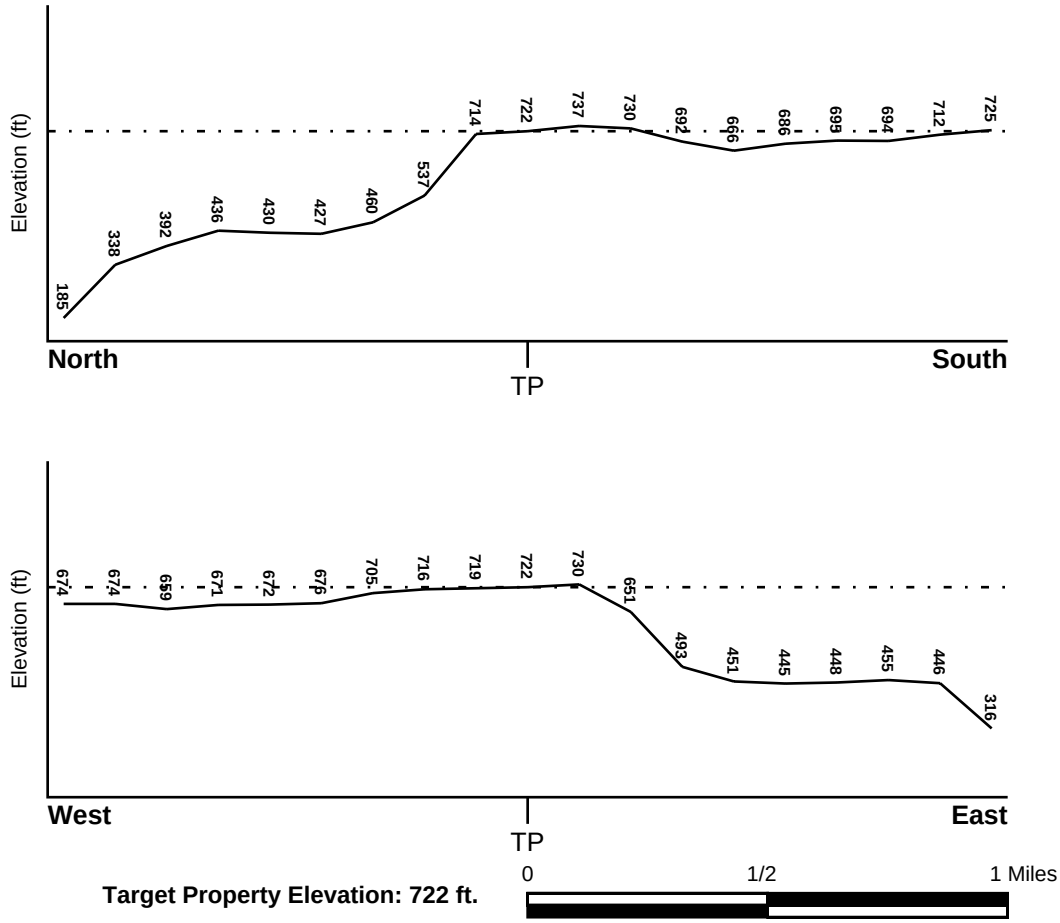
TOPOGRAPHIC INFORMATION

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

General Topographic Gradient: General NNE

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES



Target Property Elevation: 722 ft.

Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Flood Plain Panel at Target Property	FEMA Source Type
41005C0085D	FEMA FIRM Flood data

Additional Panels in search area:	FEMA Source Type
41005C0080D	FEMA FIRM Flood data

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
SANDY	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

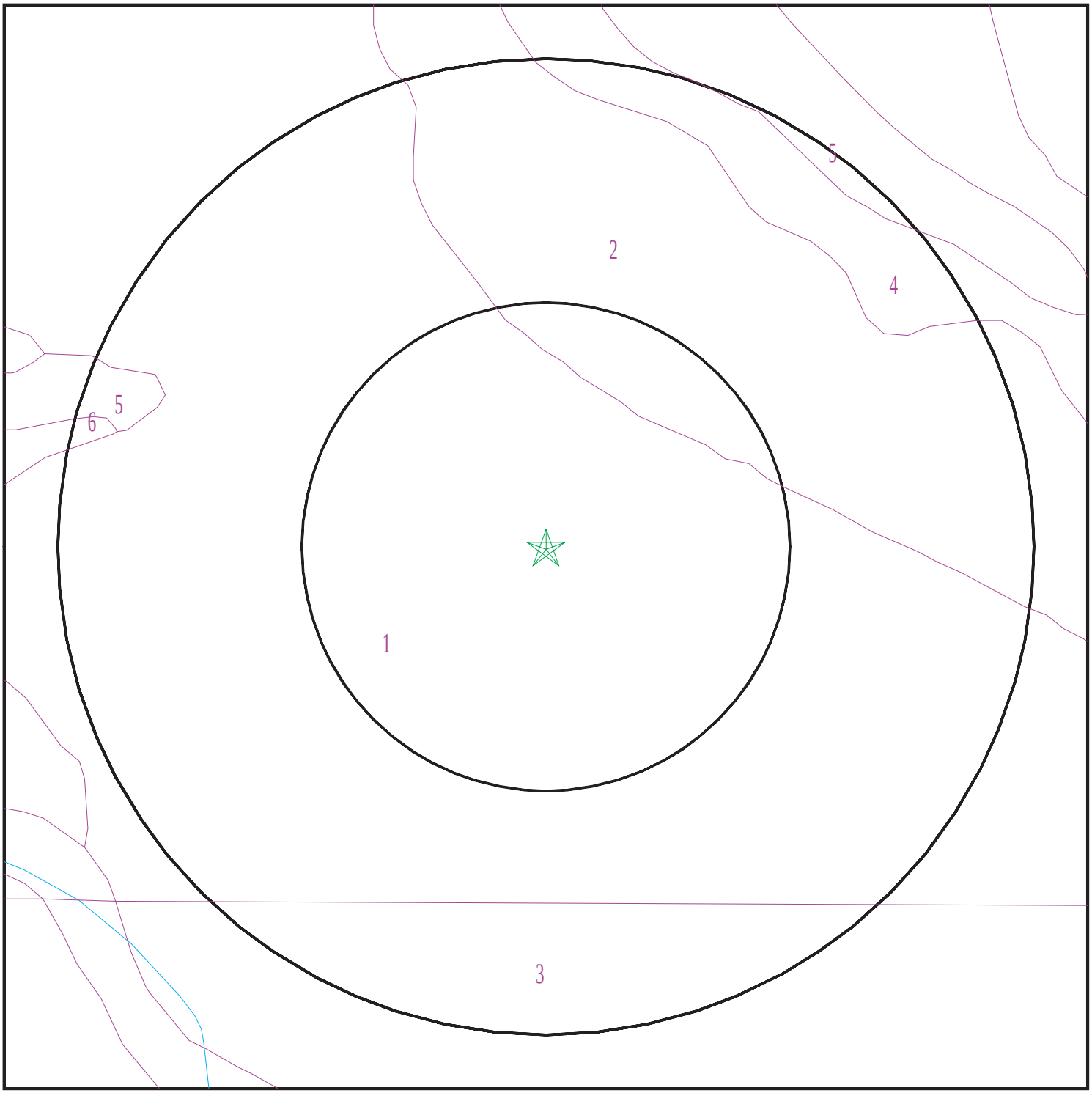
Era:	Cenozoic
System:	Tertiary
Series:	Upper Tertiary andesite
Code:	uTa *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Volcanic Rocks

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

SSURGO SOIL MAP - 5165381.2s



Target Property
SSURGO Soil
Water

0 1/16 1/8 1/4 Miles

N

SITE NAME:	PWB Carpenter Lane Site	CLIENT:	Cooper Zietz Engineers, Inc DBA Akana.
ADDRESS:	SE Carpenter Lane Gresham OR 97080	CONTACT:	Tim Norman
		INQUIRY #:	5165381.2s
LAT/LONG:	45.464009 / -122.295549	DATE:	January 22, 2018 6:10 pm

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GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. The following information is based on Soil Conservation Service SSURGO data.

Soil Map ID: 1

Soil Component Name: Cazadero

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	16 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.1
2	16 inches	59 inches	silty clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 2

Soil Component Name: Haplumbrepts

Soil Surface Texture: silt loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Not Reported

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	14 inches	silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 1.4	Max: 6 Min: 5.1
2	14 inches	59 inches	gravelly clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Gravels, Gravels with fines, Clayey Gravel	Max: 14 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 3

Soil Component Name: Cazadero

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	20 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.1
2	20 inches	75 inches	clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 4

Soil Component Name: Haplumbrepts

Soil Surface Texture: silt loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Not Reported

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	14 inches	silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 1.4	Max: 6 Min: 5.1

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
2	14 inches	59 inches	gravelly clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Gravels, Gravels with fines, Clayey Gravel	Max: 14 Min: 1.4	Max: 6 Min: 5.1

Soil Map ID: 5

Soil Component Name: Wollent

Soil Surface Texture: silt loam

Hydrologic Group: Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

Soil Drainage Class: Poorly drained

Hydric Status: All hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 15 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	9 inches	silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.6
2	9 inches	59 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.6

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Map ID: 6

Soil Component Name: Cazadero

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	16 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 5.1
2	16 inches	59 inches	silty clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt.	Max: 4 Min: 1.4	Max: 6 Min: 5.1

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

APPENDIX J
RECORDS OF COMMUNICATION

PCB Inquiry

Upon request, PGE can research for the PCB content of PGE owned transformers, at a cost of $75 per transformer.

Records searches sometimes reveal that the PCB content of the specified PGE owned transformer is unknown. In this situation, an additional request can be made to have the concentration tested. The additional cost of this request is determined on a site-by-site basis, and is based on whether or not the following activities are required: de-energizing equipment, collecting samples, contracting sample analyses, and preparation of a summary report.

Please note: PGE transformers often have stickers that indicate the PCB concentration of the oil within that transformer. The PCB content of equipment with green stickers is unknown. However, blue stickers indicate <1 parts per million (ppm) PCB, red stickers indicate <15 ppm PCB, and black stickers indicate <48 ppm PCB.

To request a records check to determine the PCB content of PGE owned equipment, please complete the attached form and return it, along with payment (payable to "PGE PCB Inquiry"), to:

PGE PCB Inquiry
121 SW Salmon Street, 3WTC0403
Portland, OR 97204

Contact Information			
Name	Tim Norman	Date	1/24/2017
Company Name (if applicable)	Akana		
Phone #	971-270-7937	Email	tim.norman@akana.us
Mailing Address	6400 SE Lake Road, Suite 270		
City, State, Zip Code	Portland OR 97222		
PGE Equipment Information			
Site Address	34826 SE Carpenter Ln,		
City, State, Zip	Gresham, OR 97080		
Transformer	Identification # (3-5 digits)	KVA (2-3 digits)	Transformer Type
Transformer #1	27191	50	☒Pole ☐Pad mount
Transformer #2	38409	480	☒Pole ☐Pad mount
Transformer #3			☐Pole ☐Pad mount
Total Number of Transformers	2	Total Cost ($75/transformer)	$150

Portland General Electric Company
121 SW Salmon Street • Portland, Oregon 97204

February 1, 2018

Tim Norman
Akana
6400 SE Lake Road, Suite 270
Portland OR 97222
Email: tim.norman@akana.us

Dear Mr. Norman:

Portland General Electric Company (PGE) has received your completed PCB Inquiry Request to perform a records check to determine the PCB content of the PGE-owned transformers servicing 34826 SE Carpenter Lane, Gresham OR 97080. The following is a summary of the record search:

PGE Company #:	***27191/50 KVA***
Serial #:	***30336-1887***
Date Tested/Installed:	***May 29, 1987***
PCB Content:	***<1 ppm PCB***
PGE Company #:	***38409/50 KVA***
Serial #:	***00A492008***
Date Tested/Installed:	***January 4, 2001***
PCB Content:	***<1 ppm PCB***

Please feel free to contact me if you have any additional questions at brandy.domina@pgn.com or 503-464-8970.

Sincerely,
Brandy Domina
Environmental Specialist

APPENDIX K
OPEN RECORDS

APPENDIX L

EDR ENVIRONMENTAL LIEN REPORT

APPENDIX M
USER QUESTIONNAIRE

USER QUESTIONNAIRE

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2002, the User must provide certain information in the Phase I Environmental Site Assessment. Failure to provide this information could result in a determination that "All Appropriate Inquiry" is not complete. To assist the User in identifying pertinent information, Akana utilizes a User Questionnaire based on the ASTM 1527-13 standard.

	QUESTION	USER
1.	**Environmental cleanup liens that are filed or recorded against the subject property (40 CFR 312.25).** Did a search of recorded land title records (or judicial records where appropriate) identify any environmental liens filed or recorded against the property under federal, tribal, state or local law? If such documentation is available, please provide.	Yes _____ No _____ Unknown X
2.	**Activity and land use limitations (AULs) that are in place on the subject property or that have been filed or recorded in a registry (40 CFR 312.26).** Did a search of recorded land title records (or judicial records where appropriate,) identify any AULs, such as engineering controls, land use restrictions or institutional controls that are in place at the property and/or have been filed or recorded against the property under federal, tribal, state or local law?	Yes _____ No _____ Unknown X
3.	**Specialized knowledge or experience of the person seeking to qualify for the LLP (40 CFR 312.28).** As the user of this environmental site assessment (ESA) do you have any specialized knowledge or experience related to the subject property or nearby properties? For example, are you involved in the same line of business as the current or former occupants of the subject property or an adjoining property so that you would have specialized knowledge of the chemicals and processes used by this type of business?	Yes ___X_____ No _____ Unknown ____
4.	**Relationship of the purchase price to the fair market value of the subject property if it were not contaminated (40 CFR 312.29).** Does the purchase price being paid for this subject property reasonably reflect the fair market value of the subject property? If you conclude that there is a difference, have you considered whether the lower purchase price is because contamination is known or believed to be present at the subject property?	Yes _____ No _____ Unknown X

	QUESTION	USER
5.	**Commonly known or reasonably ascertainable information about the subject property (40 CFR 312.30).** Are you aware of commonly known or reasonably ascertainable information about the subject property that would help the environmental professional to identify conditions indicative of releases or threatened releases? For example, as user,	Yes ___X_____ No _____ Unknown ____
	➢ Do you know the past use of the subject property?	Yes ___X_____ No _____ Unknown ____
	➢ Do you know the specific chemicals that are present or once were present at the subject property?	Yes _____ No _____ Unknown X
	➢ Do you know of spills or other chemical releases that have taken place at the subject property?	Yes _____ No ___X_____ Unknown ____
	➢ Do you know of any environmental cleanups that have taken place at the subject property?	Yes _____ No ___X_____ Unknown ____
6.	**The degree of obviousness of the presence or likely presence of the contamination at the subject property, and the ability to detect the contamination by appropriate investigation (40 CFR 312.31).** Based on your knowledge and experience related to the property are there any obvious indicators that point to the presence or likely presence of contamination at the property?	Yes _____ No ___X_____ Unknown ____

This questionnaire was completed by:

Name:	Tim Norman (Akana) on the behalf of Pat Holt, Owner R&H Nursey
Title:	Pat Holt, Owner R & H Nursery
Association:	Adjacent Land Owner West of Subject Property
Signature:	
Date:	1/22/2018

APPENDIX N
TRANSACTION SCREEN QUESTIONNAIRE

APPENDIX O
SITE PHOTO DOCUMENTATION

PH 1 Photograph Log – Taken January 2018
Carpenter Lane Site – 108 –Acres
Gresham, Multnomah County, Oregon

Photograph 1 Northeast corner of Subject Property water line leaving the property at Dodge Park BLVD, facing southwest.	

Photograph 2 Fence and water line marker at top of hill in northeast portion of the Subject Property, telecommunication pole on Subject Property outside of fence, facing northeast.	

Photograph 3 South central portion of the Subject Property water line marker and general direction of the buried water line across the field on north side of two Pleasant Valley Water District tanks, facing northeast.	

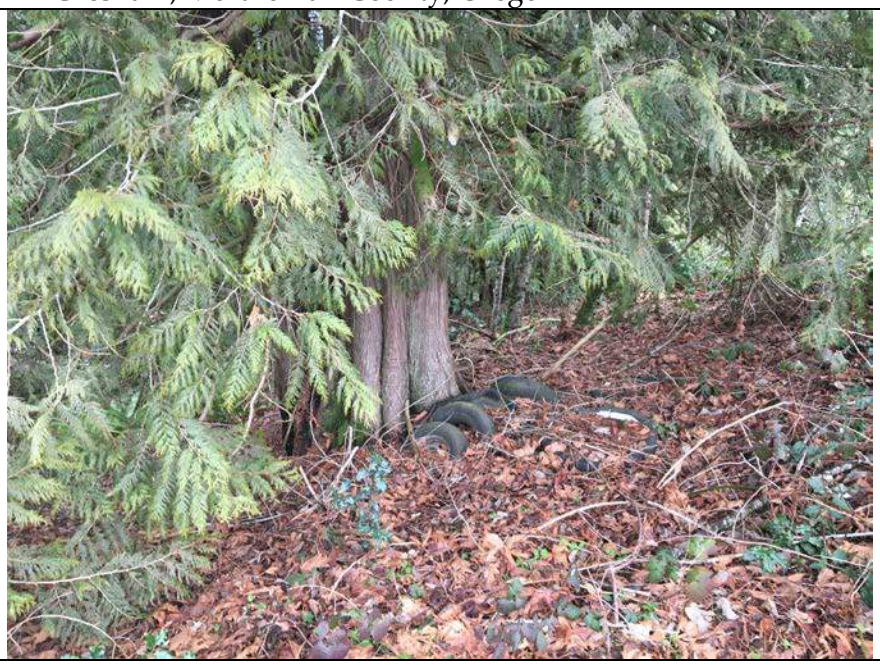
Photograph 4 Northeast corner of Subject Property along Dodge Park Blvd. Facing southeast.	

Photograph 5 Northeast corner of Subject Property along Dodge Park Blvd. Facing northwest.	

Photograph 6 Northern border of Subject Property along Dodge Park Blvd, Verizon communications junction box for communication cable conduit run, facing south.	

Photograph 7 Northcentral portion of the Subject Property fence line on left side of photo is northern boundary of the eastern portion of the Subject Property, observed vault with pumps next to bollard in center of photo, facing southeast.	

Photograph 8 Northcentral portion of the Subject property observed tires and debris dumped on top of slope under a tree. Facing north.	

Photograph 9 Northcentral portion of the Subject property observed tires and debris dumped on top of slope under a tree west of the white gate in fence. Facing northwest.	

Photograph 10 Northeast portion of the Subject property on the south side of the fence at the top of the slope Facing northwest.	

Photograph 11 Northeastern portion of Subject Property utility pole located on the north side of the fence. Facing north.	

Photograph 12 Northeastern portion of Subject Property utility pole located on the north side of the fence with communication cables terminated and run down into underground conduits. Facing north.	

Photograph 13 Northeastern portion of Subject Property dirt road turns to south and fence runs south along the properties eastern boundary. Shade trees and saplings planted in the cultivated field to the west of boundary. Facing south.	

Photograph 14 Eastern portion of Subject Property agricultural fields west of the eastern boundary road and fence. Water towers in center of photo are surrounded on three sides by Subject Property. Facing southwest.	

Photograph 15 Southcentral portion of Subject Property looking at south side of water tower area and south border road. Facing northeast.	

Photograph 16 Southcentral portion of Subject Property looking at south side of water tower area and south border road. Facing north.	

Photograph 17 Southcentral portion of Subject Property looking at south side of water tower area and south border road. Facing north.	

Photograph 18 Southcentral portion of Subject Property observed discarded concrete in middle of grove of trees located north of the water tank fenced area. Facing southeast.	

Photograph 19 Central portion of the Subject Property showing cultivated field separated by a dirt road on the north side of the water tanks. Facing northwest.	

Photograph 20 Central portion of the Subject Property showing cultivated fields separated by a dirt road on the north side of the water tanks. Also showing grove of trees at north central part of Subject Property. Facing north.	

Photograph 21 Northcentral portion of the Subject Property where trailers are parked, observed a pile of treated wooden power poles discarded on the south side of the parking area. Facing north.	

Photograph 22 Northcentral portion of the Subject Property where trailers are parked, observed a pile of treated wooden power poles discarded on the south side of the parking area. Facing west.	

Photograph 23 Northcentral portion of the Subject Property where trailers are parked, parking area surrounded on three sides by cultivated agricultural fields. Facing west.	

Photograph 24 Northcentral portion of the Subject Property where trailers are parked, parking area surrounded on three sides by cultivated agricultural fields. Facing south.	

Photograph 25 Southwest portion of the Subject Property west of water towers, trail sloping down to the west to southwest corner of the Subject Property near Johnson Creek. Facing east southeast.	

Photograph 26 Southwest portion of the Subject Property west of water towers, irrigation pipes and valves stored in the southwest corner of the Subject Property near Johnson Creek. Facing southwest.	

Photograph 27 Southwest corner of the Subject Property, power pole with power meter and circuit breaker cabinet southwest corner of the Subject Property near Johnson Creek. Facing south.	

Photograph 28 Southwest corner of the Subject Property, power pole with power meter near Johnson Creek. Facing southeast.	

Photograph 29 Southwest corner of the Subject Property, PGE power pole with pole tag near Johnson Creek. Facing south.	

Photograph 30 Southwest corner of the Subject Property, PGE power pole with two aerial mounted transformers near Johnson Creek. Facing southwest.	

Photograph 31 Southwest corner of the Subject Property, PGE power pole with two aerial mounted transformers near Johnson Creek. Facing southeast.	

Photograph 32 West central portion of the Subject Property just east of western boundary. Observed large burn pile with debris discarded for burning. Facing east.	

Photograph 33 West central portion of the Subject Property just east of western boundary. Observed large burn pile with debris discarded for burning. Facing north.	

Photograph 34 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row two trucks have been parked and abandoned. Facing northeast.	

Photograph 35 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row two trucks have been parked and abandoned. Facing east.	

Photograph 36 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row debris and farm tractor and truck implements have been parked and abandoned. Facing east.	

Photograph 37 **West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row debris are abandoned or stored. Facing southeast.**	

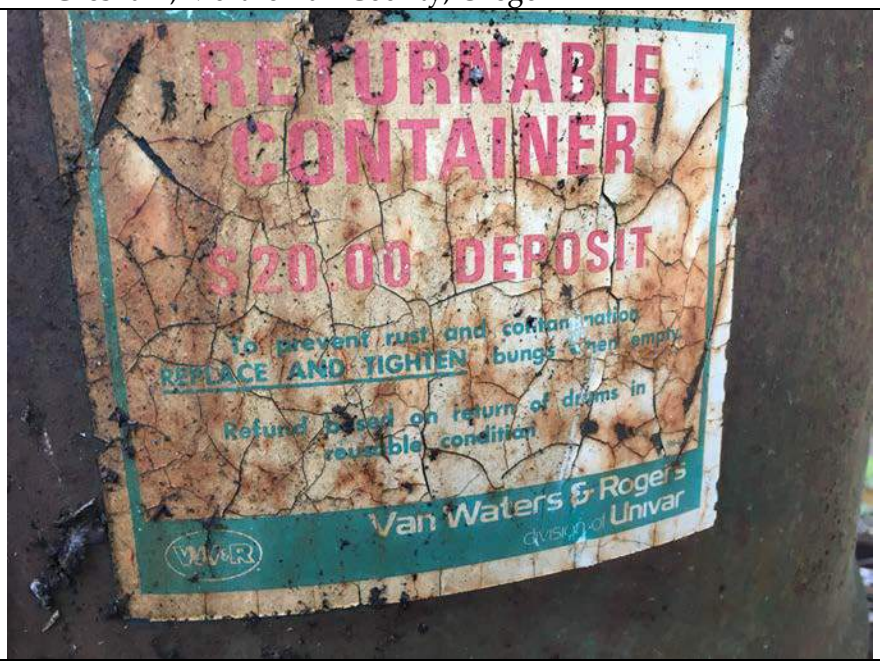
Photograph 38 **West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row truck and discarded construction debris have been parked and abandoned. Facing northeast.**	

Photograph 39 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row truck and discarded construction debris have been parked and abandoned. Facing northeast.	

Photograph 40 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly discarded construction debris and one metal barrel abandoned or discarded. Facing southeast.	

Photograph 41 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row discarded metal barrel abandoned or discarded. Facing south.	

Photograph 42 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row discarded metal barrel abandoned or discarded. Facing south.	

Photograph 43 West central portion of the Subject Property just east of western boundary. Observed on north side of the holly tree row discarded metal barrel abandoned or discarded. Facing south.	
Photograph 44 Northwestern portion of the Subject Property south of the northwestern corner. Observed this area has a surface water collection drain directed to a small infiltration ditch. Facing east.	

Photograph 45 Northwestern portion of the Subject Property south of the northwestern corner. Observed this area has a surface water collection drain directed to a small infiltration ditch. Facing north.	

Photograph 46 Northwestern portion of the Subject Property south of the northwestern corner. Area has a gravel access road surrounded by nursery plantings. Facing south.	

Photograph 47 Northwestern portion of the Subject Property at the northwestern corner. Area has a gravel access road intersected by Carpenter Lane surrounded by nursery plantings. Facing east.	

Photograph 48 Northwestern portion of the Subject Property at the northwestern corner. Area has a gravel access road intersected by Carpenter Lane surrounded by nursery plantings. Facing west.	

Photograph 49 Northcentral portion of the Subject Property. Area has two gravel access roads surrounded by cultivated agricultural fields and nursery plantings. Facing southwest.	

Photograph 50 Northcentral portion of the Subject Property. Area has two gravel access roads surrounded by cultivated agricultural fields and nursery plantings. Facing northeast.	

APPENDIX D –
ENDANGERED SPECIES ACT SITE SPECIFIC DATA SETS

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Project information

NAME

Filtration Decision Support - Project Delivery

LOCATION

Multnomah County, Oregon

DESCRIPTION

Site evaluation for PWB Carpenter Lane site

Local office

Oregon Fish And Wildlife Office

(503) 231-6179
(503) 231-6195

2600 Southeast 98th Avenue, Suite 100
Portland, OR 97266-1398

https://www.fws.gov/oregonfwo/articles.cfm?id=149489416

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Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Log in to IPaC.
2. Go to your My Projects list.
3. Click PROJECT HOME for this project.
4. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

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Birds

NAME	STATUS
Northern Spotted Owl Strix occidentalis caurina There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/1123	Threatened
Streaked Horned Lark Eremophila alpestris strigata There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/7268	Threatened

Flowering Plants

NAME	STATUS
Bradshaw's Desert-parsley Lomatium bradshawii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5743	Endangered
Kincaid's Lupine Lupinus sulphureus ssp. kincaidii There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/3747	Threatened
Nelson's Checker-mallow Sidalcea nelsoniana No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7340	Threatened
Water Howellia Howellia aquatilis No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7090	Threatened
Willamette Daisy Erigeron decumbens There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/6270	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see maps of where birders and the general public have sighted birds in and around your project area, visit E-bird tools such as the E-bird data mapping tool (search for the name of a bird on your list to see specific locations where that bird has been reported to occur within your project area over a certain timeframe) and the E-bird Explore Data Tool (perform a query to see a list of all birds sighted in your county or region and within a certain timeframe). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

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NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Jan 1 to Sep 30
Clark's Grebe *Aechmophorus clarkii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jan 1 to Dec 31
Golden Eagle *Aquila chrysaetos* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds Jan 1 to Aug 31

Lesser Yellowlegs Tringa flavipes This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Long-billed Curlew Numenius americanus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5511	Breeds elsewhere
Marbled Godwit Limosa fedoa This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9481	Breeds elsewhere
Olive-sided Flycatcher Contopus cooperi This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3914	Breeds May 20 to Aug 31
Red-throated Loon Gavia stellata This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Rufous Hummingbird selasphorus rufus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8002	Breeds Apr 15 to Jul 15
Semipalmated Sandpiper Calidris pusilla This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Short-billed Dowitcher Limnodromus griseus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9480	Breeds elsewhere
Whimbrel Numenius phaeopus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9483	Breeds elsewhere

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Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in your project's counties during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

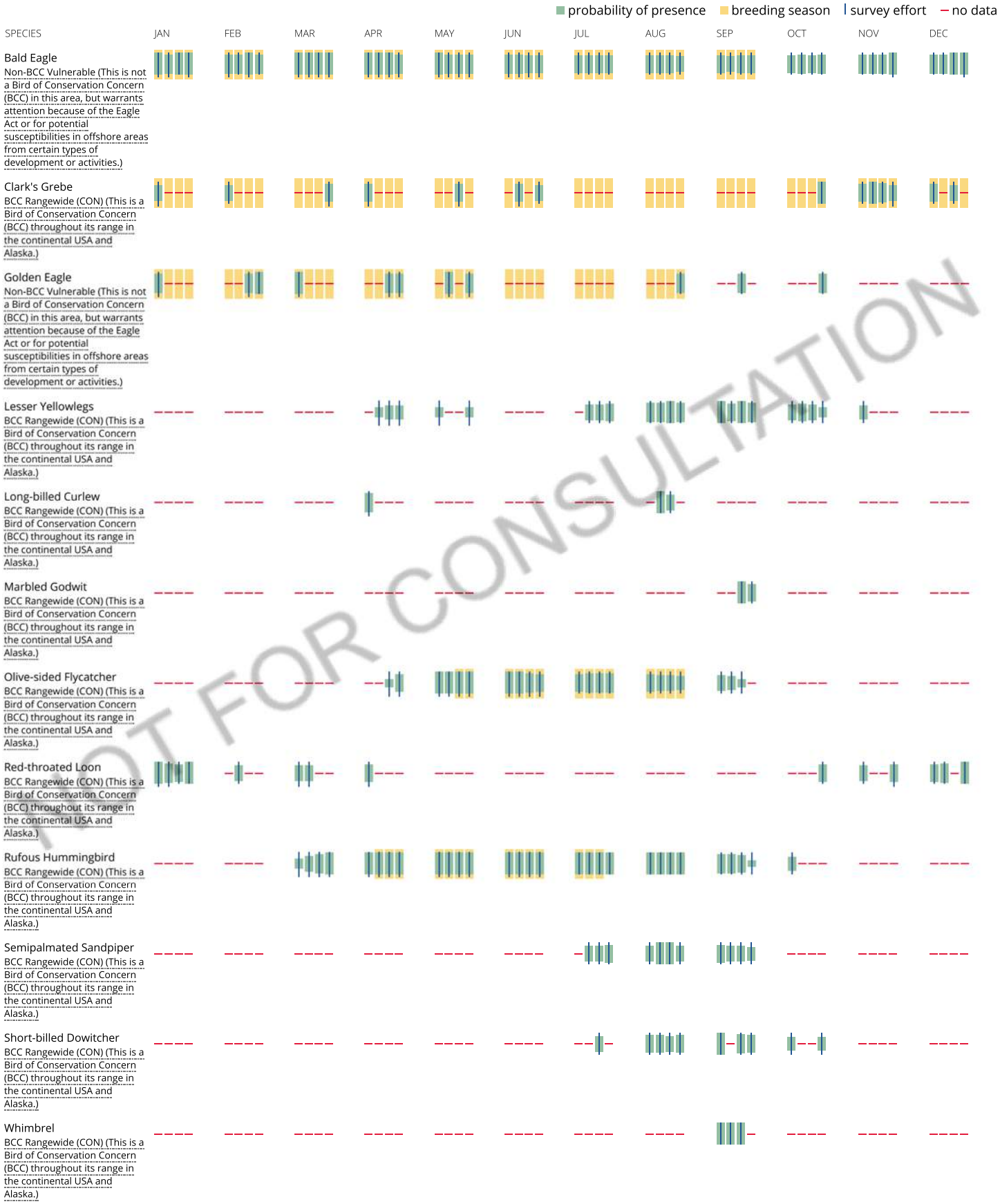
Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the counties of your project area. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information.



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Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the counties which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird entry on your migratory bird species list indicates a breeding season, it is probable that the bird breeds in your project's counties at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the BGEPA should such impacts occur.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

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Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

THERE ARE NO KNOWN WETLANDS AT THIS LOCATION.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

NOT FOR CONSULTATION

Oregon Biodiversity Information Center

Institute for Natural Resources
Portland State University
Mail Stop: INR
Post Office Box 751
Portland, Oregon 97207
503.725.9950
http://inr.oregonstate.edu/orbic

January 24, 2018

Tim Norman
Akana
6400 SE Lake Road, Suite 270
Portland, OR 97222

Dear Mr. Norman:

Thank you for requesting information from the Oregon Biodiversity Information Center (ORBIC). We have conducted a data system search for rare, threatened and endangered plant and animal records for your Carpenter Lane Site Project in Cottrell area.

Six (6) element occurrence records were noted within a two-mile radius of your project and are included on the enclosed computer printout.

Please remember that a lack of rare element information from a given area does not necessarily indicate there are no significant elements present, only that there is no information known to us from the site. To ensure there are no significant elements present that may be affected by your project, you should inventory the site during the appropriate season.

This data is confidential and for the specific purposes of your project and is **not to be distributed**. Please also note that as our database is continually updated, the data in this report should be considered current for a maximum of one year from the date it was generated and should not be cited thereafter.

Please forward the included invoice to the appropriate party in your organization for payment.

If you need additional information or have any further questions, please do not hesitate to contact me.

Sincerely,

Lindsey Wise

Lindsey Wise
Biodiversity Data Manager
lindsey.wise@pdx.edu
503.725.9951

encl.: **invoice (H-012418-LKW2)**
computer printout and data key

Scientific Name: ***Batrachoseps wrighti*** EO NUM: 1

Common Name: **Oregon slender salamander** EO ID: 19078

Federal Status: SOC GRANK: G3 NHP List: 4 Category: Vertebrate Animal

State Status: SV SRANK: S3 HP Track: W ELCODE: AAAAD02100

Confirmed: Y First Obs: 1972 Last Obs: 2015-02-14 EO Rank: AB - Excellent or good estimated viability

Directions: Oxbow Regional Park and Sandy River Gorge TNC preserve. From Portland: Hwy I-84 E. to Wood Village exit S. to Division St, then E. to Oxbow Parkway. South on Hosner Rd to Lusted Rd. then E., steep curve. Stables on left, walk to river.

County Name	Ecoregion	Owner Name/Type	Watershed
Multnomah	WC	Metro	170800010702 - Trout Creek-Sandy River
	WV	FEDERAL; PRIVATE; COI	170800010703 - Beaver Creek-Sandy River

Town/Range Sect Meridian TRS Note	QuadCode	QuadName	Managed Area Name
001S004E - 14 - WM -	45122-D3	Sandy	Sandy River Gorge RNA
001S004E - 15 - WM -			Sandy River Gorge Preserve
001S004E - 22 - WM -			SANDY RIVER STATE SCENIC WATERWAY
001S004E - 23 - WM -			
001S004E - 24 - WM -			

Source Feature	Uncertainty Type (Distance)	[Use Class]
9547 - Point	Estimated (200 m)	Not applicable
19078 - Point	Estimated (400 m)	Not applicable
48685 - Polygon	Estimated (25 m)	Not applicable

Annual Observations
- 2006 - 12 adults and 1 juvenile
- 1999 - 20
- 1998 - 20
- 1983 - 19
- 1972 - present

SFeat ID	Date	Visit data
19078	2015-02-14	1 adult female found on Oxbow Regional Park Equestrian Trail (no coordinates or map provided). Old growth Douglas fir forest with lots of snags and decaying logs. Moss, ferns, and cedar trees. 500 mm SVL/100m total length, possible records. Population stable.
48685	2006-05-24	1 Juvenile found. Condition: Good. Notes: BAWR JUV. IN CWD. Aspect 224 degrees. Slope 20%. Part Shade conditions. Late_Forest seral stage. Stand age 180 years. Multiple stand structure. Fire presence: Absent. Associated species: PRCO, Prophysaon coeruleum. PRAN, Prophysaon andersoni. ANSP3, Ancotrema sportella. HAVA, Haplotrema vancouverense.
48685	2006-05-24	1 Adult found. Condition: Good. Notes: BAWR ADULT IN CWD. Aspect 144 degrees. Slope 55%. Part Shade conditions. Late_Forest seral stage. Stand age 150 years. Multiple stand structure. Fire presence: Absent.
48685	2006-05-23	1 Adult found. Condition: Good. Notes: ADULT BAWR IN CWD. Aspect 196 degrees. Slope 6%. Part Shade conditions. Mid_Forest seral stage. Stand age 70 years. Multiple stand structure. Fire presence: Absent. Associated species: CRGE, Cryptomastix germana. VECO1, Vespericola columbiana. MEHE, Megomphix hemphilli. ANSP3, Ancotrema sportella.
48685	2006-04-16	2 salamanders observed.
48685	2006-04-15	8 salamanders observed.
9547	1999-04-20	16 salamanders captured and released. From ODFW scientific taking permit report. Collections ended on this date.
9547	1999-04-12	16 salamanders captured and released. From ODFW scientific taking permit report. Collections continued to April 20, 1999.
9547	1999-03-18	5 adult and 1 juvenile salamanders observed.
9547	1999-03-04	Approx. 20 individuals observed. Mixed adults, subadults, juveniles and hatchlings in fern, moss and fir.
9547	1998-04-04	Approx. 20 individuals observed. Mixed adults, subadults, juveniles and hatchlings in fern, moss and fir.
19078	1983-08-01	1983: 19 Oregon slender salamanders found, making this site one of the most numerous of the 5 spp. of salamanders found here.
19078	1972-01-01	Oregon slender salamanders found here during State Parks and Recreation study.

Occurence Data

EO Type: Min. Elev.(m): 305

EO Data: 2015: 1 adult female seen in Oxbow Regional Park (incidental observation). 2006: (5:24) 2 adults and 1 juvenile found. (4:16) 10 salamanders observed. 1999 (04-12 and 20): 16 salamanders captured and released. 1999: Peak of approx. 20 salamanders observed. 1998: approx. 20 salamanders observed. 1983: 19 Oregon slender salamanders found, making this site one of the most numerous of the 5 spp. of salamanders found here. 1972: salamanders found during State Parks and Recreation study. See source observations for details.

EO Comments: Found predominantly in old decaying down logs. Showing preference for old-growth timber areas.

Protection: Further development not to be allowed near water.

Management: BLM parcels are designated Outstanding Natural Area.

References: Lysgaard-Rutz ; Harrington ; Lukas 1983; BLM 2007; Macatens, Thomas ; ODFW

Specimens:

General: 2015 sighting report by David Harrington. 2007 Nov GeoBOB records of 2006 observations by T. Wood (x2) and D. Lysgaard-Rutz (x1). Largest specimens of this species collected here; Dr. Storm OSU amphibian collection. Stumps and logs should not be removed. 1999: From ODFW scientific taking permit report.

Scientific Name: ***Entosphenus tridentatus*** EO NUM: 53

Common Name: **Pacific lamprey** EO ID: 38455

Federal Status: SOC GRANK: G4 NHP List: 2 Category: Vertebrate Animal

State Status: SV SRANK: S1S2 HP Track: Y ELCODE: AFBAA02100

Confirmed: First Obs: 2011 Last Obs: 2011 EO Rank: E - Verified extant (viability not assessed)

Directions: Lower Columbia River to Sandy

County Name	Ecoregion	Owner Name/Type	Watershed
Clackamas	WC		170800010101 - Headwaters Sandy River
Multnomah	WV		170800010102 - Clear Creek-Sandy River
			170800010303 - Middle Salmon River
			170800010304 - Lower Salmon River
			170800010401 - Wildcat Creek-Sandy River
			170800010402 - Cedar Creek-Sandy River
			170800010701 - Gordon Creek
			170800010702 - Trout Creek-Sandy River
			170800010703 - Beaver Creek-Sandy River
			170800010801 - Tanner Creek-Columbia River
			170800010802 - Hamilton Creek-Columbia River
			170800010803 - Viento Creek-Columbia River
			170800010804 - Latourell Creek-Columbia River

Town/Range	Sect	Meridian	TRS Note
001N003E	13	WM	
001N003E	14	WM	
001N003E	23	WM	
001N003E	24	WM	
001N003E	25	WM	
001N003E	36	WM	
001N004E	18	WM	
001N004E	20	WM	
001N004E	25	WM	
001N004E	26	WM	
001N004E	27	WM	
001N004E	28	WM	
001N004E	30	WM	
001N004E	31	WM	
001N005E	12	WM	
001N005E	14	WM	
001N005E	15	WM	
001N005E	19	WM	
001N005E	20	WM	
001N005E	21	WM	
001N006E	03	WM	
001N006E	04	WM	
001N006E	07	WM	
001N006E	08	WM	
001S003E	01	WM	
001S004E	03	WM	
001S004E	05	WM	
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001S004E	14	WM	
001S004E	15	WM	
001S004E	23	WM	
001S004E	24	WM	
001S004E	25	WM	
001S004E	26	WM	
001S004E	36	WM	
001S005E	07	WM	
001S005E	08	WM	
001S005E	09	WM	
001S005E	18	WM	
001S005E	30	WM	
001S005E	31	WM	
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002N006E	35	WM	
002N006E	36	WM	
002N007E	21	WM	
002N007E	29	WM	
002N007E	30	WM	
002N007E	31	WM	
002S004E	01	WM	
002S004E	12	WM	
002S005E	07	WM	
002S005E	08	WM	
002S005E	13	WM	
002S005E	14	WM	

QuadCode	QuadName
45121-B8	High Rock
45121-C7	Government Camp
45121-C8	Rhododendron
45121-D7	Bull Run Lake
45121-D8	Hickman Butte
45121-E8	Tanner Butte
45121-F8	Bonneville Dam
45122-C1	Salmon
45122-D1	Brightwood
45122-D2	Bull Run
45122-D3	Sandy
45122-E1	Multnomah Falls
45122-E2	Bridal Veil
45122-E3	Washougal
45122-E4	Camas

Managed Area Name
Salmon-Huckleberry Wilderness Area
Mount Hood Wilderness Area
Sandy River Gorge RNA
Sandy River Gorge Preserve

002S005E - 15 - WM -
002S005E - 16 - WM -
002S005E - 17 - WM -
002S005E - 18 - WM -
002S005E - 24 - WM -
002S006E - 18 - WM -
002S006E - 19 - WM -
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003S007E - 16 - WM -
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003S007E - 21 - WM -
003S007E - 22 - WM -
003S007E - 27 - WM -
003S007E - 28 - WM -
003S007E - 33 - WM -
003S007E - 34 - WM -
003S007E - 35 - WM -
004S007E - 01 - WM -
004S007E - 02 - WM -

Source Feature	Uncertainty Type (Distance)	[Use Class]	Annual Observations
63874 - Line	Negligible (8 m)	Freshwater	
63174 - Line	Negligible (8 m)	Undetermined	
63077 - Line	Negligible (8 m)	Undetermined	
63074 - Line	Negligible (8 m)	Undetermined	
63091 - Line	Negligible (8 m)	Undetermined	
63076 - Line	Negligible (8 m)	Undetermined	
63032 - Line	Negligible (8 m)	Undetermined	
63089 - Line	Negligible (8 m)	Undetermined	
63152 - Line	Negligible (8 m)	Undetermined	
63079 - Line	Negligible (8 m)	Undetermined	
63016 - Line	Negligible (8 m)	Undetermined	
63597 - Line	Negligible (8 m)	Undetermined	
63626 - Line	Negligible (8 m)	Undetermined	
63017 - Line	Negligible (8 m)	Undetermined	
63090 - Line	Negligible (8 m)	Undetermined	
63009 - Line	Negligible (8 m)	Undetermined	
63836 - Line	Negligible (8 m)	Freshwater	
63875 - Line	Negligible (8 m)	Freshwater	
63837 - Line	Negligible (8 m)	Freshwater	
63835 - Line	Negligible (8 m)	Freshwater	
62986 - Line	Negligible (8 m)	Undetermined	
63876 - Line	Negligible (8 m)	Freshwater	
63151 - Line	Negligible (8 m)	Undetermined	
63078 - Line	Negligible (8 m)	Undetermined	
63092 - Line	Negligible (8 m)	Undetermined	
62992 - Line	Negligible (8 m)	Undetermined	
62970 - Line	Negligible (8 m)	Undetermined	
63710 - Line	Negligible (8 m)	Freshwater	
62968 - Line	Negligible (8 m)	Undetermined	
63150 - Line	Negligible (8 m)	Undetermined	
63877 - Line	Negligible (8 m)	Freshwater	
62990 - Line	Negligible (8 m)	Undetermined	
63051 - Line	Negligible (8 m)	Undetermined	
62969 - Line	Negligible (8 m)	Undetermined	
63060 - Line	Negligible (8 m)	Undetermined	
63059 - Line	Negligible (8 m)	Undetermined	
63058 - Line	Negligible (8 m)	Undetermined	
62991 - Line	Negligible (8 m)	Undetermined	
63052 - Line	Negligible (8 m)	Undetermined	
62987 - Line	Negligible (8 m)	Undetermined	
62993 - Line	Negligible (8 m)	Undetermined	
63054 - Line	Negligible (8 m)	Undetermined	
63057 - Line	Negligible (8 m)	Undetermined	
62989 - Line	Negligible (8 m)	Undetermined	
63053 - Line	Negligible (8 m)	Undetermined	
63008 - Line	Negligible (8 m)	Undetermined	

SFeat ID	Date	Visit data
63874	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63008	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63077	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63074	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63091	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63076	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63089	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63079	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63597	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Brown.
63626	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63090	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63836	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63837	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63835	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63078	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63092	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Brown.
62990	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63032	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63016	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63017	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63152	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63151	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63009	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62992	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63875	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63876	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63877	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62986	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62970	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62968	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63710	2011	Use type: Spawning. Documented fish observation. Agency data steward: Eric Brown.
63150	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63051	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62969	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63060	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63059	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63058	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62991	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63052	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62987	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62993	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63054	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63057	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
62989	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63053	2011	Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.
63174	2011	Use type: Unknown. Documented fish observation. Agency data steward: John Hamilton.

Occurence Data

EO Type: Min. Elev.(m):

EO Data: 2011: Use type: Unknown. Documented fish observation. Agency data steward: Eric Hiebenthal.

EO Comments:

Protection:

Management:

References: ODFW 2012

Specimens:

General: From the 2012 edition of the ODFW Oregon Fish Habitat Distribution - Pacific Lamprey geodatabase; these data are based on sampling and describe areas of suitable habitat currently and historically used by Pacific lamprey populations.

Scientific Name: ***Oncorhynchus kisutch pop. 1*** EO NUM: 88

Common Name: **Coho salmon (Lower Columbia River ESU)** EO ID: 12621

Federal Status: LT GRANK: G4T2Q NHP List: 1 Category: Vertebrate Animal

State Status: LE SRANK: S2 HP Track: Y ELCODE: AFCHA02031

Confirmed: First Obs: 2001 Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)

Directions: SANDY RIVER & TRIBUTARIES

County Name	Ecoregion	Owner Name/Type	Watershed
Clackamas	WC	FEDERAL; PRIVATE	170800010101 - Headwaters Sandy River
Multnomah	WV		170800010102 - Clear Creek-Sandy River
			170800010201 - Still Creek
			170800010202 - Zigzag Canyon
			170800010303 - Middle Salmon River
			170800010304 - Lower Salmon River
			170800010401 - Wildcat Creek-Sandy River
			170800010402 - Cedar Creek-Sandy River
			170800010505 - Little Sandy River
			170800010506 - Lower Bull Run River
			170800010701 - Gordon Creek
			170800010702 - Trout Creek-Sandy River
			170800010703 - Beaver Creek-Sandy River

Town/Range	Sect	Meridian	TRS Note
001S003E	01	WM	
001S004E	03	WM	
001S004E	05	WM	
001S004E	06	WM	
001S004E	07	WM	
001S004E	08	WM	
001S004E	09	WM	
001S004E	10	WM	
001S004E	11	WM	
001S004E	12	WM	
001S004E	13	WM	
001S004E	14	WM	
001S004E	15	WM	
001S004E	23	WM	
001S004E	24	WM	
001S004E	25	WM	
001S004E	26	WM	
001S004E	36	WM	
001S005E	07	WM	
001S005E	08	WM	
001S005E	09	WM	
001S005E	10	WM	
001S005E	18	WM	
001S005E	30	WM	
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001S005E	34	WM	
001S005E	35	WM	
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002S005E	01	WM	
002S005E	03	WM	
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002S005E	06	WM	
002S005E	07	WM	
002S005E	08	WM	
002S005E	10	WM	
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002S005E	12	WM	
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002S005E	14	WM	
002S005E	15	WM	
002S005E	16	WM	
002S005E	17	WM	
002S005E	18	WM	
002S005E	24	WM	
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002S006E	07	WM	
002S006E	08	WM	
002S006E	09	WM	
002S006E	18	WM	
002S006E	19	WM	
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002S006E	21	WM	
002S006E	22	WM	
002S006E	23	WM	
002S006E	24	WM	
002S006E	25	WM	
002S006E	26	WM	

QuadCode	QuadName
45121-C7	Government Camp
45121-C8	Rhododendron
45121-D7	Bull Run Lake
45121-D8	Hickman Butte
45122-C1	Salmon
45122-D1	Brightwood
45122-D2	Bull Run
45122-D3	Sandy
45122-E2	Bridal Veil
45122-E3	Washougal

Managed Area Name
ZIGZAG RANGER DISTRICT
Salmon-Huckleberry Wilderness Area
Mount Hood Wilderness Area
Sandy River Gorge RNA
Sandy River Gorge Preserve
MOUNT HOOD NATIONAL FOREST

002S006E - 28 - WM -
002S006E - 36 - WM -
002S007E - 13 - WM -
002S007E - 14 - WM -
002S007E - 23 - WM -
002S007E - 24 - WM -
002S007E - 25 - WM -
002S007E - 26 - WM -
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002S007E - 29 - WM -
002S007E - 30 - WM -
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002S008E - 19 - WM -
002S008E - 20 - WM -
002S008E - 21 - WM -
002S008E - 28 - WM -
002S008E - 30 - WM -
003S006E - 01 - WM -
003S007E - 02 - WM -
003S007E - 03 - WM -
003S007E - 04 - WM -
003S007E - 05 - WM -
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003S007E - 11 - WM -
003S007E - 13 - WM -
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003S007E - 15 - WM -
003S007E - 16 - WM -
003S007E - 20 - WM -
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003S007E - 24 - WM -
003S007E - 27 - WM -
003S007E - 28 - WM -
003S007E - 33 - WM -
003S007E - 34 - WM -
003S007E - 35 - WM -
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003S008E - 15 - WM -
003S008E - 16 - WM -
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003S008E - 18 - WM -
003S008E - 19 - WM -
003S008E - 20 - WM -
003S008E - 21 - WM -
003S008E - 29 - WM -
003S008E - 30 - WM -
003S008E - 32 - WM -
003S008E - 33 - WM -
004S007E - 01 - WM -
004S007E - 02 - WM -

Source Feature | Uncertainty Type (Distance) [Use Class] | Annual Observations

Data currently not available.

SFeat ID | Date | Visit data

Occurence Data

EO Type: SPAWNING & REARING - fish Min. Elev.(m):

EO Data: 2009: Classified as spawning by ODFW. 1990-1991; ODFW CONDUCTED SPAWNING SURVEYS ON TEN TRIBUTARIES OF THE SANDY RIVER AND FOUND SPAWNING COHO IN SEVEN: 0.5 MILES OF CEDAR CREEK (178 FISH); 0.5 MILES OF CLEAR CREEK (8 FISH); 0.1 MILES OF SALMON RIVER (5 FISH); 1.5 MILES OF STILL CREEK (13 FISH); 0.5 MILES OF LOST CREEK (1 FISH); 0.5 MILES OF CLEAR FORK (4 FISH); 1.0 MILES OF TROUT CREEK (29 FISH). ALL BUT 5 OF THESE FISH WERE FOUND BEFORE DEC.14 (CONSIDERED 'EARLY RUN' FISH, PRIMARILY OF HATCHERY ORIGIN). ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.

EO Comments: Spawning and rearing use. In 2001 several areas were updated to rearing and migration use and previous/historic use. Rearing and migration use areas: Big Creek, Buck Creek, North Boulder Creek and tributary to Salmon Creek above Mount Hood golf course. Previous/historic use areas: above Little Sandy Dam. 2009: Area above Little Sandy River Dam classified as spawning. All other areas also classified as spawning.

Protection:

Management: Sandy fish hatchery is located on Cedar Creek near its confluence with the Sandy River.

References: Coastal Coho Spawning and Rearing Distribution Maps 1995; ODFW 2009; ODFW 2000; Bennett ; Massey ; ODFW ; ODFW 2004

Specimens:

General: In 1992 ODFW commented that late-run wild coho from the Sandy River (which largely comprise the remaining wild coho in the basin) were declining based on Marmot dam counts and late-run spawning surveys and that the run may in fact be extinct. Distribution information used in this EOR was derived from ODFW geographic resources data produced and distributed in 1999. Unless specific data exists in the data field, the information presented in this EOR represents the "best professional judgement" by ODFW's district fisheries biologist; the presence of coho in described areas should be considered undocumented but as having a potential of being present. EOR was updated using ODFW geographic resources data produced and distributed in 2004. Updated with 2009 ODFW data.

Scientific Name: ***Oncorhynchus mykiss pop. 27*** EO NUM: 19

Common Name: **Steelhead (Lower Columbia River ESU, winter run)** EO ID: 2730

Federal Status: LT GRANK: G5T2Q NHP List: 1 Category: Vertebrate Animal

State Status: SC SRANK: S2 HP Track: Y ELCODE: AFCHA02132

Confirmed: First Obs: 1999-PRE Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)

Directions: SANDY RIVER & TRIBUTARIES

County Name	Ecoregion	Owner Name/Type	Watershed
Clackamas	WC		170800010101 - Headwaters Sandy River
Multnomah	WV		170800010102 - Clear Creek-Sandy River
			170800010201 - Still Creek
			170800010202 - Zigzag Canyon
			170800010303 - Middle Salmon River
			170800010304 - Lower Salmon River
			170800010401 - Wildcat Creek-Sandy River
			170800010402 - Cedar Creek-Sandy River
			170800010505 - Little Sandy River
			170800010506 - Lower Bull Run River
			170800010701 - Gordon Creek
			170800010702 - Trout Creek-Sandy River
			170800010703 - Beaver Creek-Sandy River

Town/Range	Sect	Meridian	TRS Note
001N003E	25	WM	
001N003E	36	WM	
001N004E	30	WM	
001N004E	31	WM	
001S003E	01	WM	
001S003E	02	WM	
001S003E	12	WM	
001S004E	03	WM	
001S004E	05	WM	
001S004E	06	WM	
001S004E	07	WM	
001S004E	08	WM	
001S004E	09	WM	
001S004E	10	WM	
001S004E	11	WM	
001S004E	12	WM	
001S004E	13	WM	
001S004E	14	WM	
001S004E	15	WM	
001S004E	17	WM	
001S004E	18	WM	
001S004E	23	WM	
001S004E	24	WM	
001S004E	25	WM	
001S004E	26	WM	
001S004E	36	WM	
001S005E	07	WM	
001S005E	08	WM	
001S005E	09	WM	
001S005E	10	WM	
001S005E	18	WM	
001S005E	30	WM	
001S005E	31	WM	
001S005E	33	WM	
001S005E	34	WM	
001S005E	35	WM	
002S004E	01	WM	
002S004E	12	WM	
002S005E	01	WM	
002S005E	03	WM	
002S005E	04	WM	
002S005E	05	WM	
002S005E	06	WM	
002S005E	07	WM	
002S005E	08	WM	
002S005E	10	WM	
002S005E	11	WM	
002S005E	12	WM	
002S005E	13	WM	
002S005E	14	WM	
002S005E	15	WM	
002S005E	16	WM	
002S005E	17	WM	
002S005E	18	WM	
002S005E	24	WM	
002S006E	06	WM	
002S006E	07	WM	
002S006E	08	WM	
002S006E	09	WM	
002S006E	13	WM	

QuadCode	QuadName
45121-B8	High Rock
45121-C6	Mount Hood South
45121-C7	Government Camp
45121-C8	Rhododendron
45121-D7	Bull Run Lake
45121-D8	Hickman Butte
45122-C1	Salmon
45122-D1	Brightwood
45122-D2	Bull Run
45122-D3	Sandy
45122-D4	Damascus
45122-E2	Bridal Veil
45122-E3	Washougal
45122-E4	Camas

Managed Area Name
Salmon-Huckleberry Wilderness Area
Mount Hood Wilderness Area
Sandy River Gorge RNA
Sandy River Gorge Preserve

002S006E - 18 - WM -
002S006E - 19 - WM -
002S006E - 20 - WM -
002S006E - 21 - WM -
002S006E - 22 - WM -
002S006E - 23 - WM -
002S006E - 24 - WM -
002S006E - 25 - WM -
002S006E - 26 - WM -
002S006E - 28 - WM -
002S006E - 29 - WM -
002S006E - 32 - WM -
002S006E - 33 - WM -
002S006E - 36 - WM -
002S007E - 13 - WM -
002S007E - 14 - WM -
002S007E - 23 - WM -
002S007E - 24 - WM -
002S007E - 25 - WM -
002S007E - 26 - WM -
002S007E - 27 - WM -
002S007E - 29 - WM -
002S007E - 30 - WM -
002S007E - 31 - WM -
002S007E - 32 - WM -
002S007E - 33 - WM -
002S007E - 34 - WM -
002S008E - 03 - WM -
002S008E - 04 - WM -
002S008E - 08 - WM -
002S008E - 09 - WM -
002S008E - 10 - WM -
002S008E - 13 - WM -
002S008E - 14 - WM -
002S008E - 15 - WM -
002S008E - 16 - WM -
002S008E - 17 - WM -
002S008E - 18 - WM -
002S008E - 19 - WM -
002S008E - 20 - WM -
002S008E - 21 - WM -
002S008E - 22 - WM -
002S008E - 23 - WM -
002S008E - 24 - WM -
002S008E - 25 - WM -
002S008E - 26 - WM - RANGE=8.5E
002S008E - 27 - WM -
002S008E - 28 - WM -
002S008E - 30 - WM -
003S006E - 01 - WM -
003S006E - 05 - WM -
003S006E - 12 - WM -
003S006E - 13 - WM -
003S006E - 24 - WM -
003S007E - 02 - WM -
003S007E - 03 - WM -
003S007E - 04 - WM -
003S007E - 05 - WM -
003S007E - 06 - WM -
003S007E - 08 - WM -
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003S007E - 11 - WM -
003S007E - 12 - WM -
003S007E - 13 - WM -
003S007E - 14 - WM -
003S007E - 15 - WM -
003S007E - 16 - WM -
003S007E - 20 - WM -
003S007E - 21 - WM -
003S007E - 22 - WM -
003S007E - 24 - WM -
003S007E - 25 - WM -
003S007E - 27 - WM -
003S007E - 28 - WM -
003S007E - 33 - WM -
003S007E - 34 - WM -
003S007E - 35 - WM -
003S008E - 07 - WM -
003S008E - 09 - WM -
003S008E - 11 - WM -
003S008E - 12 - WM -
003S008E - 13 - WM - RANGE=8.5E
003S008E - 14 - WM -
003S008E - 15 - WM -
003S008E - 16 - WM -
003S008E - 17 - WM -
003S008E - 18 - WM -
003S008E - 19 - WM -
003S008E - 20 - WM -
003S008E - 21 - WM -
003S008E - 22 - WM -
003S008E - 24 - WM - RANGE=8.5E
003S008E - 25 - WM -
003S008E - 25 - WM - RANGE=8.5E
003S008E - 26 - WM - RANGE=8.5E
003S008E - 29 - WM -
003S008E - 30 - WM -
003S008E - 32 - WM -
003S008E - 33 - WM -
003S008E - 34 - WM -
003S008E - 35 - WM -
003S008E - 36 - WM -
003S009E - 07 - WM -
003S009E - 18 - WM -
004S007E - 01 - WM -
004S007E - 02 - WM -
004S007E - 03 - WM -
004S007E - 04 - WM -
004S007E - 05 - WM -
004S007E - 09 - WM -
004S007E - 12 - WM -

Source Feature Uncertainty Type (Distance) [Use Class] Annual Observations

Data currently not available.

SFeat ID Date Visit data

Occurence Data

EO Type: SPAWNING & REARING - fish Min. Elev.(m):

EO Data: 2009: Classified as spawning by ODFW. Documented fish observation on Clear Creek. WINTER RUN: ODFW DISTRIBUTIION MAPS USED TO CREATE THE 1:24,000 COVERAGE

EO Comments:

Protection:

Management:

References: ODFW 2000; Bennett ; Massey ; ODFW

Specimens:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT. SANDY RIVER FISH HATCHERY IS LOCATED ON CEDAR CREEK NEAR THE CONFLUENCE WITH THE SANDY RIVER.

Scientific Name: ***Oncorhynchus tshawytscha pop. 21*** EO NUM: 1

Common Name: **Chinook salmon (Lower Columbia River ESU, spring run)** EO ID: 19065

Federal Status: LT GRANK: G5T2Q NHP List: 1 Category: Vertebrate Animal

State Status: SC SRANK: S2 HP Track: Y ELCODE: AFCHA0205W

Confirmed: First Obs: 1999-PRE Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)

Directions: SANDY RIVER

County Name	Ecoregion	Owner Name/Type	Watershed
Clackamas	WC		170800010702 - Trout Creek-Sandy River
Multnomah	WV		170800010703 - Beaver Creek-Sandy River
			170800010804 - Latourell Creek-Columbia River
			170800030200 - Hayden Island-Columbia River

Town/Range Sect Meridian TRS Note	QuadCode	QuadName	Managed Area Name
001N003E - 14 - WM -	45122-D2	Bull Run	Sandy River Gorge RNA
001N003E - 23 - WM -	45122-D3	Sandy	Sandy River Gorge Preserve
001N003E - 24 - WM -	45122-E3	Washougal	
001N003E - 25 - WM -	45122-E4	Camas	
001N003E - 36 - WM -			
001N004E - 19 - WM -			
001N004E - 20 - WM -			
001N004E - 29 - WM -			
001N004E - 30 - WM -			
001N004E - 31 - WM -			
001S003E - 01 - WM -			
001S004E - 03 - WM -			
001S004E - 05 - WM -			
001S004E - 06 - WM -			
001S004E - 08 - WM -			
001S004E - 09 - WM -			
001S004E - 10 - WM -			
001S004E - 11 - WM -			
001S004E - 14 - WM -			
001S004E - 15 - WM -			
001S004E - 23 - WM -			
001S004E - 24 - WM -			
001S004E - 25 - WM -			
001S004E - 26 - WM -			
001S005E - 30 - WM -			
001S005E - 31 - WM -			

Source Feature Uncertainty Type (Distance) [Use Class] Annual Observations

Data currently not available.

SFeat ID Date Visit data

Occurence Data

EO Type: REARING & MIGRATION - fish Min. Elev.(m):

EO Data: 2009: Classified as rearing by ODFW. Undocumented fish observation. SPRING RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE

EO Comments:

Protection:

Management:

References: ODFW 2000; Bennett ; Massey ; ODFW

Specimens:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF CHINOOK IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT. Updated with 2009 ODFW 1:24,000 data.

Scientific Name: ***Oncorhynchus tshawytscha pop. 22*** EO NUM: 5

Common Name: **Chinook salmon (Lower Columbia River ESU, fall run)** EO ID: 11203

Federal Status: LT GRANK: G5T2Q NHP List: 1 Category: Vertebrate Animal

State Status: SC SRANK: S2 HP Track: Y ELCODE: AFCHA0205Y

Confirmed: First Obs: 1999-PRE Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)

Directions: SANDY RIVER & TRIBUTARIES

County Name	Ecoregion	Owner Name/Type	Watershed
Clackamas	WC		170800010401 - Wildcat Creek-Sandy River
Multnomah	WV		170800010402 - Cedar Creek-Sandy River
			170800010505 - Little Sandy River
			170800010506 - Lower Bull Run River
			170800010701 - Gordon Creek
			170800010702 - Trout Creek-Sandy River
			170800010703 - Beaver Creek-Sandy River
			170800010804 - Latourell Creek-Columbia River
			170800030200 - Hayden Island-Columbia River

Town/Range	Sect	Meridian	TRS Note
001N003E	14	WM	
001N003E	23	WM	
001N003E	24	WM	
001N003E	25	WM	
001N003E	36	WM	
001N004E	30	WM	
001N004E	31	WM	
001S003E	01	WM	
001S004E	03	WM	
001S004E	05	WM	
001S004E	06	WM	
001S004E	08	WM	
001S004E	09	WM	
001S004E	10	WM	
001S004E	11	WM	
001S004E	12	WM	
001S004E	13	WM	
001S004E	14	WM	
001S004E	15	WM	
001S004E	23	WM	
001S004E	24	WM	
001S004E	25	WM	
001S004E	26	WM	
001S004E	36	WM	
001S005E	07	WM	
001S005E	18	WM	
001S005E	30	WM	
001S005E	31	WM	
001S005E	33	WM	
001S005E	34	WM	
001S005E	35	WM	
002S004E	01	WM	
002S004E	12	WM	
002S005E	01	WM	
002S005E	03	WM	
002S005E	04	WM	
002S005E	05	WM	
002S005E	06	WM	
002S005E	07	WM	
002S005E	08	WM	
002S005E	10	WM	
002S005E	11	WM	
002S005E	12	WM	
002S005E	13	WM	
002S005E	14	WM	
002S005E	15	WM	
002S005E	16	WM	
002S005E	17	WM	
002S005E	18	WM	
002S005E	24	WM	
002S006E	06	WM	
002S006E	07	WM	
002S006E	08	WM	
002S006E	09	WM	
002S006E	18	WM	
002S006E	19	WM	
002S006E	20	WM	

QuadCode	QuadName
45122-D1	Brightwood
45122-D2	Bull Run
45122-D3	Sandy
45122-E3	Washougal
45122-E4	Camas

Managed Area Name
Sandy River Gorge RNA
Sandy River Gorge Preserve

Source Feature	Uncertainty Type (Distance) [Use Class]	Annual Observations

Data currently not available.

SFeat ID	Date	Visit data

Occurence Data

EO Type: SPAWNING & REARING - fish Min. Elev.(m):

EO Data: 2009: Classified as spawning by ODFW. 1999: FALL RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE

EO Comments:

Protection:

Management:

References: ODFW 2000; Bennett ; Massey ; ODFW

Specimens:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF CHINOOK IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT. SANDY RIVER FISH HATCHERY IS LOCATED ON CEDAR CREEK NEAR THE CONFLUENCE WITH THE SANDY RIVER. Updated with 2009 1:24,000 ODFW coverage.

6 records total

Key to Oregon Biodiversity Information Center Data

Field Name	Description
Scientific Name	The scientific name of the species.
Common Name	The common name of the species.
Category	Value that indicates the broad biological category for each species.
ELCODE	Unique NatureServe code for identifying this element. 1st and 2nd byte (PD=Plant dict, PM=Plant monocot, PG=Plant gymnosperm, PP=Plant pteridophyte, AA=amphibian, AB=bird, AF=fish, AM=mammal, AR=reptile, I=invertebrate. 3rd-5th byte (family abbreviation). 6th-7th (genus code). 8th-9th (species). 10th (tie breaker).
Federal Status	US Fish and Wildlife Service or NOAA Fisheries status. **LE**=listed endangered, **LT**=listed threatened, **PE** or **PT**=proposed endangered or threatened, **C**=candidate for listing with enough information available for listing, **SOC** or **SC**=species of concern, **PS:***xx*=partial status for species.
State Status	For animals, Oregon Department of Fish and Wildlife status; **LE**=listed endangered, **PE**=proposed endangered, **PT**=proposed threatened, **SC** or **C**=sensitive-critical, **SV** or **V**=sensitive-vulnerable, **SP** or **P**=sensitive-peripheral, **SU** or **U**=sensitive-undetermined status. For plants, Oregon Department of Agriculture status; **LE**=listed endangered, **LT**=listed threatened, **C**=candidate.
GRANK/SRANK	ORNHIC participates in an international system for ranking rare, threatened and endangered species throughout the world. The system was developed by The Nature Conservancy and is now maintained by NatureServe in cooperation with Heritage Programs or Conservation Data Centers (CDCs) in all 50 states, in 4 Canadian provinces, and in 13 Latin American countries. The ranking is a 1-5 scale, primarily based on the number of known occurrences, but also including threats, sensitivity, area occupied, and other biological factors. In this book, the ranks occupy two lines. The top line is the Global Rank and begins with a "G". If the taxon has a trinomial (a subspecies, variety or recognized race), this is followed by a "T" rank indicator. A "Q" at the end of this line indicates the taxon has taxonomic questions. The second line is the State Rank and begins with the letter "S". The ranks are summarized as follows: **1** = Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences; **2** = Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences; **3** = Rare, uncommon or threatened, but not immediately imperiled, typically with 21-100 occurrences; **4** = Not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences; **5** = Demonstrably widespread, abundant, and secure; **H** = Historical Occurrence, formerly part of the native biota with the implied expectation that it may be rediscovered; **X** = Presumed extirpated or extinct; **U** = Unknown rank; **?** = Not yet ranked, or assigned rank is uncertain.
NHP list	All rare species in Oregon are assigned a list number of 1, 2, 3 or 4, where **1**=threatened or endangered throughout range, **2**=threatened or endangered in Oregon but more common elsewhere, **3**=Review List (more information is needed), **4**=Watch List (currently stable). A null value indicates the species is not currently on our rare species list.
HP Track	We currently obtain and computerize locational information for only those elements marked with **Y**(es). Those species marked with **N**(o) or **W**(atch) have incomplete data as we do not actively track them at this time.
EO NUM	The number of the Element Occurrence (EO) for this species. An element occurrence is an area of land or water where the species is or was known to occur and has conservation value. EOs are the main tracking unit for Heritage Programs.
EO ID	Unique identifier for the Element Occurrence (EO). Unique for each occurrence in the database.
First_obs	First reported sighting date for this occurrence in the form YYYY-MM-DD.
Last_obs	Last reported sighting date, usually in the form YYYY-MM-DD.

Key to Oregon Biodiversity Information Center Data

Field Name	Description
Confirmed	Indication of whether taxonomic identification of the Element represented by this occurrence has been confirmed by a reliable individual. Blank=unknown, assumed to be correctly identified. Y=Yes, confident identification. ?=identification questions.
EO Rank	ORNHIC's determination of the viability of the occurrence.
Directions	Site name and/or directions to site.
County	County name(s) in which EO is mapped.
Ecoregion	Physiographic Province in which EO is mapped: **CR**=Coast Range, **WV**=Willamette Valley, **KM**=Klamath Mountains, **WC**=West slope and crest of the Cascades, **EC**=East slope of the Cascades, **BM**=Ochoco, Blue and Wallowa Mts., **BR**=Basin and Range, **CB**=Columbia Basin, **SP**=Snake River Plains. **ME**=Marine and Estuarine.
Town-Range, Sec, and Note	United States rectangular land survey (also known as the Public Land Survey System) legal township, range, and section descriptions in which the EO is mapped. Township first (4 bytes), range second (4 bytes). For example: 004S029E = Township 4S, Range 29E. All locations are with reference to the Willamette Meridian. Fractional ranges or townships are indicated in the Note field.
Quadcode	USGS code for the USGS topographic quadrangle map(s) where the record is mapped.
Quadname	Name of the USGS topographic quadrangle map(s) where the record is mapped.
Watershed	Watershed(s), identified according to the U.S. Geological Survey (USGS) Hydrologic Unit Map 10-digit code, within which the Element Occurrence is located.
Owner Name/Type	Federal, State, Private, etc.
Managed Area Name	BLM District, USFS Forest, Private Preserve
Annual Observation	Summary of yearly observation.
Source Feature	A Source Feature is the initial translation of a discrete unit of observation data as a spatial feature. Creation of a Source Feature requires an interpretive process. The likely location and extent of an observation is determined through consideration of the amount and direction of any variability between the recorded and actual locations of the observation data. In most cases, the Source Feature is delineated to encompass locational uncertainty. A Source Feature can be a point, line, or polygon. The type of Source Feature developed depends on both the preceding conceptual feature type and the locational uncertainty associated with the feature.
Feature ID	Unique identifier for source feature.
Obs Date	Date of source feature observation.
Source Observation Data	Observations specific to the source feature.

Key to Oregon Biodiversity Information Center Data

Field Name	Description
Uncertainty Type (Distance)	The recorded location of an observation of an Element may vary from its true location due to many factors, including the level of expertise of the data collector, differences in survey techniques and equipment used, and the amount and type of information obtained. This inaccuracy is characterized as locational uncertainty, and is assessed for Source Feature(s) based on the uncertainty associated with the underlying information on the location of the observation. Four categories of locational uncertainty have been identified, as follows: Negligible uncertainty is less than or equal to 6.25 meters in any dimension. Source Features with negligible uncertainty are based on a comprehensive field survey with high quality mapping and a high degree of certainty. Linear uncertainty is greater than 6.25 meters, and varies along an axis (e.g., a path, stream, ridgeline). The true location of an observation with linear uncertainty may be visualized as effectively sliding along a line that delineates the uncertainty. Areal delimited uncertainty is greater than 6.25 meters, and varies in more than one dimension. The true location of an observation can be visualized as floating within an area with a boundary that can be specifically delimited. Boundaries can be defined using roads, bodies of water, etc. Areal estimated uncertainty is greater than 6.25 meters, and varies in more than one dimension. A boundary cannot be specifically delimited based on the observation information, i.e., the actual extent is unknown. The true location of the observation can be visualized as floating within an area for which boundaries cannot be specifically delimited. Source Features with areal estimated uncertainty require that the user specify an estimated uncertainty distance to be used for buffering the feature to incorporate the locational uncertainty.
Use Class	How the source feature is used by migratory species (e.g. breeding, maternity colony, hibernaculum).
EO Type	For animals, type of occurrence, e.g. roost, nest, spawning.
EO Data	Summary of species and population biology for the EO – may include number observed, number of sites, reproduction data, assessment of viability, etc.
EO Comments	Habitat information, e.g. aspect, slope, soils, associated species, community type.
Minimum Elevation	Minimum elevation of the area covered by the range of the taxon, in meters. Negative numbers or blank=not determined.
Protection	Comments on protectibility and threats.
Management	Comments on how the site is managed.
Specimens	Details on specimens that have been collected at this occurrence site. Order of information is: Collector (Collector's number). Year collected. Acquisition number. Collection code.
General	Miscellaneous comments.

APPENDIX E—
WETLAND DELINEATION REPORT

WETLAND DELINEATION / DETERMINATION REPORT COVER FORM

Fully completed and signed report cover forms and applicable fees are required before report review timelines are initiated by the Department of State Lands. Make checks payable to the Oregon Department of State Lands. To pay fees by credit card, go online at https://apps.oregon.gov/DSL/EPS/program?key=4.

Attach this completed and signed form to the front of an unbound report or include a hard copy with a digital version (single PDF file of the report cover form and report, minimum 300 dpi resolution) and submit to: **Oregon Department of State Lands, 775 Summer Street NE, Salem, OR 97301-1279.** A single PDF of the completed cover form and report may be e-mailed to **Wetland_Delineation@dsl.state.or.us**. For submittal of PDF files larger than 10 MB, e-mail DSL instructions on how to access the file from your ftp or other file sharing website.

Contact and Authorization Information

☒ Applicant ☐ Owner Name, Firm and Address: HDR, Attn: Andy McCaskill 1001 SW 5th Avenue, Suite 1800, Portland, OR 97204	Business phone # 503-423-3846 Mobile phone # (optional) E-mail: Andy.McCaskill@hdrinc.com
☐ Authorized Legal Agent, Name and Address: N/A	Business phone # Mobile phone # E-mail:

I either own the property described below or I have legal authority to allow access to the property. I authorize the Department to access the property for the purpose of confirming the information in the report, after prior notification to the primary contact.

Typed/Printed Name: _____ **Signature:** _____

Date: _____ Special instructions regarding site access: Please call ahead before accessing site.

Project and Site Information

Project Name: Wetland Determination Report for Tax Lots 100 and 400, Map No. 1S 4E 22D	Latitude: 45.463126 deg. Longitude: -122.295430 deg. **decimal degree** - centroid of site or start & end points of linear project
Proposed Use: PWB Filtration Plant	Tax Map # 1S 4E 22D (QQ: NE, SE; SE, SE) Tax Lot(s) 100
	Tax Map # 1S 4E 22D (QQ: NW, SE; SW, SE) Tax Lot(s) 400
Project Street Address (or other descriptive location): Study area is south of the easterly terminus of SE Carpenter Lane	Township 1S Range 4E Section 22 QQ see above Use separate sheet for additional tax and location information
City: Boring County: Multnomah	Waterway: None River Mile: N/A

Wetland Delineation Information

Wetland Consultant Name, Firm and Address: PBS Engineering and Environmental, Attn: Greg Swenson 4412 SW Corbett Avenue Portland, Oregon 97239	Phone # 503-935-5492 Mobile phone # E-mail: greg.swenson@pbsusa.com

The information and conclusions on this form and in the attached report are true and correct to the best of my knowledge.

Consultant Signature: _____ Date: 8/13/18

Primary Contact for report review and site access is ☐ Consultant ☒ Applicant/Owner ☐ Authorized Agent

Wetland/Waters Present? ☐ Yes ☒ No | Study Area size: 91.17 ac. Total Wetland Acreage: 0 ac.

Check Applicable Boxes Below

☐ R-F permit application submitted	☐ Fee payment submitted $ 437
☐ Mitigation bank site	☐ Fee ($100) for resubmittal of rejected report
☐ Industrial Land Certification Program Site	☐ Request for Reissuance. See eligibility criteria. (no fee)
☐ Wetland restoration/enhancement project (not mitigation)	DSL# _____ Expiration date _____
☐ Previous delineation/application on parcel If known, previous DSL #	☐ LWI shows wetlands or waters on parcel Wetland ID code

For Office Use Only

DSL Reviewer: _____ Fee Paid Date: ____ / ____ / ____ DSL WD # _____

Date Delineation Received: ____ / ____ / ____ Scanned: ☐ Electronic: ☐ DSL App. # _____

Wetland Determination Report for Tax Lots 100 and 400, Map No. 1S 4E 22D

SE Carpenter Lane
Boring, Oregon

Akana
6400 SE Lake Road, Suite 270
Portland, Oregon 97222

January 27, 2018
PBS Project No. 75350.000

4412 SW CORBETT AVENUE
PORTLAND, OR 97239
503.248.1939 MAIN
866.727.0140 FAX
PBSUSA.COM

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INTRODUCTION

PBS Engineering and Environmental (PBS) was contracted to conduct a wetland determination on 91.17 acres of agricultural land located south of the easterly terminus of SE Carpenter Lane in Boring, Multnomah County, Oregon (Appendix A, Figure 1). The study area is bounded by agricultural land to the west and south, rural residences to the north and east, and SE Dodge Park Boulevard to the northeast. Tax lots consist of 100 and 400 on Multnomah County assessor map 1S 4E 22D in Township 1 South, Range 4 East, Section 22 (ORMAP 2018) (Figure 2). PBS' fieldwork and reporting was conducted by Greg Swenson Professional Wetland Scientist.

A. LANDSCAPE SETTING AND LAND USE

The study area is located within the Willamette Valley foothills (USGS 2018) west of the Sandy River. Topography is rolling, and slopes range from gentle to very steep (i.e., 3% to >45% per Soil Science Division Staff 2017 terminology). Most of the study area has a westerly and southwesterly aspect that drains toward Johnson Creek. The north and northeasterly edges of the study area drain toward the Sandy River. According to the *Metro Portland* contour data (DOGAMI 2014), study area elevations range from approximately 670 to 744 feet (NGVD29) above sea level. The study area is mostly in agricultural production for landscape nursery stock. Moderately steep and very steep forested areas run along Johnson Creek near the southwest property corner and along SE Dodge Park Boulevard.

B. SITE ALTERATIONS

Site alterations are exclusively related to agricultural practices. Trees were cleared from the land likely during settlement. Plowing and other typical agricultural practices have been ongoing for decades. A small amount of fill was observed near the west edge of the study area where farm refuse is disposed. No wetlands or waters were affected by the placement of the refuse.

C. PRECIPITATION DATA AND ANALYSIS

Precipitation data were obtained from the National Oceanic and Atmospheric Administration / National Weather Service (NWS 2018) website and the Natural Resource Conservation Service (NRCS) WETS website for the Portland International Airport stations (NRCS 2018) (Appendix D). As indicated in Table 1A, slightly below normal precipitation occurred in the two weeks before the January 12, 2018 field study date. Cumulative precipitation for the water year starting October 1, 2017 was essentially normal. Cumulative precipitation was within the normal range in the three-month period leading up to the field study date (Table 1B). Due to the winter timing of the field study and generally normal preceding precipitation patterns, field observations were considered to be reliable for making the wetland hydrology determination.

Table 1A. Precipitation To-Date Data

Field Study Date	Observed Precipitation on the Date of the Field Study (in.)	Observed Precipitation Two Weeks Prior to the Field Study Date	Percentage of Normal Precipitation for the Water Year to Date
January 12, 2018	0.07	2.18 in. (93% of normal 1981-2010 data)	99%

Table 1B. Precipitation Data for the Preceding 3 Months

Prior Month	WETS Rainfall Percentile (in.)		Measured Rainfall (in.)	Condition: Dry, Wet, Normal	Condition Value: (1=dry, 2=normal, or 3=wet)	Month weight	Multiply previous two columns
	30th	70th					
October	1.75	3.64	4.57	Wet	3	3	9
November	3.85	6.71	6.44	Normal	2	2	4
December	4.01	6.45	3.09	Dry	1	1	1
						Sum	**14**
Rainfall of prior period was: **drier** than normal (sum is 6-9), **normal** (sum is 10-14), **wetter** than normal (sum is 15-18).							Normal

WETS Station: Portland International Airport, 1981-2010
Measured Rainfall: Portland, OR October 2017 - December 2017
Data From: http://agacis.rcc-acis.org/?fips=41051

D. METHODS

The field study occurred on January 12, 2018. The method used for determining the presence / absence of wetlands and waters followed the routine approach of the U.S. Army Corps of Engineers (USACE) *Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (Version 2.0) (U.S. Army Corps of Engineers 2010). Soils, vegetation, and indicators of hydrology were recorded at two sample plot locations on standard wetland determination data forms (Appendix B). Wetland plant ratings were assigned based on the *2016 National Wetland Plant List* (Lichvar et. al. 2016). Plot locations were chosen to represent contrasts in landscape positions. No modification of the standard wetland boundary determination methodology (i.e., presence of hydric soil indicators, hydrophytic plant dominance, and wetland hydrology indicators) was necessary during the delineation. Please note: due to ongoing cultivation, most of the vegetation within the study area would not be reliable for wetland determination purposes; however, the plot locations had remnant vegetation that was less disturbed. The remnant vegetation was considered reliable as noted on the data forms.

E. DESCRIPTION OF ALL WETLANDS AND OTHER NON-WETLAND WATERS

No wetlands or waters were documented within the study area.

F. DEVIATION FROM LWI OR NWI

The National Wetlands Inventory (NWI) (USFWS 2018) does not show any wetlands or waters within the study area (Figure 3). The NWI mapping was confirmed during the field study. A local wetland inventory has not been completed for the town of Boring or Multnomah County.

G. MAPPING METHOD

A recent color aerial photograph with the study area boundary was used as the base map for the field study. The GPS location data for the sample plot locations and photograph locations were collected using a Trimble Geo7X Mapping Grade GPS unit (Figures 6A-6K). Accuracy for all mapped features is estimated at 1 meter or less based on the manufacturer's reported tolerance for the instrument and the post-processing report. Digitized mapping and cartography was completed in ArcGIS and AutoCAD. Soil mapping units are depicted

on Figure 4. A current aerial photograph depicting the study area is included as Figure 5. Ground-level site photographs are included in Appendix C.

H. ADDITIONAL INFORMATION

The vast majority of the study area is positioned on high ground and very clearly upland. Two areas of *Wollent silt loam* soils are mapped near the west edge of the study area (Figure 4). Plots were established in both of these hydric units to check the accuracy of the NRCS mapping. Both plots had upland soils that were significantly outside of the range in characteristics for the *Wollent* soil.

Johnson Creek runs very close to the southwest corner of the study area. The property corners were reflagged during the field study confirming that Johnson Creek and its floodplain are offsite.

I. RESULTS AND CONCLUSIONS

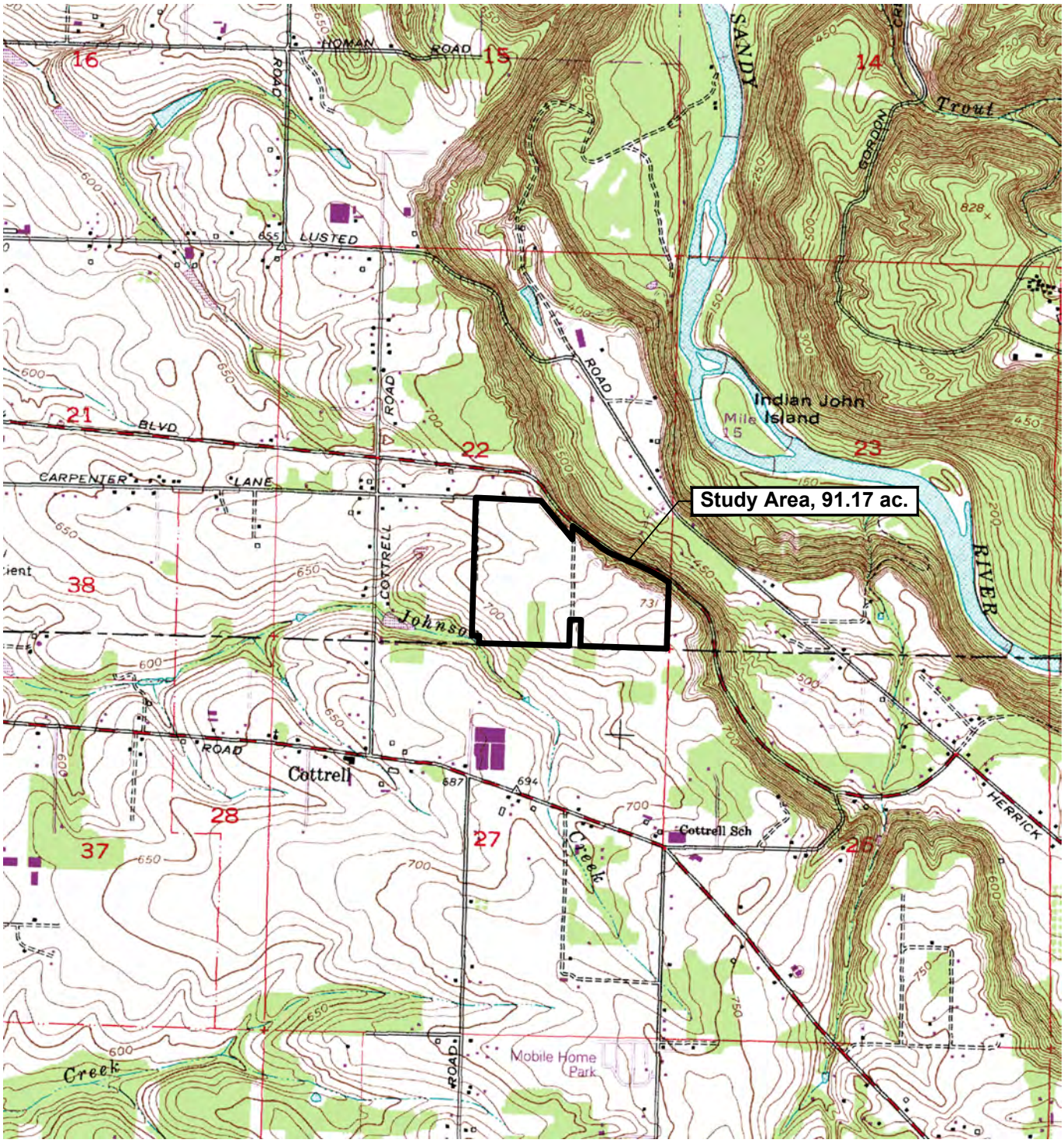
No wetlands or waters were documented within the study area.

J. DISCLAIMER

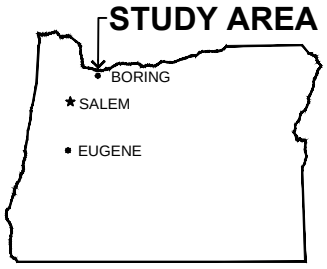
This report documents the investigation, best professional judgment, and conclusions of the investigator. It is correct and complete to the best of my knowledge. It should be considered a Preliminary Jurisdictional Determination of wetlands and other waters and used at your own risk unless it has been reviewed and approved in writing by the Oregon Department of State Lands in accordance with OAR 141-090-0005 through 141-090-0055.

APPENDIX A

Maps



SOURCE: USGS SANDY, OR. QUADRANGLE, 1961.



SCALE: 1" = 2,000'

0 1,000' 2,000' 4,000'

PREPARED FOR: AKANA.

PBS

LOCATION MAP

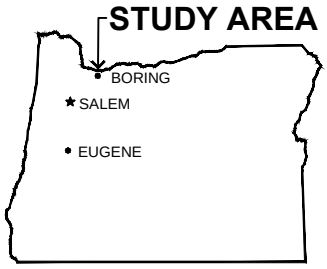
TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

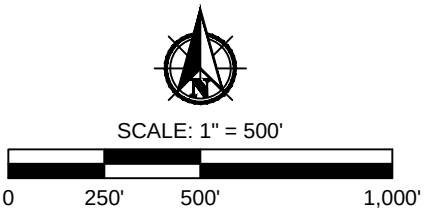
JAN 2018
75350.000

FIGURE
1

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:04:30 PM

SOURCE: ORMAP, 2018.





PREPARED FOR: AKANA.

PBS

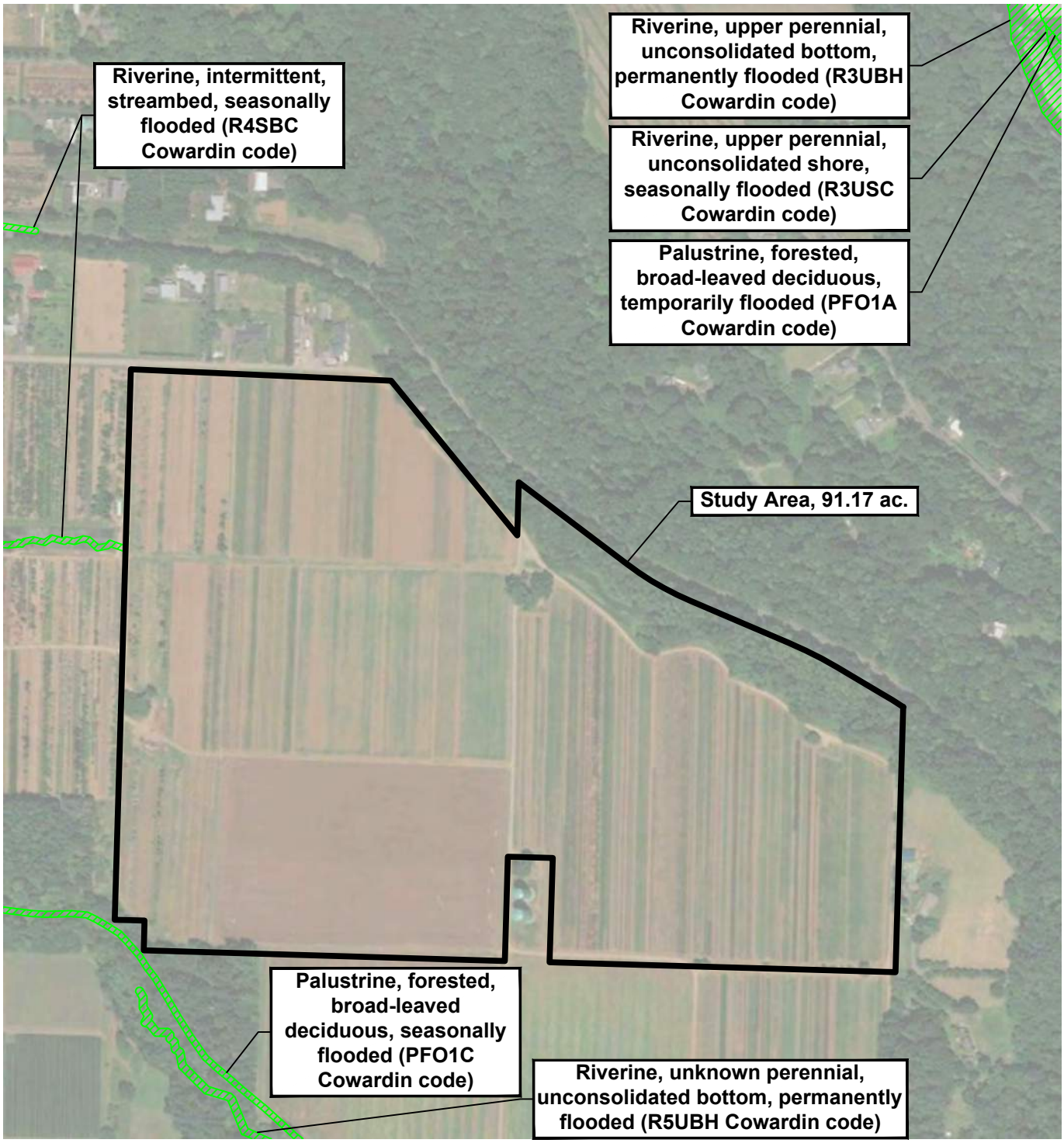
TAX LOT MAP 1S 4E 22D

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

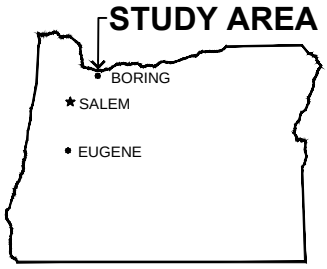
JAN 2018
75350.000

FIGURE
2

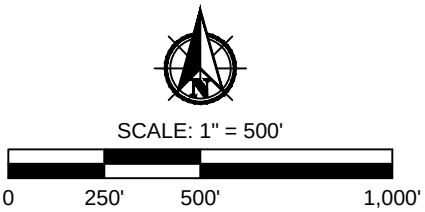
Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:04:41 PM



SOURCE: NWI POLYGONS FROM US FISH AND WILDLIFE SERVICE.
AERIAL PHOTOGRAPH FROM ESRI (2018).



NO NWI WETLANDS MAPPED IN STUDY AREA



PREPARED FOR: AKANA.

PBS

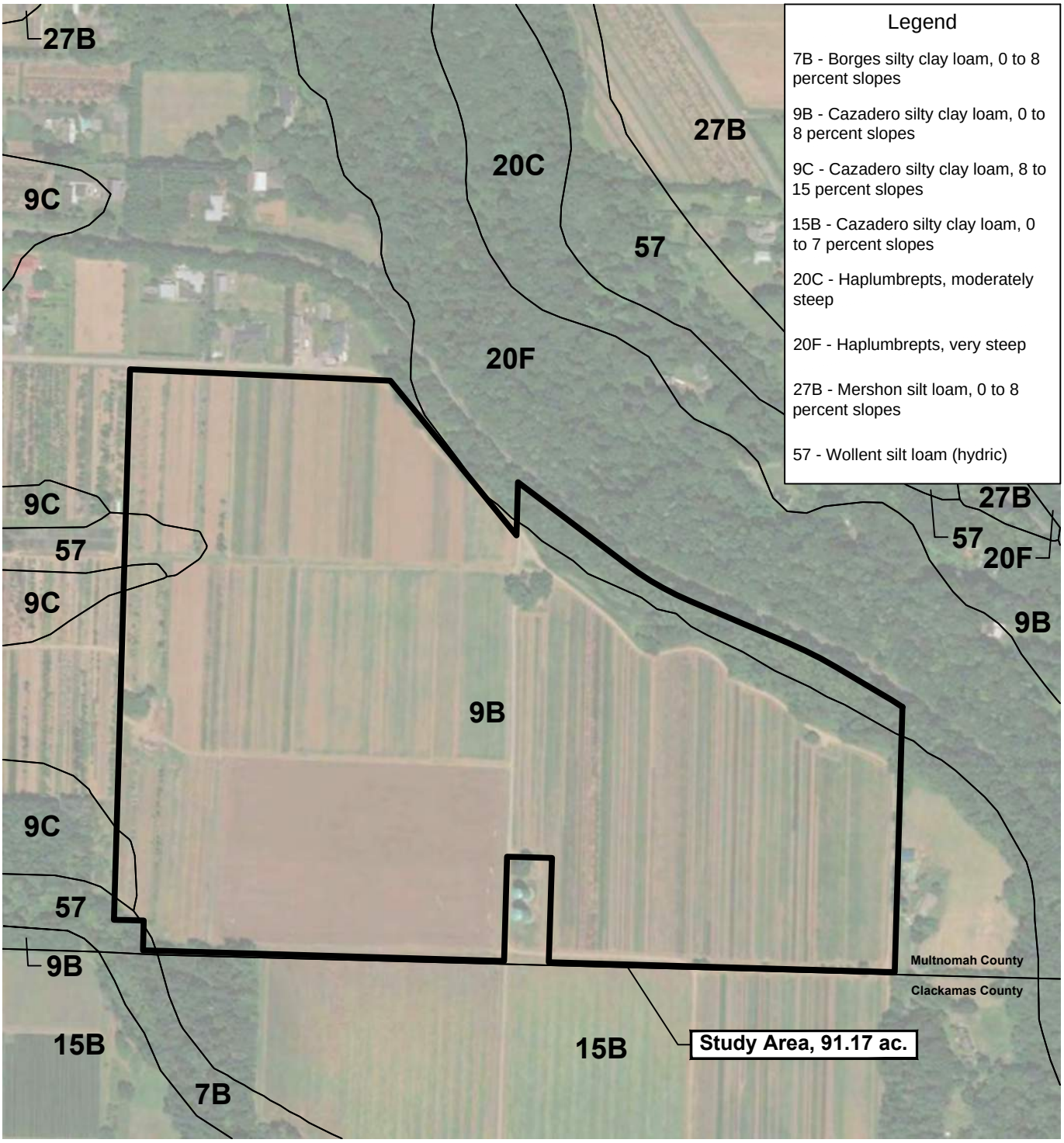
NATIONAL WETLANDS INVENTORY MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

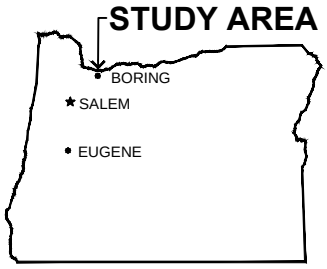
JAN 2018
75350.000

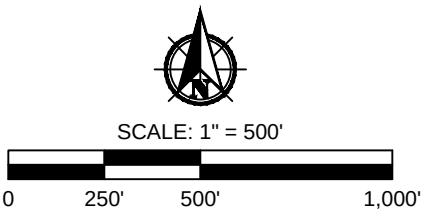
FIGURE
3

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:04:51 PM



SOURCE: SOIL MAPPING UNITS FROM NRCS. AERIAL PHOTOGRAPH FROM ESRI (2018).





PREPARED FOR: AKANA.

PBS

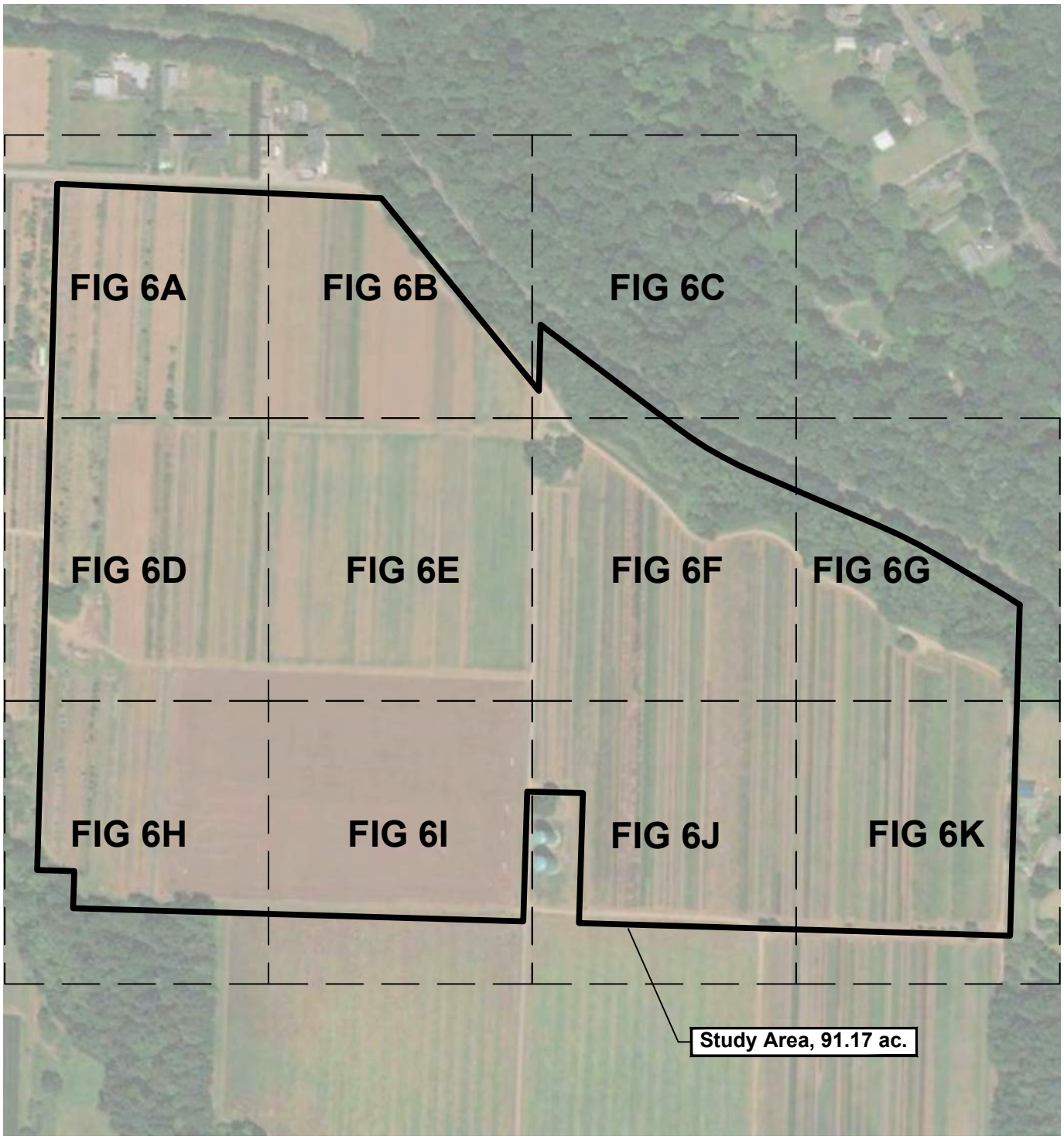
COUNTY SOIL SURVEY MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

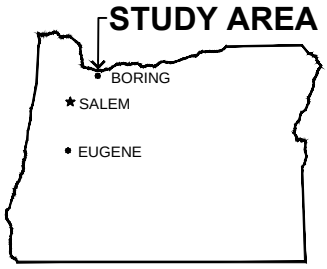
JAN 2018
75350.000

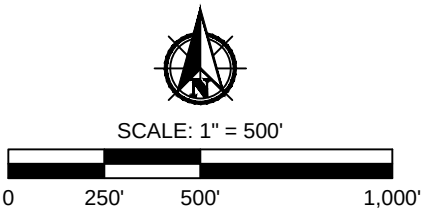
FIGURE
4

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:05:00 PM



SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).





PREPARED FOR: AKANA.

PBS

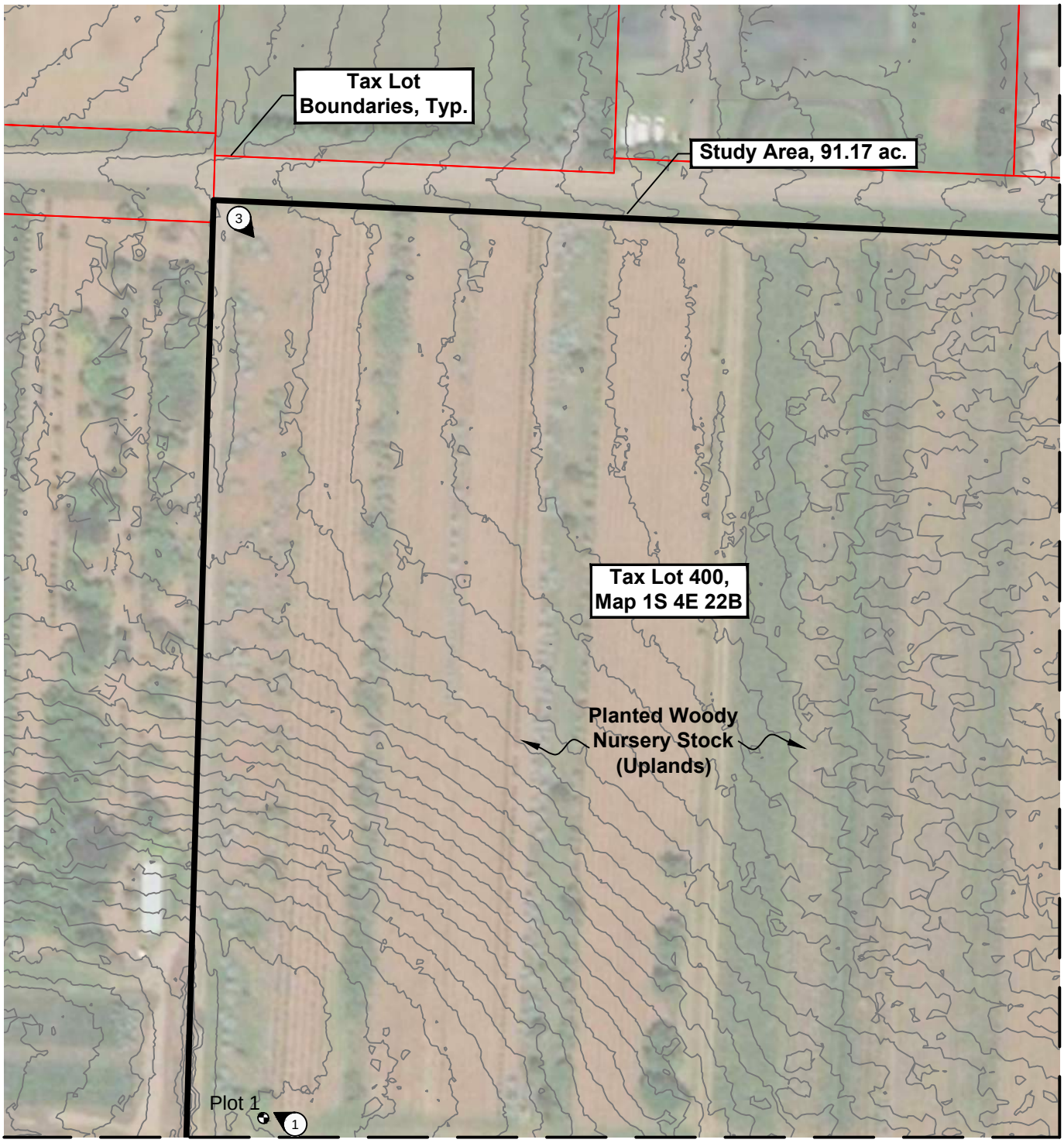
AERIAL PHOTOGRAPH & INSET MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

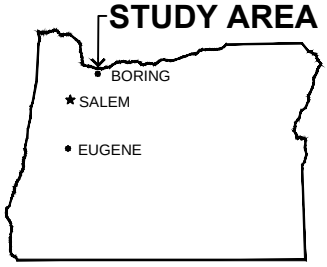
FIGURE
5

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:05:10 PM



MATCHLINE TO FIG 6D

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018). CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

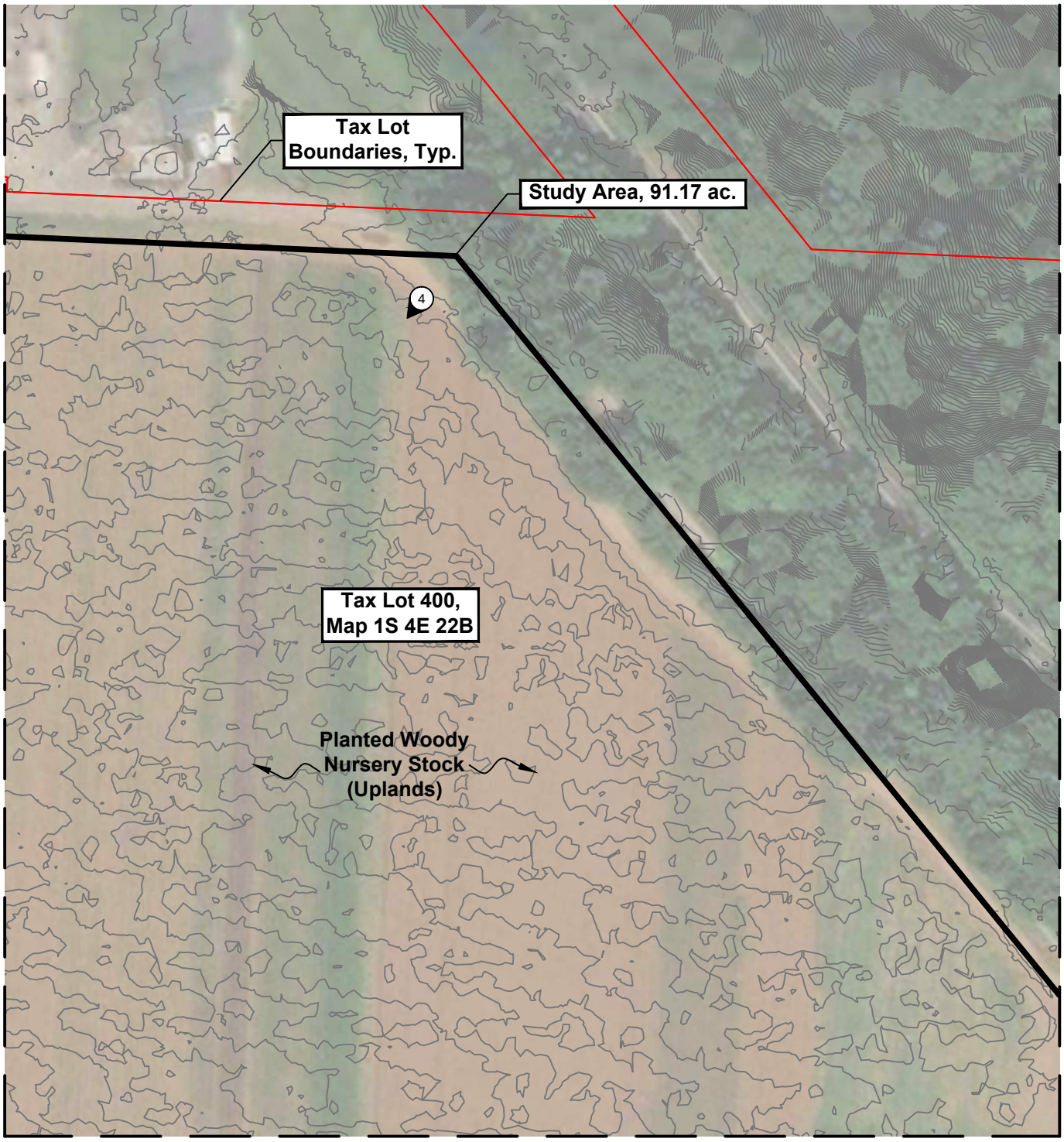
WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

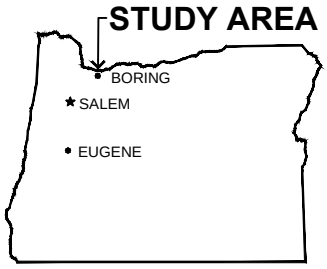
JAN 2018
75350.000

FIGURE
6A

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:05:23 PM



SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

N

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

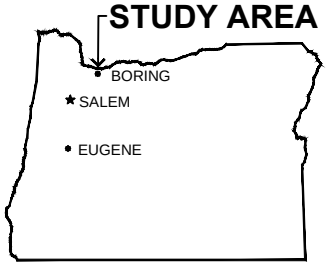
TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

FIGURE
6B

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:05:32 PM

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018). CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

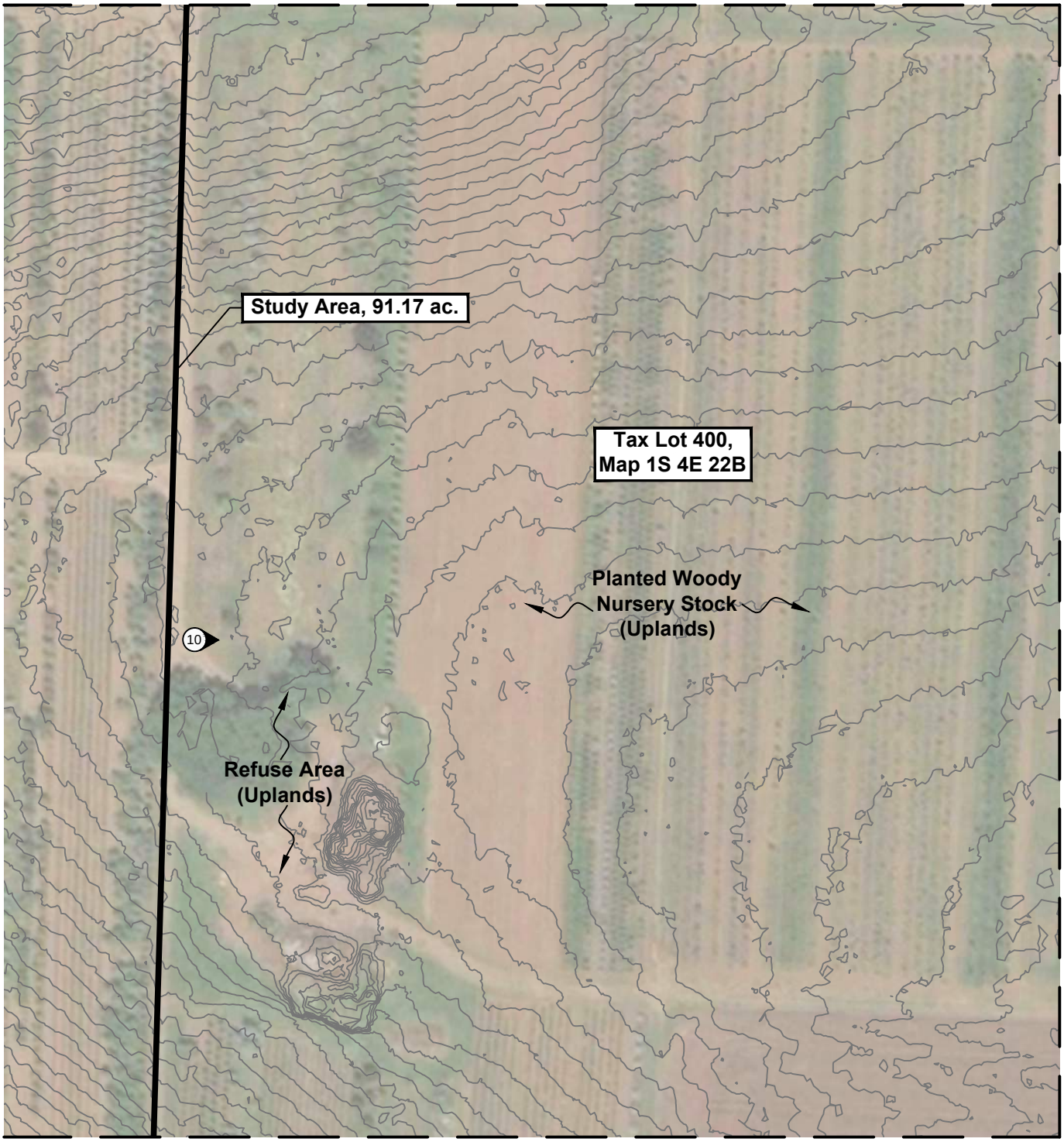
TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

FIGURE
6C

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:05:42 PM

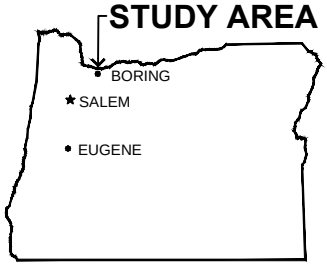
MATCHLINE TO FIG 6A



MATCHLINE TO FIG 6E

MATCHLINE TO FIG 6H

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

N

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

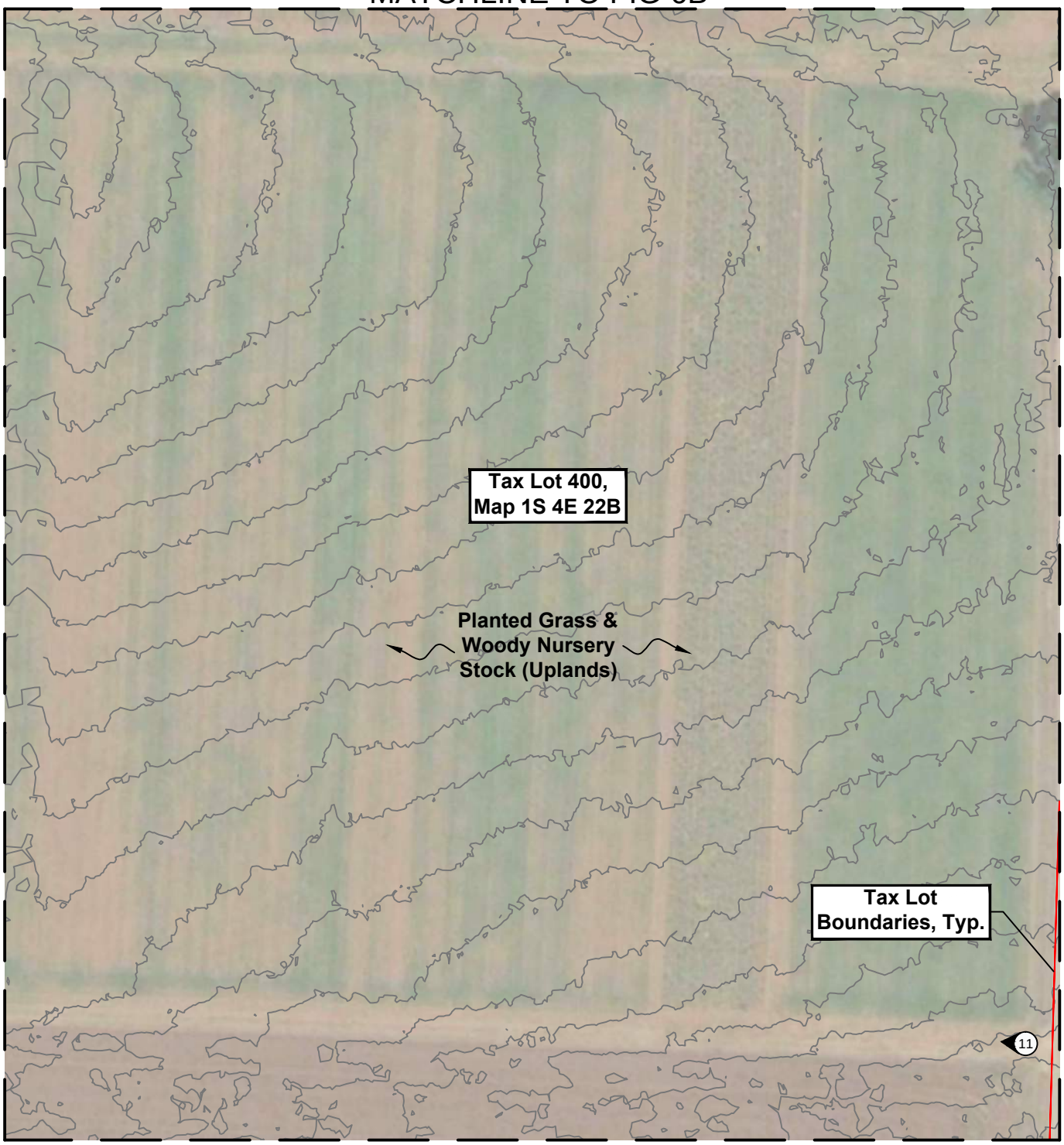
FIGURE
6D

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:05:52 PM

MATCHLINE TO FIG 6B

MATCHLINE TO FIG 6D

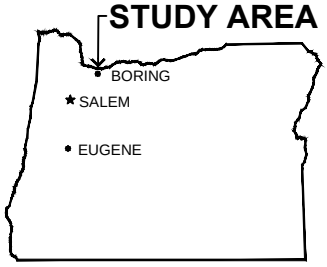
MATCHLINE TO FIG 6F



MATCHLINE TO FIG 6I

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.

STUDY AREA



OREGON

Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

N

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

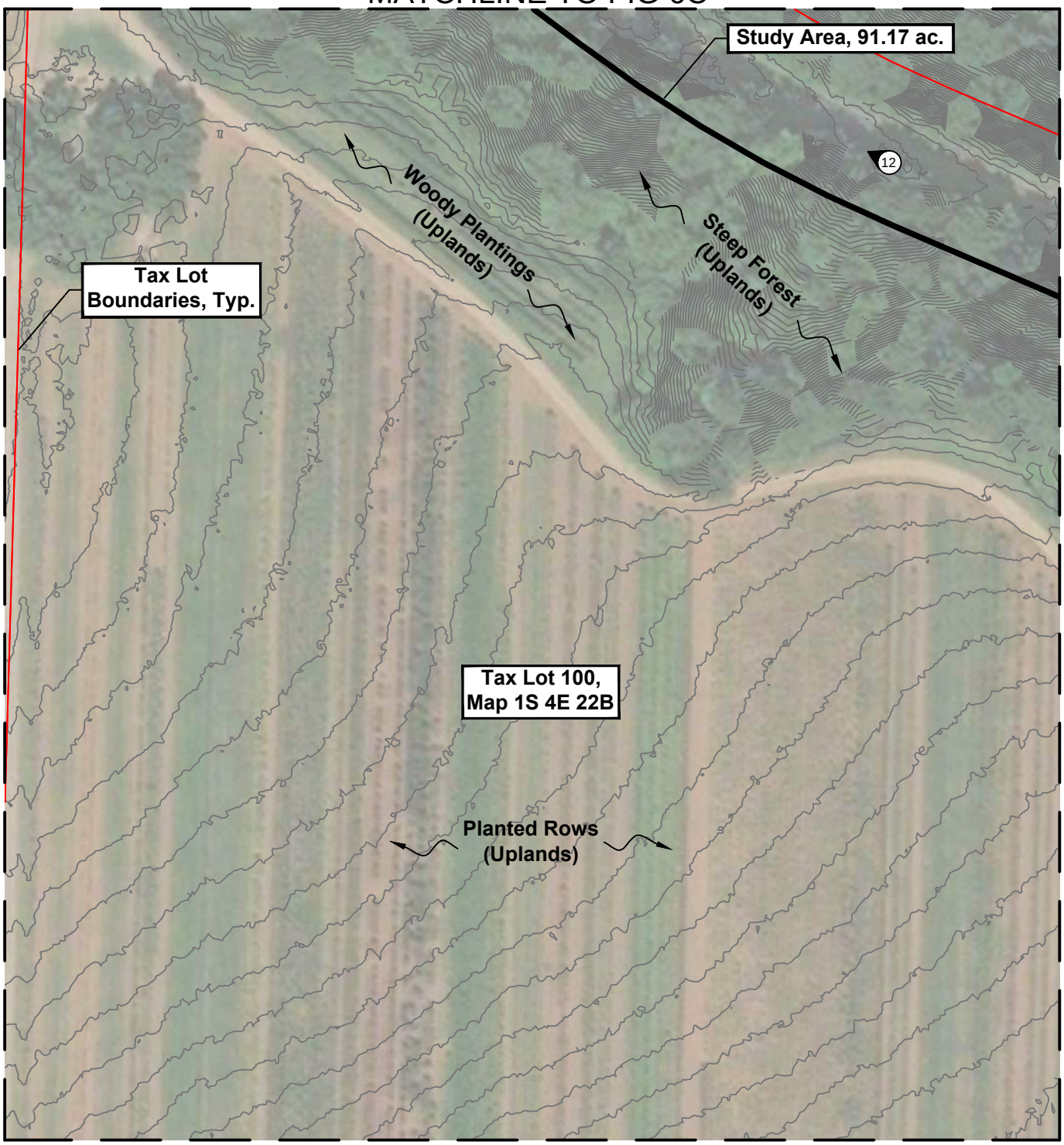
TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

FIGURE
6E

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:06:03 PM

MATCHLINE TO FIG 6C



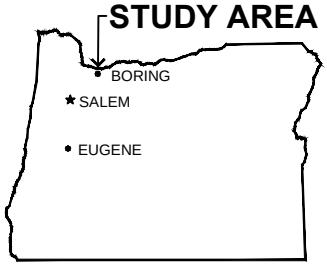
MATCHLINE TO FIG 6E

MATCHLINE TO FIG 6G

MATCHLINE TO FIG 6J

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018). CONTOURS DERIVED FROM LIDAR.

STUDY AREA



OREGON

Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

N

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION

BORING, MULTNOMAH COUNTY, OREGON

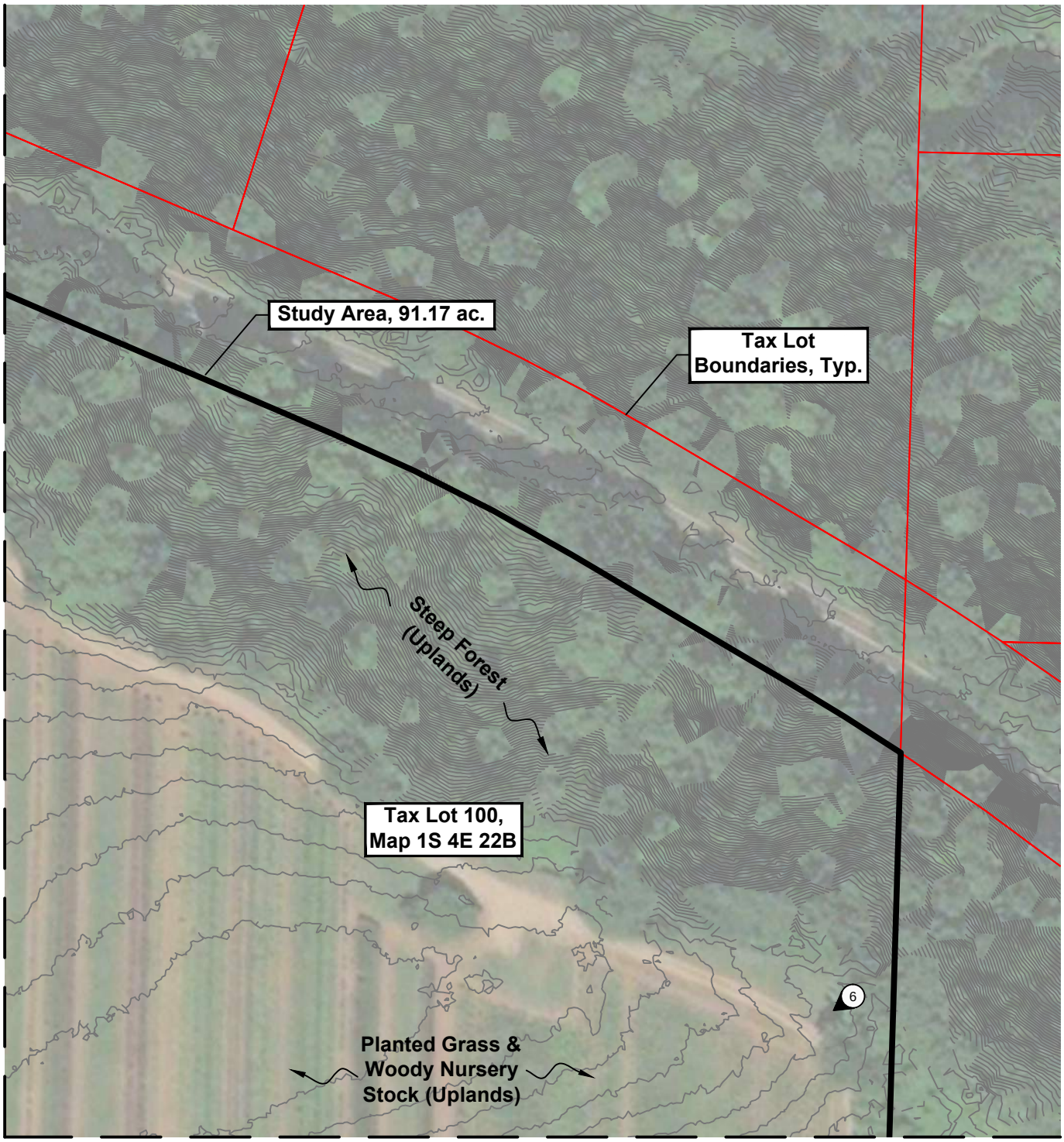
JAN 2018

75350.000

FIGURE

6F

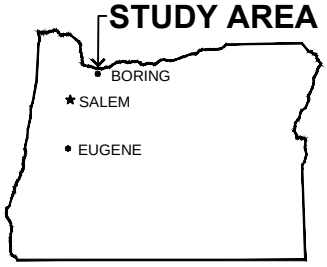
Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:06:12 PM



MATCHLINE TO FIG 6F

MATCHLINE TO FIG 6K

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018). CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION

BORING, MULTNOMAH COUNTY, OREGON

JAN 2018

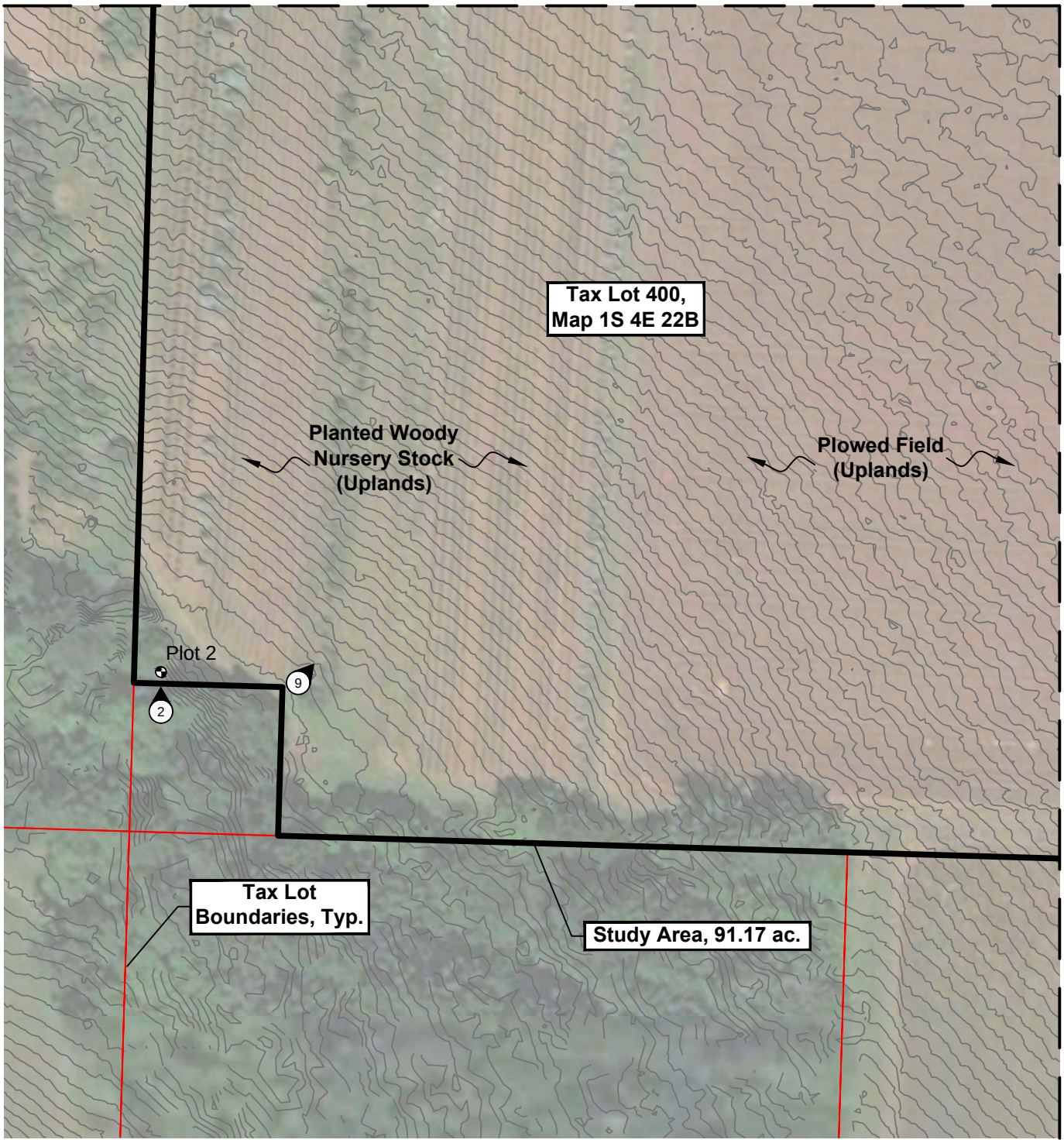
75350.000

FIGURE

6G

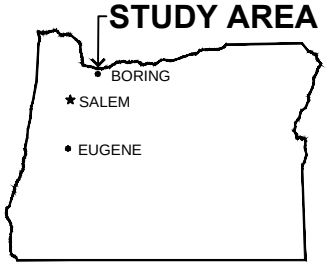
Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:06:22 PM

MATCHLINE TO FIG 6D



MATCHLINE TO FIG 6I

SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

N

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

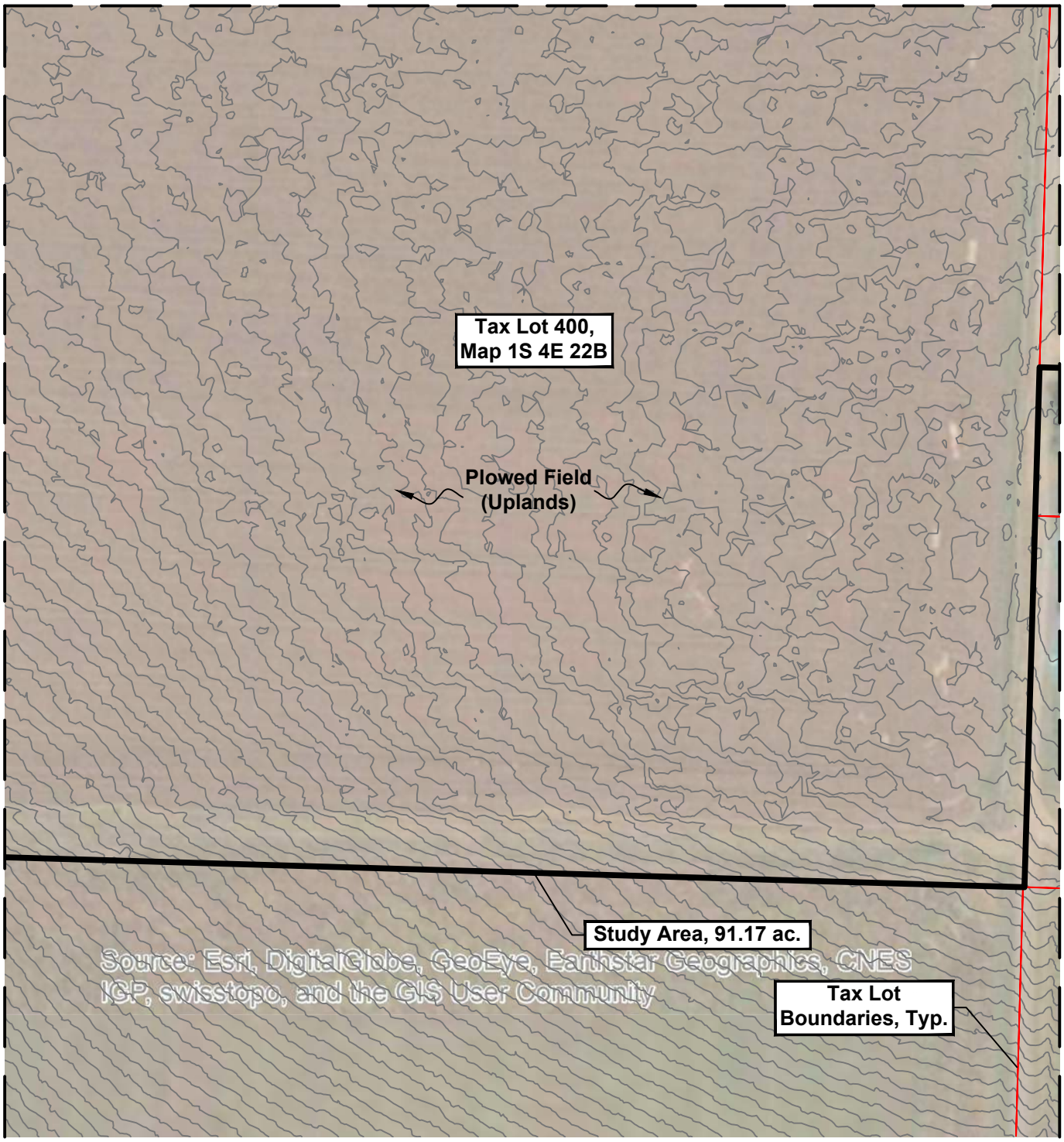
FIGURE
6H

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:06:31 PM

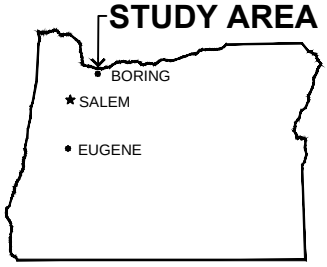
MATCHLINE TO FIG 6E

MATCHLINE TO FIG 6H

MATCHLINE TO FIG 6J



SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph (None this figure)

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

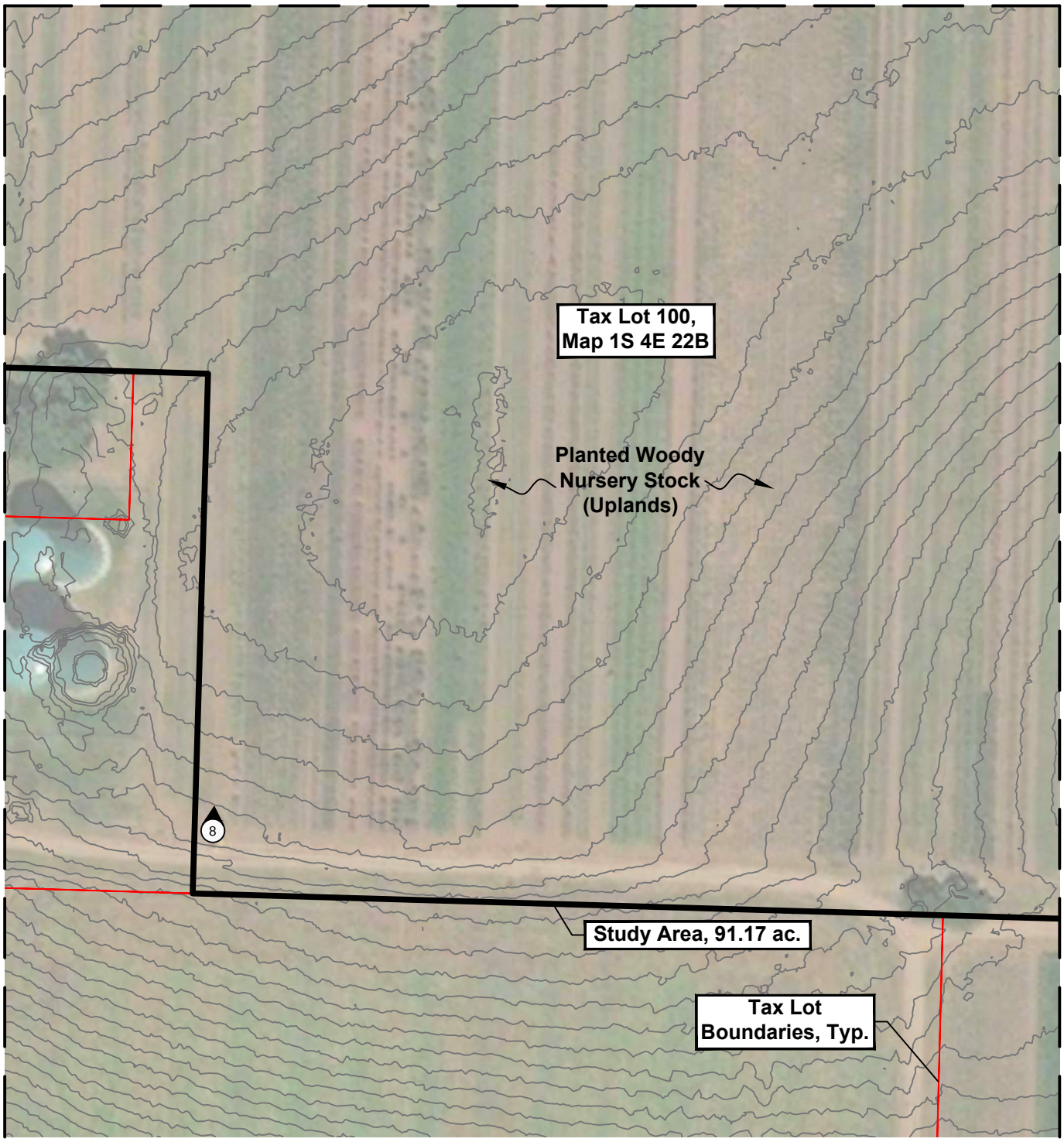
FIGURE
6I

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:06:41 PM

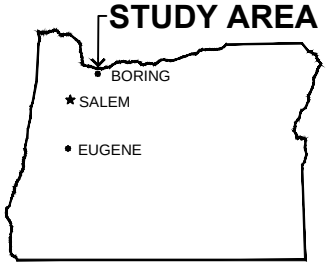
MATCHLINE TO FIG 6F

MATCHLINE TO FIG 6I

MATCHLINE TO FIG 6K



SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

N

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

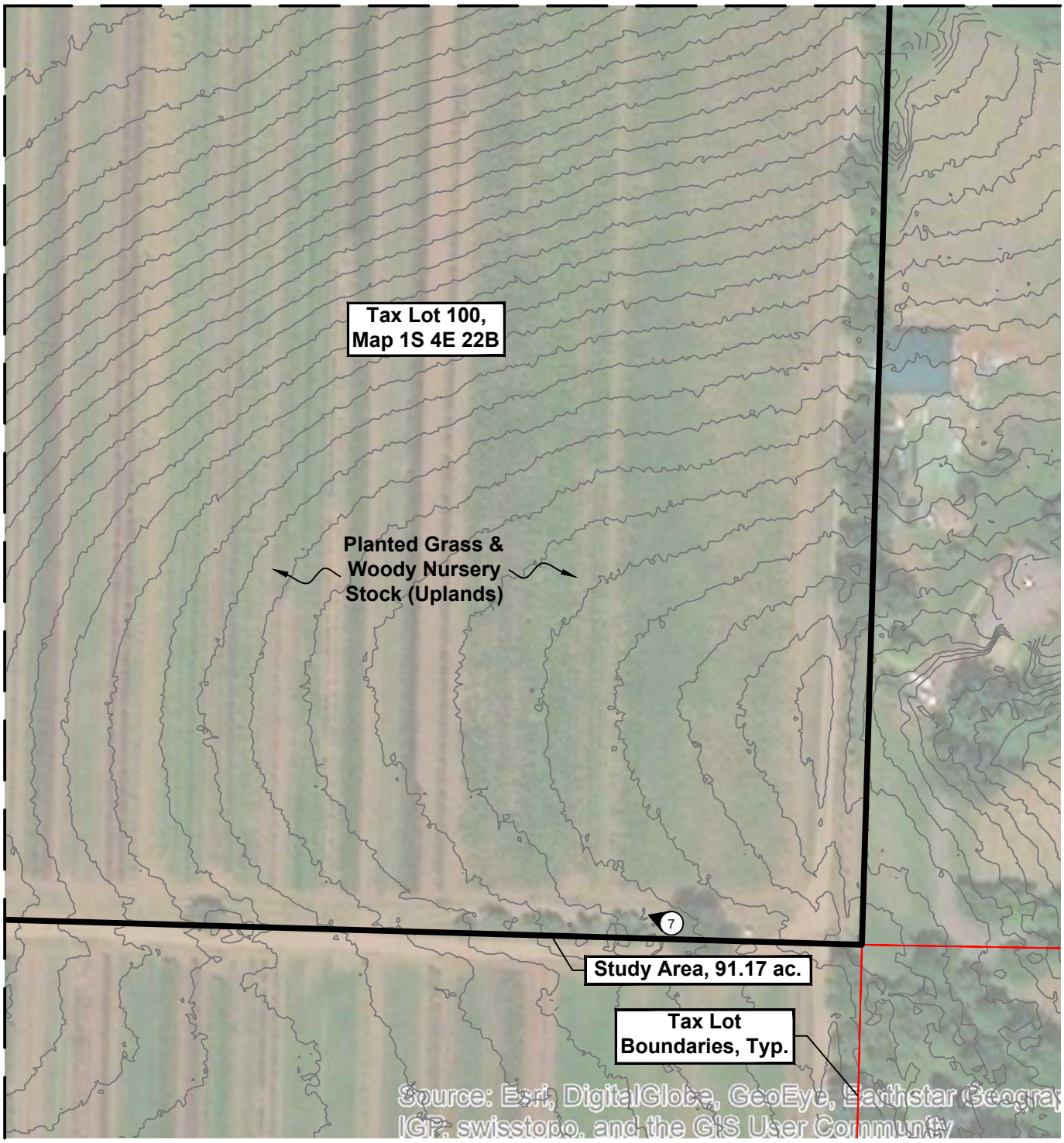
JAN 2018
75350.000

FIGURE
6J

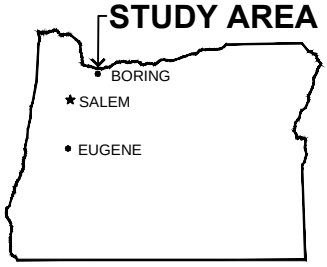
Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:06:53 PM

MATCHLINE TO FIG 6G

MATCHLINE TO FIG 6J



SOURCE: AERIAL PHOTOGRAPH FROM ESRI (2018).
CONTOURS DERIVED FROM LIDAR.



Legend

Plot 1 — Wetland Determination Plot (No wetlands or waters documented)

1 — Ground Level Photograph

Sample plots and photo points were mapped using a Trimble Geo7X handheld GPS unit with submeter accuracy after post-processing.

SCALE: 1" = 100'

0 50' 100' 200'

PREPARED FOR: AKANA.

PBS

WETLAND DETERMINATION MAP

TAX LOTS 100 & 400 MAP NO. 1S 4E 22D WETLAND DETERMINATION
BORING, MULTNOMAH COUNTY, OREGON

JAN 2018
75350.000

FIGURE
6K

Filename: L:\Projects\75000\75300-75399\75350\75350-000\GIS\CAD\CarpenterLn.dwg CAD Plot Date/Time: 1/27/2018 5:07:01 PM

APPENDIX B

Data Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site:	Tax Lots 100 & 400, Map No. 1S 4E 22D	City/County:	Boring / Multnomah	Sampling Date:	1/12/2018
Applicant/Owner:	Akana	State:	Oregon	Sampling Point:	Plot 1
Investigator(s):	G. Swenson	Section/Township/Range:	Sec. 22, T. 1S, R. 4E		
Landform (hillslope, terrace etc.):	Very subtle swale w/in hillslope	Local relief:	Sl. concave	Slope (%):	5
Subregion (LRR):	A - Northwest Forests and Coast	Lat: 45.465077	Long: -122.300448	Datum:	WGS84
Soil Map Unit Name:	Wollent silt loam	NWI Classification:	None		

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks)

Are Vegetation ___ ,Soil ___ , or Hydrology ___ significantly disturbed?

Are Vegetation ___ ,Soil ___ , or Hydrology ___ naturally problematic?

Are "Normal Circumstances" present? (If needed, explain any answers in remarks) Yes X No ___

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	X	No	
Hydric Soil Present?	Yes		No	X
Wetland Hydrology Present?	Yes		No	X

Is the Sampled Area within a wetland? **Yes** ___ **No** X

Remarks: Northwest part of study area, 615 feet south of north study area boundary and 50 feet east of west study area boundary.

VEGETATION - Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 30' r)			
1.			
2.			
3.			
4.			
Total Cover:	0		
Sapling/Shrub Stratum (Plot size: 30' r)			
1. *Picea pungens*	10	Yes	FAC
2.			
3.			
4.			
5.			
Total Cover:	10		
Herb Stratum (Plot size: 5' r)			
1. *Lolium perenne*	48	Yes	FAC
2. *Trifolium repens*	30	Yes	FAC
3. *Plantago lanceolata*	10	No	FACU
4. *Taraxacum officinale*	5	No	FACU
5. *Plantago major*	2	No	FAC
6. *Vicia sp.*	2	No	(FACU)
7. *Rumex crispus*	1	No	FAC
8.			
Total Cover:	98		
Woody Vine Stratum (Plot Size: 30' r)			
1.			
2.			
Total Cover:	0		

% Bare Ground in Herb Stratum 2 %

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:			Multiply by:
OBL species	0	x 1 =	
FACW species	0	x 2 =	
FAC species	91	x 3 =	273
FACU species	15	x 4 =	60
UPL species	0	x 5 =	
Column Totals:	106 (A)		333 (B)

Prevalence Index = B/A = 3.14

Hydrophytic Vegetation Indicators:

	1- Rapid Test for Hydrophytic Vegetation
X	2- Dominance Test is >50%
	3- Prevalence Index is ≤3.0[1]
	4- Morphological Adaptations1 (Provide supporting data in Remarks or on a separate sheet)
	5- Wetland Non-Vascular Plants[1]
	Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks:

Blue Spruce is planted. Indicator status in parentheses is estimated. Herbaceous vegetation appears to be less distubed and therefore reliable.

SOIL

Sampling Point: Plot 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

	Matrix		Redox Features					
Depth (in.)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-10.5	7.5YR 3/4	100					sicl	moist
10.5-20+	7.5YR 3/3	100					sicl	moist

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present?

Yes ___ **No** **X**

Remarks:

10.5-20+" horizon has 5% 2.5YR 4/8 sandy parent material inclusions.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D4)

Field Observations:

Surface Water Present?	Yes	___	No	X	Depth (in): ___
Water Table Present?	Yes	___	No	X	Depth (in): >20
Saturation Present? (includes capillary fringe)	Yes	___	No	X	Depth (in): >20

Wetland Hydrology Present?

Yes ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial photograph

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site:	Tax Lots 100 & 400, Map No. 1S 4E 22D	City/County:	Boring / Multnomah	Sampling Date:	1/12/2018
Applicant/Owner:	Akana	State:	Oregon	Sampling Point:	Plot 2
Investigator(s):	G. Swenson	Section/Township/Range:	Sec. 22, T. 1S, R. 4E		
Landform (hillslope, terrace etc.):	Hillslope	Local relief:	Convex	Slope (%):	18
Subregion (LRR):	A - Northwest Forests and Coast	Lat: 45.461720	Long: -122.300610	Datum:	WGS84
Soil Map Unit Name:	Wollent silt loam	NWI Classification:	None		

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed?

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic?

Are "Normal Circumstances" present? (If needed, explain any answers in remarks) Yes X No ___

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X	**Is the Sampled Area within a wetland?**	**Yes** ___ **No** X
Hydric Soil Present?	Yes ___	No X		
Wetland Hydrology Present?	Yes ___	No X		

Remarks: Southwest corner of study area, 10 feet north of south study area boundary and 20 feet east of west study area boundary.

VEGETATION - Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 30' r)			
1. *Alnus rubra*	40	Yes	FAC
2.			
3.			
4.			
Total Cover:	40		
Sapling/Shrub Stratum (Plot size: 30' r)			
1. *Rubus armeniacus*	15	Yes	FAC
2. *Rubus ursinus*	10	Yes	FACU
3.			
4.			
5.			
Total Cover:	25		
Herb Stratum (Plot size: 5' r)			
1. *Polystichum munitum*	10	Yes	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
Total Cover:	10		
Woody Vine Stratum (Plot Size: 30' r)			
1.			
2.			
Total Cover:	0		

% Bare Ground in Herb Stratum 90 %

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:			Multiply by:
OBL species	0	x 1 =	
FACW species	0	x 2 =	
FAC species	55	x 3 =	165
FACU species	20	x 4 =	80
UPL species	0	x 5 =	
Column Totals:	75 (A)		245 (B)

Prevalence Index = B/A = 3.27

Hydrophytic Vegetation Indicators:

- 1- Rapid Test for Hydrophytic Vegetation
- 2- Dominance Test is >50%
- 3- Prevalence Index is ≤3.0[1]
- 4- Morphological Adaptations1 (Provide supporting data in Remarks or on a separate sheet)
- 5- Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ___ **No** X

Remarks:

Plot is in forested area with reliable vegetation.

SOIL

Sampling Point: Plot 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

	Matrix		Redox Features					
Depth (in.)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	7.5YR 2.5/3	100					cl	moist
12-20+	5YR 4/6	100					cl	moist

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Sandy Mucky Mineral (S1)
- ____ Sandy Gleyed Matrix (S4)
- ____ Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ____ Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ____ 2 cm Muck (A10)
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____

Depth (inches): ____

Hydric Soil Present?

Yes ____ **No** **X**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ____ Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Surface Soil Cracks (B6)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
- ____ Salt Crust (B11)
- ____ Aquatic Invertebrates (B13)
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres along Living Roots (C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Stunted or Stressed Plants (D1) (**LRR A**)
- ____ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ____ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
- ____ Drainage Patterns (B10)
- ____ Dry-Season Water Table (C2)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- ____ FAC-Neutral Test (D5)
- ____ Raised Ant Mounds (D6) (**LRR A**)
- ____ Frost-Heave Hummocks (D4)

Field Observations:

Surface Water Present?	Yes	____	No	X	Depth (in): ____
Water Table Present?	Yes	____	No	X	Depth (in): >20
Saturation Present? (includes capillary fringe)	Yes	____	No	X	Depth (in): >20

Wetland Hydrology Present?

Yes ____ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial photograph

Remarks:

APPENDIX C

Ground Level Color Photographs

Photo 1. Panoramic photo of the northwest part of the study area (upland). View is to the northwest. Sample plot 1 is visible left of center. Photo taken January 12, 2018.

Photo 2. Panoramic photo of the southwest part of the study area (upland). View is to the north. Sample plot 2 is visible in the center. Photo taken January 12, 2018.

Photo 3. Panoramic photo of the northwest part of the study area (upland). View is to the southeast. Photo taken January 12, 2018.

Photo 4. Panoramic photo of the northwest part of the study area (upland). View is to the southwest. Photo taken January 12, 2018.

Photo 5. Panoramic photo of the north-central part of the study area (upland). View is to the south. Photo taken January 12, 2018.

Photo 6. Panoramic photo of the northeast part of the study area (upland). View is to the southeast. Photo taken January 12, 2018.

Photo 7. Panoramic photo of the southeast part of the study area (upland). View is to the northwest. Photo taken January 12, 2018.

Photo 8. Panoramic photo of the south part of the study area (upland). View is to the north. Photo taken January 12, 2018.

Photo 9. Panoramic photo of the southwest part of the study area (upland). View is to the northeast. Photo taken January 12, 2018.

Photo 10. Panoramic photo of the west part of the study area (upland). View is to the east. Photo taken January 12, 2018.

Photo 11. Panoramic photo of the central part of the study area (upland). View is to the west. Photo taken January 12, 2018.

Photo 12. Photo of the north part of the study area (upland). View is to the northeast. Photographer is offsite but photo is representative of steeply sloping forest land along the north edge of the study area. Photo taken January 12, 2018.

APPENDIX D

Additional Tables and Information

Explanation of the Preliminary Monthly Climate Data (F6) Product

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - http://www.ncdc.noaa.gov.

WFO Monthly/Daily Climate Data

```
568
CXUS56 KPQR 261200
CF6PDX
PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

                                          STATION:   PORTLAND OR
                                          MONTH:     JANUARY
                                          YEAR:      2018
                                          LATITUDE:   45 35 N
                                          LONGITUDE: 122 36 W

  TEMPERATURE IN F:        :PCPN:    SNOW:  WIND      :SUNSHINE: SKY     :PK WND
==============================================================================
1   2   3   4   5  6A  6B    7    8   9   10  11  12  13   14  15   16   17  18
                                     12Z  AVG MX 2MIN
DY MAX MIN AVG DEP HDD CDD  WTR  SNW DPTH SPD SPD DIR MIN PSBL S-S WX    SPD DR
==============================================================================

 1  46  29  38  -2  27   0 0.00  0.0    0  6.0 17 110   M    M   6 12     21 110
 2  44  30  37  -3  28   0 0.00  0.0    0 11.7 24 110   M    M   8        30 110
 3  47  34  41   1  24   0 0.00  0.0    0 10.9 22 110   M    M   7        30 120
 4  45  39  42   2  23   0 0.05  0.0    0  9.6 24 120   M    M   9        30 120
 5  53  39  46   6  19   0 0.22  0.0    0 13.8 24 190   M    M   7 1      31 200
 6  50  38  44   4  21   0 0.06  0.0    0  2.8 17 220   M    M   7 1      22 220
 7  45  39  42   2  23   0 0.12  0.0    0  5.6 13 120   M    M  10        15 120
 8  45  35  40  -1  25   0 0.07  0.0    0  2.6  9 100   M    M   8 1      12 130
 9  49  41  45   4  20   0 0.51  0.0    0  3.7  9 290   M    M  10 1      11 290
10  48  42  45   4  20   0 0.04  0.0    0  6.6 14 110   M    M  10 1      17 110
11  58  46  52  11  13   0 0.59  0.0    0 13.6 28 200   M    M  10 1      40 200
12  54  48  51  10  14   0 0.07  0.0    0  9.4 18 200   M    M   9 18     24 190
13  59  41  50   9  15   0 0.00  0.0    0  2.5  8 320   M    M   6 12      9 310
14  58  39  49   8  16   0 0.00  0.0    0 11.5 23 100   M    M   5 128    28 100
15  57  42  50   9  15   0 0.08  0.0    0 13.9 35 100   M    M   8 1      41  80
16  57  42  50   8  15   0 0.04    M    0 10.2 20 120   M    M   8 1      23 120
17  52  45  49   7  16   0 0.52    M    0 12.8 22 110   M    M  10 1      28 120
18  52  41  47   5  18   0 0.17    M    0  9.5 24 170   M    M   9 1      30 180
19  49  40  45   3  20   0 0.03  0.0    0 12.3 22 200   M    M   9        28 210
20  50  43  47   5  18   0 0.01    M    0 11.1 20 190   M    M   9        25 190
21  51  42  47   5  18   0 0.20    M    0 10.3 28 180   M    M   8 1      35 180
22  50  40  45   3  20   0 0.11    M    0  7.6 20 300   M    M   7 1      24 280
23  49  42  46   4  19   0 0.68    M    0 13.2 21 110   M    M  10 1      25 110
24  52  42  47   5  18   0 0.62    M    0 11.0 26 190   M    M  10 1      32 210
25  46  38  42   0  23   0 0.33    M    0 12.8 24 200   M    M   9 1      30 210
==============================================================================
SM 1266  997       488   0  4.52     0.0 235.0          M      209
==============================================================================
AV 50.6 39.9                                 9.4 FASTST   M    M   8    MAX(MPH)
                                 MISC ---->  # 35 100                # 41   80
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NOTES:
LAST OF SEVERAL OCCURRENCES

COLUMN 17 PEAK WIND IN M.P.H.

PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6) , PAGE 2

STATION: PORTLAND OR
MONTH: JANUARY
YEAR: 2018
LATITUDE: 45 35 N
LONGITUDE: 122 36 W

[TEMPERATURE DATA]

AVERAGE MONTHLY: 45.3
DPTR FM NORMAL: 4.1
HIGHEST: 59 ON 13
LOWEST: 29 ON 1

[PRECIPITATION DATA]

TOTAL FOR MONTH: 4.52
DPTR FM NORMAL: 0.49
GRTST 24HR 0.68 ON 23-23

SNOW, ICE PELLETS, HAIL
TOTAL MONTH: 0.0 INCH
GRTST 24HR 0.0
GRTST DEPTH: 0

SYMBOLS USED IN COLUMN 16

1 = FOG OR MIST
2 = FOG REDUCING VISIBILITY TO 1/4 MILE OR LESS
3 = THUNDER
4 = ICE PELLETS
5 = HAIL
6 = FREEZING RAIN OR DRIZZLE
7 = DUSTSTORM OR SANDSTORM: VSBY 1/2 MILE OR LESS
8 = SMOKE OR HAZE
9 = BLOWING SNOW
X = TORNADO

[NO. OF DAYS WITH]

MAX 32 OR BELOW: 0
MAX 90 OR ABOVE: 0
MIN 32 OR BELOW: 2
MIN 0 OR BELOW: 0

[WEATHER - DAYS WITH]

0.01 INCH OR MORE: 20
0.10 INCH OR MORE: 11
0.50 INCH OR MORE: 5
1.00 INCH OR MORE: 0

[HDD (BASE 65)]
TOTAL THIS MO. 488
DPTR FM NORMAL -109
TOTAL FM JUL 1 2189
DPTR FM NORMAL -140

CLEAR (SCALE 0-3) 0
PTCLDY (SCALE 4-7) 10
CLOUDY (SCALE 8-10) 15

[CDD (BASE 65)]
TOTAL THIS MO. 0
DPTR FM NORMAL 0
TOTAL FM JAN 1 0
DPTR FM NORMAL 0

[PRESSURE DATA]
HIGHEST SLP M ON M
LOWEST SLP 29.61 ON 9

[REMARKS]

Explanation of the Preliminary Monthly Climate Data (F6) Product

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - http://www.ncdc.noaa.gov.

WFO Monthly/Daily Climate Data

668
CXUS56 KPQR 241518
CF6PDX
PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

STATION: PORTLAND OR
MONTH: DECEMBER
YEAR: 2017
LATITUDE: 45 35 N
LONGITUDE: 122 36 W

TEMPERATURE IN F:							:PCPN:	SNOW:		WIND			:SUNSHINE:		SKY		:PK WND	
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
									12Z	AVG	MX	2MIN						
DY	MAX	MIN	AVG	DEP	HDD	CDD	WTR	SNW	DPTH	SPD	SPD	DIR	MIN	PSBL	S-S	WX	SPD	DR
1	50	45	48	5	17	0	0.02	0.0	0	6.5	16	200	M	M	10	1	21	210
2	47	43	45	3	20	0	0.28	0.0	0	7.5	16	200	M	M	10	1	20	210
3	47	39	43	1	22	0	0.07	0.0	0	3.8	10	270	M	M	8	1	13	280
4	46	38	42	0	23	0	T	0.0	0	4.0	9	320	M	M	8		12	320
5	50	34	42	0	23	0	0.00	0.0	0	4.2	17	90	M	M	4	1	22	80
6	52	38	45	3	20	0	0.00	0.0	0	15.8	35	90	M	M	0		41	90
7	50	37	44	3	21	0	0.00	0.0	0	17.1	26	100	M	M	0		35	110
8	45	33	39	-2	26	0	0.00	0.0	0	10.7	20	130	M	M	3		23	130
9	46	26	36	-5	29	0	0.00	0.0	0	8.8	20	120	M	M	2		24	110
10	45	27	36	-5	29	0	0.00	0.0	0	11.3	23	110	M	M	2		29	100
11	44	30	37	-3	28	0	0.00	0.0	0	11.6	21	110	M	M	1		27	100
12	45	25	35	-5	30	0	0.00	0.0	0	4.1	12	140	M	M	5		13	140
13	46	29	38	-2	27	0	0.00	0.0	0	7.8	20	110	M	M	3		23	120
14	44	32	38	-2	27	0	0.00	0.0	0	11.0	22	100	M	M	4		25	100
15	40	32	36	-4	29	0	T	0.0	0	3.9	15	120	M	M	8	18	18	120
16	45	37	41	1	24	0	0.02	0.0	0	3.8	9	140	M	M	10	1	12	140
17	49	41	45	5	20	0	0.02	0.0	0	6.6	12	190	M	M	10	1	15	190
18	53	47	50	10	15	0	0.02	0.0	0	7.3	21	200	M	M	10	1	26	200
19	53	41	47	7	18	0	0.50	0.0	0	12.2	26	190	M	M	9	1	35	180
20	46	30	38	-2	27	0	0.03	0.0	0	8.7	22	200	M	M	5	1	27	200
21	37	26	32	-8	33	0	0.00	0.0	0	3.0	7	260	M	M	8	12	9	130
22	40	34	37	-3	28	0	0.42	0.0	0	4.7	15	110	M	M	10	12	17	110
23	40	34	37	-3	28	0	0.13	T	0	15.1	24	100	M	M	9	1	31	80
24	35	28	32	-8	33	0	0.25	1.0	0	15.7	25	100	M	M	9	156	32	110
25	33	28	31	-9	34	0	0.10	0.0	1	8.1	18	130	M	M	10	16	22	130
26	35	23	29	-11	36	0	T	0.0	1	5.8	14	120	M	M	6	6	17	110
27	37	31	34	-6	31	0	0.05	0.0	0	7.7	13	110	M	M	10	16	16	120
28	53	37	45	5	20	0	0.66	0.0	0	9.3	17	120	M	M	10	1	22	180
29	56	49	53	13	12	0	0.52	0.0	0	13.8	29	200	M	M	10	1	37	190
30	52	34	43	3	22	0	0.00	0.0	0	2.6	15	220	M	M	5	12	17	230

```
31  50  31  41   1  24   0 0.00  0.0    0  9.2 22 100   M    M   7 2      29 100
================================================================================
SM 1411 1059       776   0  3.09     1.0 261.7          M      206
================================================================================
AV 45.5 34.2                                8.4 FASTST   M    M   7    MAX(MPH)
                                  MISC ---->  # 35  90               # 41   90
================================================================================
NOTES:
# LAST OF SEVERAL OCCURRENCES

COLUMN 17 PEAK WIND IN M.P.H.

PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6) , PAGE 2

                                          STATION:  PORTLAND OR
                                          MONTH:    DECEMBER
                                          YEAR:     2017
                                          LATITUDE:   45 35 N
                                          LONGITUDE: 122 36 W

[TEMPERATURE DATA]       [PRECIPITATION DATA]       SYMBOLS USED IN COLUMN 16

AVERAGE MONTHLY: 39.8   TOTAL FOR MONTH:   3.09    1 = FOG OR MIST
DPTR FM NORMAL:  -0.6   DPTR FM NORMAL:   -2.40    2 = FOG REDUCING VISIBILITY
HIGHEST:    56 ON 29    GRTST 24HR  0.66 ON 28-28      TO 1/4 MILE OR LESS
LOWEST:     23 ON 26                               3 = THUNDER
                        SNOW, ICE PELLETS, HAIL    4 = ICE PELLETS
                        TOTAL MONTH:   1.0 INCH    5 = HAIL
                        GRTST 24HR   1.0 ON 24-24  6 = FREEZING RAIN OR DRIZZLE
                        GRTST DEPTH:   1 ON 26,25  7 = DUSTSTORM OR SANDSTORM:
                                                       VSBY 1/2 MILE OR LESS
                                                   8 = SMOKE OR HAZE
[NO. OF DAYS WITH]       [WEATHER - DAYS WITH]     9 = BLOWING SNOW
                                                   X = TORNADO
MAX 32 OR BELOW:   0    0.01 INCH OR MORE:  15
MAX 90 OR ABOVE:   0    0.10 INCH OR MORE:   8
MIN 32 OR BELOW:  14    0.50 INCH OR MORE:   3
MIN  0 OR BELOW:   0    1.00 INCH OR MORE:   0

[HDD (BASE 65) ]
TOTAL THIS MO.   776    CLEAR  (SCALE 0-3)   7
DPTR FM NORMAL    13    PTCLDY (SCALE 4-7)  10
TOTAL FM JUL 1  1701    CLOUDY (SCALE 8-10) 14
DPTR FM NORMAL   -31

[CDD (BASE 65) ]
TOTAL THIS MO.     0
DPTR FM NORMAL     0    [PRESSURE DATA]
TOTAL FM JAN 1   700    HIGHEST SLP 30.59 ON  6
DPTR FM NORMAL   276    LOWEST  SLP 29.62 ON 19

[REMARKS]
#FINAL-12-17#
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Explanation of the Preliminary Monthly Climate Data (F6) Product

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - http://www.ncdc.noaa.gov.

WFO Monthly/Daily Climate Data

595
CXUS56 KPQR 011200
CF6PDX
PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

STATION: PORTLAND OR
MONTH: NOVEMBER
YEAR: 2017
LATITUDE: 45 35 N
LONGITUDE: 122 36 W

TEMPERATURE IN F:							:PCPN:	SNOW:		WIND			:SUNSHINE:		SKY		:PK WND	
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
									12Z	AVG	MX	2MIN						
DY	MAX	MIN	AVG	DEP	HDD	CDD	WTR	SNW	DPTH	SPD	SPD	DIR	MIN	PSBL	S-S	WX	SPD	DR
1	58	47	53	3	12	0	T	0.0	0	5.8	16	280	M	M	8		19	280
2	55	44	50	0	15	0	0.08	0.0	0	9.7	24	270	M	M	8	1	31	280
3	50	42	46	-4	19	0	0.01	0.0	0	6.3	14	220	M	M	9		17	240
4	47	40	44	-6	21	0	0.10	0.0	0	9.1	25	190	M	M	10	1	34	180
5	51	38	45	-4	20	0	0.15	0.0	0	10.9	25	200	M	M	7		33	200
6	49	39	44	-5	21	0	T	0.0	0	8.7	21	100	M	M	7		27	100
7	48	40	44	-5	21	0	0.00	0.0	0	18.8	28	100	M	M	9		35	100
8	48	43	46	-3	19	0	0.33	0.0	0	18.8	29	110	M	M	10	1	35	110
9	55	42	49	1	16	0	0.27	0.0	0	11.4	25	110	M	M	9	1	31	130
10	50	44	47	-1	18	0	0.41	0.0	0	5.4	10	100	M	M	10	1	M	M
11	51	44	48	0	17	0	0.13	0.0	0	13.2	23	120	M	M	9	1	27	120
12	54	48	51	3	14	0	0.14	0.0	0	13.7	22	110	M	M	9	1	27	140
13	56	46	51	4	14	0	0.36	0.0	0	13.9	30	180	M	M	8	1	36	190
14	58	45	52	5	13	0	T	0.0	0	12.7	25	180	M	M	8		33	180
15	56	42	49	2	16	0	0.86	0.0	0	11.5	28	190	M	M	10	1	38	180
16	48	43	46	-1	19	0	0.21	0.0	0	10.9	22	210	M	M	9	1	26	210
17	52	41	47	1	18	0	0.11	0.0	0	6.8	18	200	M	M	8	1	21	210
18	53	36	45	-1	20	0	0.00	0.0	0	3.9	13	120	M	M	6	12	16	110
19	51	35	43	-3	22	0	0.17	0.0	0	7.8	16	110	M	M	9	12	19	180
20	56	43	50	4	15	0	0.92	0.0	0	6.4	22	210	M	M	7	1	31	210
21	51	45	48	3	17	0	0.61	0.0	0	11.4	24	110	M	M	9	1	30	120
22	62	49	56	11	9	0	0.22	0.0	0	12.2	21	110	M	M	9	1	25	110
23	63	46	55	10	10	0	0.18	0.0	0	8.3	21	210	M	M	8	18	29	230
24	56	41	49	5	16	0	0.00	0.0	0	7.5	14	200	M	M	5		18	190
25	49	37	43	-1	22	0	0.12	0.0	0	6.0	18	120	M	M	8	12	23	130
26	55	45	50	6	15	0	0.55	0.0	0	9.9	23	120	M	M	9	1	28	120
27	50	41	46	2	19	0	T	0.0	0	5.5	13	130	M	M	8	12	15	130
28	47	43	45	2	20	0	0.44	0.0	0	6.9	16	310	M	M	10	1	20	310
29	52	37	45	2	20	0	0.00	0.0	0	3.2	9	280	M	M	8	12	11	160
30	47	37	42	-1	23	0	0.07	0.0	0	3.8	13	120	M	M	10	12	15	120

```
==============================================================================
SM 1578 1263       521   0  6.44     0.0 280.4          M      254
==============================================================================
AV 52.6 42.1                                9.3 FASTST   M    M   8    MAX(MPH)
                                 MISC ---->  # 30 180               # 38  180
==============================================================================
NOTES:
# LAST OF SEVERAL OCCURRENCES

COLUMN 17 PEAK WIND IN M.P.H.

PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6) , PAGE 2

                                          STATION:  PORTLAND OR
                                          MONTH:    NOVEMBER
                                          YEAR:     2017
                                          LATITUDE:   45 35 N
                                          LONGITUDE: 122 36 W

[TEMPERATURE DATA]       [PRECIPITATION DATA]       SYMBOLS USED IN COLUMN 16

AVERAGE MONTHLY: 47.4   TOTAL FOR MONTH:   6.44    1 = FOG OR MIST
DPTR FM NORMAL:   0.8   DPTR FM NORMAL:    0.81    2 = FOG REDUCING VISIBILITY
HIGHEST:    63 ON 23    GRTST 24HR  0.92 ON 20-20      TO 1/4 MILE OR LESS
LOWEST:     35 ON 19                               3 = THUNDER
                        SNOW, ICE PELLETS, HAIL    4 = ICE PELLETS
                        TOTAL MONTH:   0.0 INCH    5 = HAIL
                        GRTST 24HR     0.0         6 = FREEZING RAIN OR DRIZZLE
                        GRTST DEPTH:   0           7 = DUSTSTORM OR SANDSTORM:
                                                       VSBY 1/2 MILE OR LESS
                                                   8 = SMOKE OR HAZE
[NO. OF DAYS WITH]       [WEATHER - DAYS WITH]     9 = BLOWING SNOW
                                                   X = TORNADO
MAX 32 OR BELOW:   0    0.01 INCH OR MORE:  22
MAX 90 OR ABOVE:   0    0.10 INCH OR MORE:  19
MIN 32 OR BELOW:   0    0.50 INCH OR MORE:   4
MIN  0 OR BELOW:   0    1.00 INCH OR MORE:   0

[HDD (BASE 65) ]
TOTAL THIS MO.   521    CLEAR  (SCALE 0-3)   0
DPTR FM NORMAL   -30    PTCLDY (SCALE 4-7)  12
TOTAL FM JUL 1   925    CLOUDY (SCALE 8-10) 18
DPTR FM NORMAL   -44

[CDD (BASE 65) ]
TOTAL THIS MO.     0
DPTR FM NORMAL     0    [PRESSURE DATA]
TOTAL FM JAN 1   700    HIGHEST SLP 30.47 ON 29
DPTR FM NORMAL   276    LOWEST  SLP 29.55 ON 20

[REMARKS]
#FINAL-11-17#
```

Explanation of the Preliminary Monthly Climate Data (F6) Product

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - http://www.ncdc.noaa.gov.

WFO Monthly/Daily Climate Data

989
CXUS56 KPQR 011544
CF6PDX
PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

STATION: PORTLAND OR
MONTH: OCTOBER
YEAR: 2017
LATITUDE: 45 35 N
LONGITUDE: 122 36 W

TEMPERATURE IN F:							:PCPN:	SNOW:		WIND			:SUNSHINE:		SKY		:PK WND	
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
									12Z	AVG	MX	2MIN						
DY	MAX	MIN	AVG	DEP	HDD	CDD	WTR	SNW	DPTH	SPD	SPD	DIR	MIN	PSBL	S-S	WX	SPD	DR
1	65	49	57	-3	8	0	0.01	0.0	0	4.5	16	320	M	M	6		21	320
2	65	49	57	-3	8	0	0.02	0.0	0	4.3	15	40	M	M	5		23	40
3	71	44	58	-1	7	0	0.00	0.0	0	5.4	22	100	M	M	1		29	90
4	71	42	57	-2	8	0	0.00	0.0	0	4.4	13	290	M	M	2	1	14	300
5	74	43	59	1	6	0	0.00	0.0	0	3.8	10	300	M	M	1	1	13	310
6	73	43	58	0	7	0	0.00	0.0	0	4.5	15	270	M	M	4	8	19	230
7	65	52	59	1	6	0	0.01	0.0	0	7.6	20	280	M	M	8		25	270
8	64	45	55	-2	10	0	0.02	0.0	0	2.3	8	290	M	M	5	1	11	290
9	67	39	53	-4	12	0	0.00	0.0	0	4.1	10	290	M	M	7	1	13	280
10	57	43	50	-7	15	0	0.01	0.0	0	3.2	13	270	M	M	7	1	15	270
11	57	45	51	-5	14	0	0.16	0.0	0	4.7	13	190	M	M	7	1	15	200
12	56	46	51	-5	14	0	0.50	0.0	0	8.4	20	260	M	M	8	13	25	250
13	59	40	50	-6	15	0	T	0.0	0	4.6	17	310	M	M	5	3	23	320
14	59	36	48	-7	17	0	0.00	0.0	0	2.8	9	280	M	M	4	1	12	280
15	67	38	53	-2	12	0	0.00	0.0	0	1.7	7	320	M	M	3	18	8	320
16	67	39	53	-2	12	0	0.00	0.0	0	1.8	6	100	M	M	1	128	7	50
17	58	42	50	-4	15	0	0.04	0.0	0	3.3	13	240	M	M	8	12	15	230
18	64	49	57	3	8	0	0.09	0.0	0	9.5	24	190	M	M	10	1	33	190
19	59	50	55	1	10	0	0.99	0.0	0	10.8	21	160	M	M	10	1	27	200
20	54	48	51	-3	14	0	0.11	0.0	0	11.1	23	270	M	M	7	1	28	280
21	61	47	54	1	11	0	2.13	0.0	0	15.5	26	210	M	M	10	1	37	210
22	61	47	54	1	11	0	0.47	0.0	0	7.5	25	210	M	M	8	12	33	210
23	64	48	56	3	9	0	0.00	0.0	0	2.7	10	290	M	M	5	12	13	290
24	70	44	57	5	8	0	0.00	0.0	0	3.4	9	310	M	M	2	1	10	270
25	62	43	53	1	12	0	T	0.0	0	4.4	12	320	M	M	7	12	15	330
26	71	51	61	9	4	0	0.01	0.0	0	9.2	25	90	M	M	4	1	30	90
27	73	46	60	8	5	0	0.00	0.0	0	8.6	25	100	M	M	0		30	100
28	71	42	57	6	8	0	0.00	0.0	0	3.1	8	130	M	M	0	1	9	130
29	59	49	54	3	11	0	T	0.0	0	4.2	9	320	M	M	6	128	12	310
30	63	41	52	1	13	0	0.00	0.0	0	17.3	29	80	M	M	1	8	38	90

```
31  62  35  49  -2  16   0 0.00  0.0    0  3.0  8 260   M    M   3         9 310
================================================================================
SM 1989 1375       326   0  4.57     0.0 181.7          M      155
================================================================================
AV 64.2 44.4                                5.9 FASTST   M    M   5    MAX(MPH)
                                  MISC ---->  # 29  80               # 38   90
================================================================================
NOTES:
# LAST OF SEVERAL OCCURRENCES

COLUMN 17 PEAK WIND IN M.P.H.

PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6) , PAGE 2

                                          STATION:  PORTLAND OR
                                          MONTH:    OCTOBER
                                          YEAR:     2017
                                          LATITUDE:   45 35 N
                                          LONGITUDE: 122 36 W

[TEMPERATURE DATA]       [PRECIPITATION DATA]       SYMBOLS USED IN COLUMN 16

AVERAGE MONTHLY: 54.3   TOTAL FOR MONTH:   4.57    1 = FOG OR MIST
DPTR FM NORMAL:  -0.6   DPTR FM NORMAL:    1.57    2 = FOG REDUCING VISIBILITY
HIGHEST:    74 ON  5    GRTST 24HR  2.13 ON 21-21      TO 1/4 MILE OR LESS
LOWEST:     35 ON 31                                3 = THUNDER
                        SNOW, ICE PELLETS, HAIL     4 = ICE PELLETS
                        TOTAL MONTH:   0.0 INCH     5 = HAIL
                        GRTST 24HR     0.0          6 = FREEZING RAIN OR DRIZZLE
                        GRTST DEPTH:   0            7 = DUSTSTORM OR SANDSTORM:
                                                        VSBY 1/2 MILE OR LESS
                                                    8 = SMOKE OR HAZE
[NO. OF DAYS WITH]       [WEATHER - DAYS WITH]      9 = BLOWING SNOW
                                                    X = TORNADO
MAX 32 OR BELOW:   0    0.01 INCH OR MORE:  14
MAX 90 OR ABOVE:   0    0.10 INCH OR MORE:   6
MIN 32 OR BELOW:   0    0.50 INCH OR MORE:   3
MIN  0 OR BELOW:   0    1.00 INCH OR MORE:   1

[HDD (BASE 65) ]
TOTAL THIS MO.   326    CLEAR  (SCALE 0-3)  10
DPTR FM NORMAL    11    PTCLDY (SCALE 4-7)  17
TOTAL FM JUL 1   404    CLOUDY (SCALE 8-10)  4
DPTR FM NORMAL   -14

[CDD (BASE 65) ]
TOTAL THIS MO.     0
DPTR FM NORMAL    -2    [PRESSURE DATA]
TOTAL FM JAN 1   700    HIGHEST SLP 30.62 ON 23
DPTR FM NORMAL   276    LOWEST  SLP 29.57 ON 19

[REMARKS]
#FINAL-10-17#
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WETS Station: PORTLAND INTL AIRPORT, OR

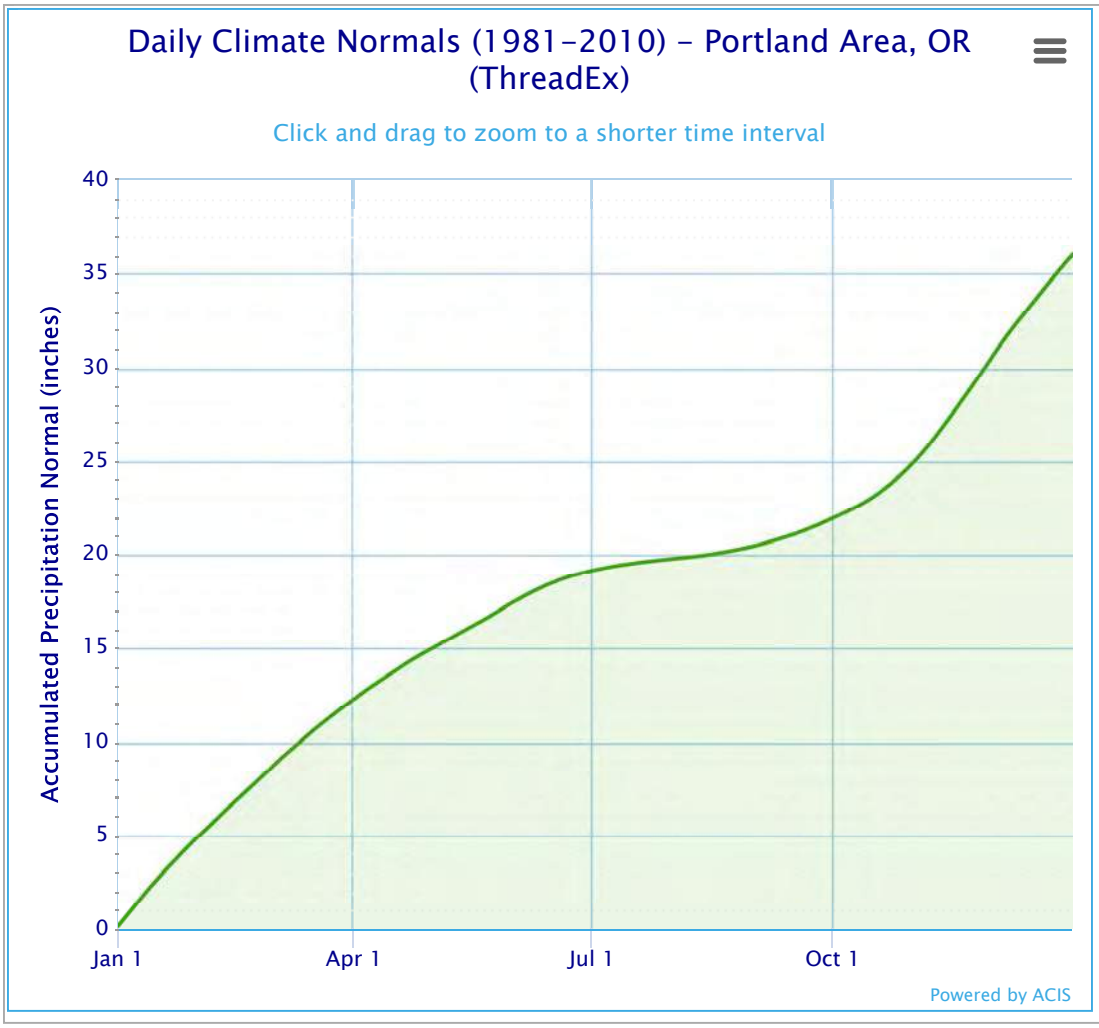
Requested years: 1981 - 2010

Month	Temperature (°F)			Precipitation (inches)				
	Avg daily max*	Avg daily min*	Avg daily mean*	Avg*	30% chance will have less than	30% chance will have more than	Avg number of days with 0.10 inch or more	Average total snowfall*
Jan	47.0	35.8	41.4	4.88	2.87	5.93	12	0.5
Feb	51.3	36.3	43.8	3.66	2.32	4.41	9	2.1
Mar	56.7	39.6	48.2	3.68	2.88	4.24	11	0.2
Apr	61.4	43.1	52.3	2.73	2.02	3.20	8	0.0
May	68.0	48.6	58.3	2.47	1.46	3.00	7	0.0
Jun	73.5	53.6	63.6	1.70	0.98	2.07	5	0.0
Jul	80.6	57.8	69.2	0.65	0.30	0.76	2	0.0
Aug	81.1	58.0	69.6	0.67	0.26	0.78	2	0.0
Sep	75.8	53.1	64.5	1.47	0.69	1.76	3	0.0
Oct	63.8	46.0	54.9	3.00	1.75	3.64	7	0.0
Nov	52.8	40.5	46.7	5.63	3.85	6.71	13	0.2
Dec	45.6	35.2	40.4	5.49	4.01	6.45	12	1.3
Annual:					31.64	39.57		
Average	63.1	45.6	54.4	-	-	-	-	-
Total	-	-	-	36.03			91	4.3

Columns marked with an asterisk (*) indicate monthly NCEI normals.
These may not be exactly equal to the average for the years 1981-2010.

GROWING SEASON DATES

Requested years of data:	1981 - 2010		
Years with missing data:	24 deg = 0	28 deg = 0	32 deg = 0
Years with no occurrence:	24 deg = 9	28 deg = 0	32 deg = 0
Data years used:	24 deg = 30	28 deg = 30	32 deg = 30



Daily Precipitation Normal (inches)												
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0.17	0.12	0.14	0.10	0.07	0.08	0.03	0.01	0.03	0.06	0.15	0.21
2	0.17	0.13	0.14	0.10	0.08	0.08	0.03	0.02	0.04	0.07	0.15	0.20
3	0.17	0.13	0.14	0.11	0.08	0.07	0.03	0.01	0.03	0.06	0.16	0.20
4	0.17	0.13	0.13	0.10	0.08	0.08	0.03	0.01	0.04	0.07	0.16	0.20
5	0.17	0.14	0.13	0.10	0.08	0.07	0.03	0.02	0.04	0.06	0.17	0.19
6	0.17	0.14	0.12	0.10	0.08	0.08	0.03	0.01	0.05	0.07	0.17	0.19
7	0.17	0.13	0.13	0.09	0.07	0.07	0.02	0.01	0.04	0.07	0.18	0.19
8	0.17	0.13	0.12	0.10	0.08	0.07	0.03	0.02	0.04	0.07	0.18	0.18
9	0.17	0.14	0.12	0.09	0.08	0.07	0.02	0.02	0.04	0.07	0.18	0.18
10	0.17	0.13	0.12	0.10	0.08	0.07	0.03	0.02	0.04	0.07	0.19	0.18
11	0.17	0.14	0.12	0.09	0.08	0.06	0.02	0.02	0.05	0.08	0.19	0.17
12	0.17	0.13	0.13	0.09	0.07	0.07	0.02	0.01	0.04	0.08	0.18	0.18
13	0.16	0.13	0.12	0.10	0.08	0.06	0.02	0.02	0.04	0.08	0.19	0.17
14	0.16	0.13	0.12	0.09	0.08	0.06	0.02	0.02	0.05	0.09	0.19	0.18
15	0.16	0.13	0.12	0.09	0.08	0.06	0.02	0.02	0.04	0.09	0.19	0.18
16	0.15	0.12	0.13	0.09	0.07	0.05	0.02	0.02	0.05	0.09	0.19	0.17
17	0.16	0.13	0.12	0.09	0.08	0.06	0.02	0.03	0.05	0.10	0.19	0.17

18	0.16	0.13	0.11	0.09	0.08	0.06	0.02	0.02	0.05	0.10	0.20	0.18
19	0.15	0.13	0.12	0.10	0.07	0.05	0.02	0.02	0.05	0.11	0.20	0.17
20	0.15	0.13	0.11	0.09	0.08	0.05	0.02	0.03	0.06	0.11	0.19	0.18
21	0.15	0.13	0.11	0.09	0.08	0.04	0.01	0.02	0.05	0.11	0.20	0.17
22	0.15	0.13	0.11	0.09	0.08	0.05	0.02	0.03	0.06	0.11	0.20	0.17
23	0.14	0.13	0.11	0.08	0.08	0.04	0.02	0.02	0.06	0.12	0.20	0.17
24	0.15	0.13	0.11	0.09	0.09	0.04	0.01	0.03	0.05	0.13	0.19	0.17
25	0.15	0.13	0.11	0.08	0.08	0.03	0.02	0.03	0.06	0.12	0.21	0.17
26	0.14	0.13	0.11	0.08	0.09	0.04	0.01	0.02	0.07	0.12	0.20	0.17
27	0.15	0.13	0.11	0.08	0.08	0.04	0.02	0.03	0.06	0.13	0.21	0.16
28	0.14	0.13	0.10	0.08	0.09	0.03	0.01	0.03	0.06	0.13	0.20	0.17
29	0.14	-	0.11	0.07	0.08	0.04	0.02	0.03	0.07	0.14	0.21	0.16
30	0.14	-	0.10	0.08	0.09	0.03	0.01	0.04	0.06	0.15	0.21	0.15
31	0.14	-	0.11	-	0.08	-	0.02	0.03	-	0.14	-	0.16

APPENDIX E

Literature Citations

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