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TECHALLOY COMPANY, INC.
GROUNDWATER TREATMENT SYSTEM
INTERIM MEASURES
Union, Illinois

ILD 005 178 975

Prepared for

TECHALLOY COMPANY, INC.
Union, Illinois

Prepared by

ROY F. WESTON, INC.
Three Hawthorn Parkway
Vernon Hills, Illinois 60061

August 1993

Work Order No. 01989-010-002

INTERIM MEASURES FINAL DESIGN
FOR
TECHALLOY COMPANY, INC.
Union, Illinois

August 1993

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SECTION 1
INTRODUCTION

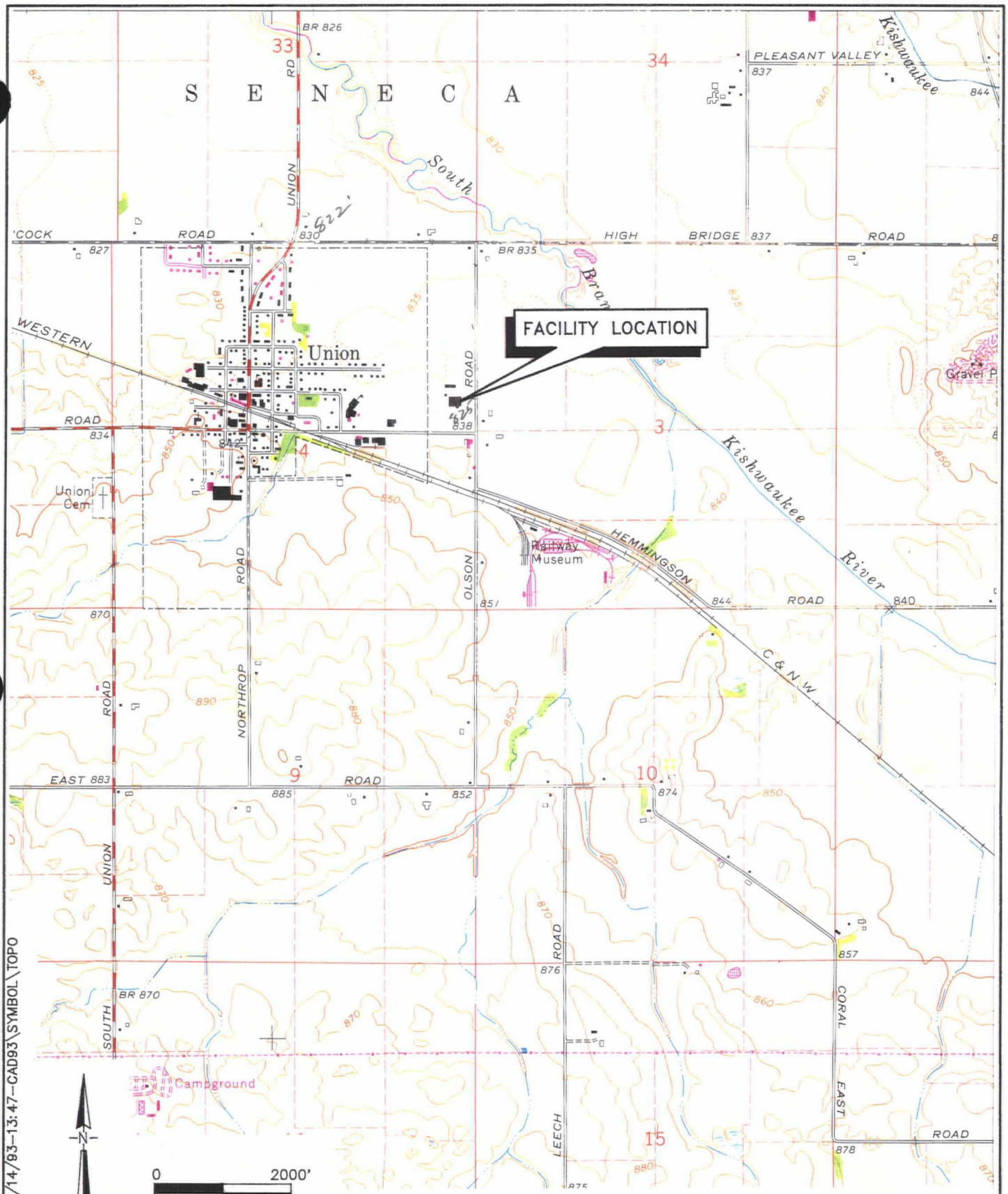
1.1 PURPOSE OF REPORT

This report presents the Interim Measures Final Design for Techalloy Company, Inc. (Techalloy) in Union, Illinois. The United States Environmental Protection Agency (U.S. EPA) Region V has issued an Administrative Order on Consent (Consent Order), Docket No. V-W-007-93, to Techalloy. The Consent Order was issued under Section 3008(h) of the Solid Waste Disposal Act, commonly referred to as the Resource Conservation and Recovery Act (RCRA) of 1976, as amended, 42 U.S.C. 6928(h). In entering into the Consent Order, Techalloy has agreed to perform Interim Measures at the facility.

Roy F. Weston, Inc. (WESTON®) has been retained by Techalloy to assist in the achievement of Interim Measures objectives outlined in the Consent Order. WESTON prepared a work plan on behalf of Techalloy, which was entitled, "Interim Measures Work Plan, Techalloy Company, Inc., Union, Illinois". This Work Plan was submitted to U.S. EPA for its review on 29 March 1993. The Work Plan outlined the scope of work and technical approach for the Interim Measures design. The Work Plan was approved by U.S. EPA with some modifications in a letter, dated July 1, 1993, to Techalloy. WESTON has prepared responses to each of the U.S. EPA's review comments. A copy of WESTON's responses to U.S. EPA's comments on the Interim Measures Work Plan has been included for reference in Appendix A of this report.

1.2 DESCRIPTION OF SELECTED REMEDY

Techalloy is located at the intersection of Olson Road and Jefferson Street in Union, Illinois, in McHenry County. Specifically, the site is located within Section 4, Township 43 North, Range 6 East. Figure 1-1 shows the location of the facility. The existing site conditions were described in detail in the Interim Measures Work Plan. The chemicals of concern in groundwater are 1,1,1-Trichloroethane (1,1,1-TCA), Trichloroethene (TCE), and



SOURCE: U.S.G.S. 7.5 Min. TOPOGRAPHIC MAP
MARENGO SOUTH QUADRANGLE

FIGURE 1–1

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WESTON
MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

AREA LOCATION MAP

TECHALLOY COMPANY, INC.
Union, Illinois

Tetrachloroethene (PCE). A groundwater plume originating from the northern half of the facility and migrating in a northwestward direction has been identified and is shown in Figure 1-2. The plume dimensions and groundwater sampling results are also shown in Figure 1-2. The maximum concentrations observed are approximately 200,000 μg/L 1,1,1-TCA, 380 μg/L TCE and 3,600 μg/L PCE.

According to the Consent Order, Techalloy will perform a RCRA Facility Investigation (RFI) to determine fully the nature and extent of any release of hazardous wastes and hazardous constituents from the facility and the potential for any future release of hazardous wastes and hazardous constituents from the facility, and to perform a Corrective Measures Study (CMS) to identify and evaluate alternatives for the corrective action necessary to prevent or mitigate any migration or release of hazardous wastes or hazardous constituents from or at the facility. Due to the magnitude and extent of the known groundwater constituents, U.S. EPA has determined that the initiation of a remedy cannot wait until completion of the RFI/CMS. The interim measures will be implemented to effectively mitigate the impact on actual and potential receptors of volatile organic compounds (VOCs) migrating in the groundwater from the facility.

The interim measures to be implemented will include the following:

- A groundwater extraction system to prevent further migration of impacted groundwater.
- A treatment system for treating extracted groundwater to acceptable levels to meet acceptable laws for proper disposal.
- A groundwater monitoring plan.
- Continued operation and maintenance of the pump-and-treat system until the final corrective measures for groundwater cleanup is fully operational.

1.3 ORGANIZATION OF REPORT

This report is organized into seven sections. Section 1 provides a brief introduction and scope of this report. WESTON's responses to U.S. EPA's comments on the Interim Measures work plan has been included for reference in Appendix A of this report.

Section 2, Summary of Predesign Activities, describes the sampling, aquifer pumping test, groundwater system modeling, and surveying activities conducted as part of the interim measures design. The sampling results, aquifer pumping test data, and groundwater modeling are included in Appendices C and D, respectively.

Section 3, Design Analysis, describes the engineering analysis performed to provide a basis of design and to support the preparation of detailed construction drawings and technical specifications pertaining to the groundwater extraction system, extracted groundwater treatment system, and treated water discharge system. Sample calculations for the design analysis are presented in Appendix E.

Section 4, Construction Drawings and Technical Specifications, introduces the construction drawings and specifications that have been prepared for the pump-and-treat system. The construction drawings and specifications are included in Appendices F and G, respectively.

Section 5, Permit Requirements, summarizes the Illinois EPA (IEPA) requirements for construction and operation of a new emission source and a new treatment system. In accordance with the Consent Order, the permit applications will be submitted after the approval of the Interim Measures final design.

Section 6, Supplemental Design Information, presents the operation and maintenance (O & M) plan, groundwater monitoring plan, and construction quality assurance plan (CQAP). The estimated construction schedule is also presented in this section. The O & M plan and CQAP are provided in Appendices H and I, respectively.

Section 7, References, lists all the documents referenced in this report.

SECTION 2

PREDESIGN INVESTIGATION AND DATA COLLECTION

This subsection describes the predesign activities which yielded additional data for the design of an efficient and cost effective groundwater extraction and treatment system. The predesign activities consisted of a field investigation, groundwater system modeling, and field surveying. The field investigation utilized included three tasks; soil sampling, groundwater sampling, and a groundwater pumping test. These tasks were performed on the 20th and 21st of May 1993, and are each described in detail in the following subsection. Groundwater system modeling and field surveying activities are also described in the following subsections.

2.1 SOIL SAMPLING

Five aquifer soil media (SB-01 through SB-05) were collected on 20 May 1993 for grain size distribution, moisture content, porosity, bulk density, and specific gravity analyses. The sample locations are shown in Figure 2-1. One sample (SB-01) was collected at the proposed treatment system building location at 20 feet below ground surface (bgs). The geotechnical analysis of this sample was used to determine the foundation requirements of the proposed treatment building. The other four samples (SB-01 through SB-04) were collected along the proposed pipeline path at 10 feet bgs. The geotechnical analyses of these samples was necessary for pipeline construction and design.

Two aquifer soil media samples (SB-01 and SB-05) were also analyzed for total organic carbon. These two samples provided average characteristics of the aquifer material within the groundwater plume area. This information was needed for groundwater system modeling.

All soil analysis ASTM method numbers are presented in Table 2-1. Table 2-2 presents the geotechnical analyses results. The average grain size distribution of the samples is 27.7 percent gravel, 61.1 percent sand, and 11.2 percent silt and clay. The average bulk density

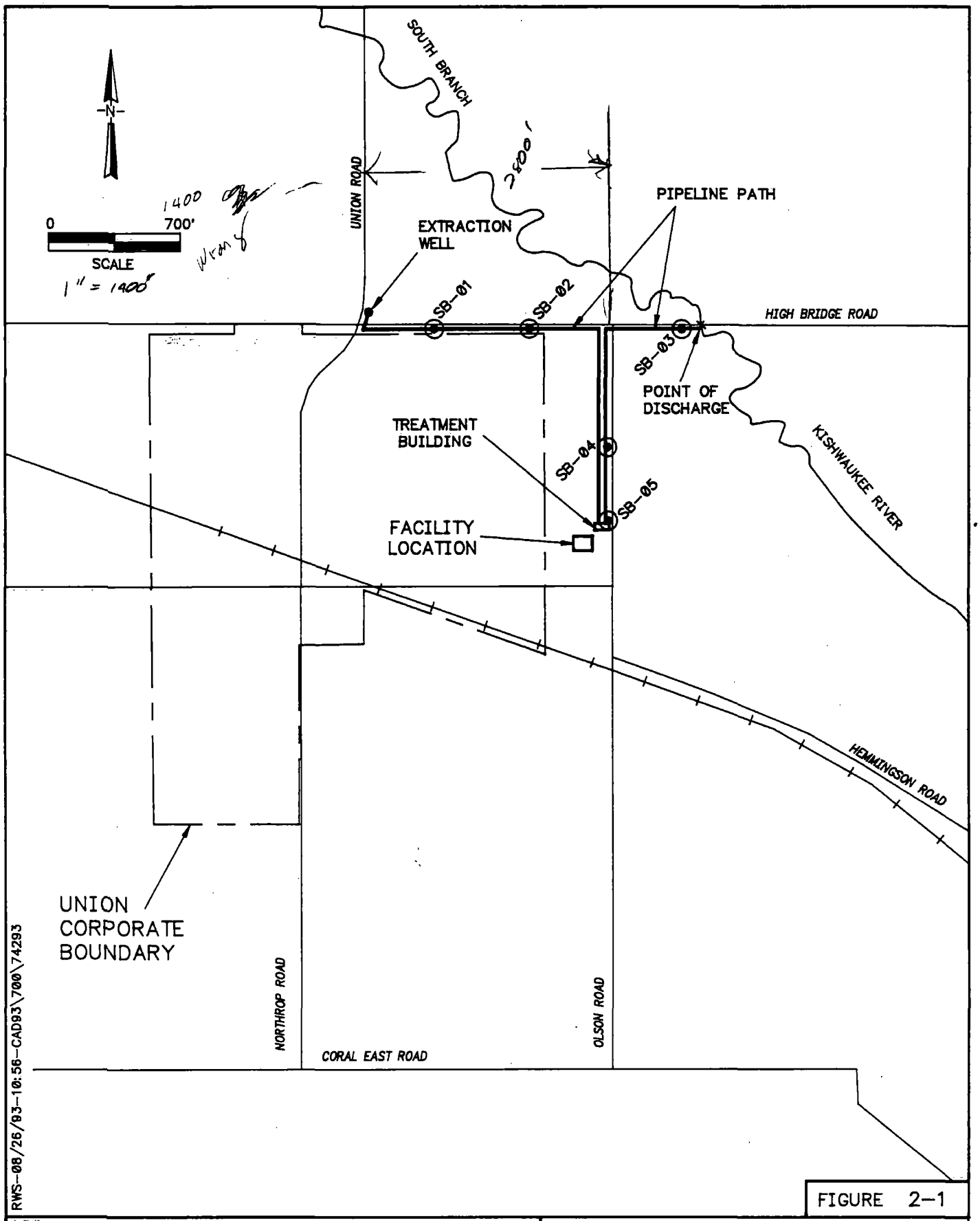

FIGURE 2-1

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Three Hawthorn Parkway
Vernon Hills, Illinois
60061

SOIL SAMPLING LOCATIONS

TECHALLOY COMPANY, INC.
Union, Illinois

Table 2-1

Analytical Methods
Interim Measures
Techalloy Company, Inc.
Union, Illinois

Parameter	Standard Method
Soil	
Fraction Organic Carbon	ASTM D513
Grain Size Distribution	ASTM D421/D422
Bulk Density	ASTM D2937
Moisture Content	ASTM D2216
Total Porosity	ASTM D2937/D2216/D854
Tube Extrusion	ASTM D2937
Specific Gravity	ASTM D854
Groundwater	
Biochemical Oxygen Demand	EPA 405.1
Chemical Oxygen Demand	Hach 8000
Total Organic Carbon	EPA 415.1
Total Suspended Solids	EPA 160.2
Ammonia	EPA 350.2
Bromide	EPA 320.1
Color	EPA 110.2
Fluoride	EPA 340.2
Nitrate and Nitrite as N	EPA 353.2
Total Organic Nitrogen as N	EPA 350.2/351.3
Phosphorus as P	EPA 365.2
Sulfate as SO_4	EPA 375.4
Sulfide as S	EPA 376.1
Total Metals: Aluminum, Barium, Boron, Cobalt, Iron, Magnesium, Molybdenum, Manganese, Tin, Titanium, Antimony, Beryllium, Cadmium, Chromium, Copper, Nickel, Silver, Zinc	EPA 200.7
Total Arsenic	EPA 206.2
Total Lead	EPA 239.2
Total Mercury	EPA 245.1
Total Selenium	EPA 270.2
Total Thallium	EPA 279.2
Total Cyanide	EPA 335.2
Total Phenols	EPA 420.2

Table 2-2

Summary of Geotechnical Laboratory Results
Techalloy Company, Inc.
Union, Illinois

Highbar Rd 2-4

Sample	Sieve Analysis			Bulk Density (g/cc)	Specific Gravity (SG)	Moisture Content (w) (% Dry Basis)	Porosity (%) Void Ratio (e)	Total Organic Carbon (%)
	Percent Gravel	Percent Sand	Percent Silt & Clay					
SB-01	34.8	52.5	12.7	2.15	2.74	9.3	28.4	0.66
SB-02	17.8	71.6	10.6	1.89	2.72	11.1	37.6	---
SB-03	36.7	52.3	11.0	2.00	2.76	10.7	34.5	---
SB-04	35.2	51.2	13.6	2.07	2.78	7.5	30.7	---
SB-05	13.8	77.7	8.5	1.94	2.75	15.0	38.5	1.2
Average	**27.7**	**61.1**	**11.2**	**2.01**	**2.75**	**10.7**	**33.9**	

is 2.01 grams per cubic centimeter (g/cc), average specific gravity is 2.75, average moisture content is 10.7 percent, and average porosity is 33.9 percent.

All samples were collected with a truck-mounted Geoprobe hydraulic mechanism. The following procedures were used for the advancement and sampling of all Geoprobe soil borings.

- A hydraulic push/pull mechanism (Geoprobe), mounted on a four-wheel-drive truck was utilized to advance all soil borings.
- The working end of the Geoprobe and all boring equipment, tools, and materials, were decontaminated prior to arriving on site in accordance with the protocols described in the Interim Measures Work Plan. Provisions were made to prevent equipment, tools, and materials from coming into contact with surface soils.
- The Geoprobe was used to advance a 1-inch diameter by 2-foot-long bore sampler with a retractable drive point to the upper limit of the first desired sampling interval.
- If the sampler met with resistance and would not push to a sufficient depth, a hydraulic hammer was used to advance the sampler.
- At the desired sample depth, the retractable drive point was released and the sampler advanced through the desired interval. Soil from this interval was impacted into the sampling sleeve.
- The sampler was retrieved from the borehole and samples were extruded into appropriate laboratory-prepared sample containers.
- Following sample collection, each soil sample was logged by a qualified WESTON geological engineer.

2.2 GROUNDWATER SAMPLING

Prior to the groundwater pumping test, groundwater was sampled from the aquifer pumping test well for laboratory chemical analysis. The location of the aquifer pumping test well is shown in Figure 1-2. The groundwater was sampled for NPDES parameters. All NPDES parameters and method numbers are presented in Table 2-1. This groundwater sampling

effort was necessary to determine any pretreatment requirements for extracted groundwater before it enters the air stripper, and to help in the preparation of the NPDES permit application.

The groundwater samples were collected directly from a pump outlet which bypassed the discharge base. This smaller outlet allowed for a less turbulent flow to be sampled. The slower pumping/discharge rate through the bypass outlet minimized sample disturbance. The discharge water was poured directly into laboratory cleaned sample containers.

Table 2-3 presents a summary of chemical analytical results. Of the metals, only eight were detectable. These eight metals are aluminum, arsenic, barium, copper, iron, magnesium, titanium, and zinc. Other inorganics found to be above detection limits included fluoride, ammonia, nitrate, nitrite, phosphorus, sulfate, COD, and total suspended solids. Color was found to be 20 color units. All laboratory data are included in Appendix B.

Sample Packaging and Shipment

Following sample collection, the exteriors of all sample containers were wiped clean with a moist cloth. In preparation for shipment to the analytical laboratory, all samples were packaged in accordance with the following procedures:

- Each sample container was checked to ensure that the container lid was securely tightened.
- Each sample container was checked to ensure that the sample label had been securely affixed to the container and correctly filled out with the appropriate sample I.D. number, sample, date, and analytical parameters as a minimum requirement.
- Each container was placed in a separate zip-lock bag and the bag securely closed (eliminating all air from within the bag).
- The low concentration samples were placed in a cooler lined with a large polyethylene bag. Enough vermiculite or equivalent absorbent material was packed around the samples to minimize the possibility of container breakage. The temperature was maintained at 4°C with cold packs and ice, sealed in

Table 2-3

Summary of Pumping Well Analytical Results
Techalloy Company, Inc.
Union, Illinois

Parameter	Detected Concentration (mg/L Unless Noted)	Detection Limit (mg/L Unless Noted)
Silver	---	0.030
Aluminum	2.7	0.200
Arsenic	0.0029	0.002
Boron	---	0.050
Barium	0.41	0.050
Beryllium	---	0.005
Cadmium	---	0.005
Cobalt	---	0.020
Chromium	---	0.020
Copper	0.025	0.020
Iron	4.9	0.030
Mercury	---	0.0002
Magnesium	68.3	0.200
Molybdenum	---	0.100
Nickel	---	0.020
Lead	---	0.050
Antimony	---	0.100
Selenium	---	0.002
Tin	---	0.100
Titanium	0.085	0.010
Thallium	---	0.500
Zinc	0.044	0.010
BOD 5 Day	---	2
Bromide	---	5
COD	17	5
Fluoride	0.14	0.100

Table 2-3

Summary of Pumping Well Analytical Results
Techalloy Company, Inc.
Union, Illinois
(Continued)

Parameter	Detected Concentration (mg/L Unless Noted)	Detection Limit (mg/L Unless Noted)
Ammonia	0.31	0.10
Nitrite	0.022	0.02
Nitrate	1.8	0.10
Total Organic Nitrogen	---	0.10
Phosphorus	0.46	0.05
Total Phenolics	---	0.005
Sulfide	---	1.0
Sulfate	69.2	25.0
Total Suspended Solids	94	5.0
Alkalinity	352	10.0
Total Organic Carbon (TOC)	7.8 J	1.0
TOC Test 2	5.5 J	1.0
Fecal Coliform	---	10 c/100 mL
Color	20.0 cu	5.0 cu

--- - Analyzed, not detected.
J - Estimated concentration.
cu - Color units.

plastic bags. The remaining space in the cooler was filled with additional packing material and the large polyethylene bag was sealed.

- The completed chain-of-custody form identifying the contents of the sample shipment container was placed in a large zip-lock bag and taped to the inside lid of the shipment container.

- The cooler lid was closed and sealed shut with strapping tape. If the cooler had a drain port, it was also sealed shut with tape. Two chain-of-custody seals were placed across the seam between the cooler lid and base. The seals were placed in a staggered configuration (either front left side and back right side or vice versa). This ensured that if the cooler was opened by unauthorized persons, the custody seal would break and indicate intrusive action. The custody seals were covered with waterproof tape to prevent accidental damage during shipment.

- The shipment airbill was affixed to the top of the cooler. It identified the shipper's and recipient's names and addresses. A WESTON mailing label was also be affixed to the top of the cooler and contained the same information as the airbill in case the airbill became detached from the cooler during shipment.

- "This Side Up" arrows were placed on the four sides of the shipment container.

- All samples were shipped within 24 hours of collection and met any holding time requirements. All samples were shipped via Federal Express overnight delivery.

2.3 AQUIFER PUMPING TEST

A pumping test was conducted on 21 May 1993 in a 6-inch diameter groundwater well previously installed on the southeast corner of the Techalloy property at a location upgradient of the plume with respect to groundwater flow (Figure 1-2). This location was chosen so as not to draw potentially contaminated groundwater into the well during the test.

A single temporary observation well was also previously installed approximately 10 feet from the extraction well to measure water table drawdown resulting from the pumping test.

The pumping test was simulated using an analytical model (WHPA, Blandford and Huyakorn, 1991) to determine if the resultant cone of depression will draw water from the contaminant plume. Based on the simulated pumping rate used for the extraction well, the distance from the contaminant plume, and the short time duration of the test, the test was found to have no effect on the plume. The contaminant plume is approximately 1,000 feet northwest of the pump test location. 500'

Drawdowns were also predicted for the observation well using the Theis Equation. The results indicated drawdowns would be very minimal even at pumping rates up to 100 gallons per minute (gpm). The pumping test was conducted at a rate of 50 gpm which was estimated to draw the water table down in the observation well approximately 1 to 2 inches.

Groundwater samples were collected from the extraction well following installation and development and analyzed for VOCs. The results indicate that the groundwater at this location is free of VOC constituents.

The pumping test consisted of four tasks performed sequentially as follows:

- Measurement of static water levels.
- Collection of water samples for analytical tests.
- Constant discharge rate aquifer test at 50 gpm.
- Aquifer water level recovery monitoring.

The initial task consisted of measurement of static water levels in the pumping well and observation well prior to the beginning of the pump test. Following static water level measurements, the pump was turned on to clean out well silt and to be set at a flow rate of 50 gpm. While undergoing initial pumping, groundwater samples were collected for NPDES laboratory analysis.

Following the well set-up, water levels were allowed to recover fully while the data was reviewed and an optimal discharge rate was selected. The aquifer test then ran for

approximately 8 hours at a constant discharge rate. Upon completion of the test, water levels were allowed to recover for a period of 2.5 hours. Static water level conditions were encountered after 2.5 hours of recharge.

Water levels were recorded in the pumping well and observation well during all phases of the test using a data logger/pressure transducer system which recorded water levels to the nearest 0.01 feet. Manual water level measurements were taken in MW-10 and MW-11 (Figure 1-2) at regular intervals throughout the pumping phase to ensure that the pumping test was not influencing the contaminated groundwater plume.

Groundwater extracted during the pumping test was piped a sufficient distance from the test area and discharged to the ground surface.

During the pumping/drawdown phase of the pump test, the maximum water level change in the pumping and observation wells were 2.39 and 0.41 feet, respectively. Water levels in MW-10 and MW-11 were virtually unaffected during the pumping test.

At the completion of this recharge phase of the pumping test, the water levels within the pumping and observation wells had returned to within 0.06 and 0.04 feet of their original water levels, respectively. The aquifer pumping test data is presented in Appendix C.

The test evaluation indicated that the mean transmissivity of the water table aquifer in the area is approximately 7,800 ft^2/day. Based on a measured aquifer, saturated thickness of 30 feet, the hydraulic conductivity of the aquifer is approximately 260 ft/day.

2.4 GROUNDWATER SYSTEM MODELING

In preparation for the concept design of the Interim Measures groundwater recovery and treatment system, WESTON used the Method-of-Characteristics (MOC) groundwater model (Konikow and Bredehoeft, 1989) to simulate the trichloroethene (TCE) groundwater plume

emanating from the source area. The objectives of the MOC modeling were to create a model that could accomplish the following:

- Simulate groundwater flow in the water table aquifer.
- Simulate the migration of the TCE plume.
- Simulate proposed Interim Measures capture zone of the recovery well.
- Predict the effectiveness of the recovery well.
- Predict the fate of the contaminant plume.
- ~~Predict the result of no action.~~

The results of the flow modeling indicate that the proposed Interim Measures recovery well can effectively intercept and prevent further migration of the full width of the contaminant plume emanating from the source area. The results of the capture zone analysis predict that the recovery well would have to be operated at a rate ~~of 280~~ gpm to attain a capture zone width of between 1,000 and 1,050 feet.

2000 2100 ?

Based on the results of the transport simulations, successful remediation of the source area will have a much ~~greater impact on the maximum contaminant~~ concentrations in the plume than will operation of the recovery well.

A detailed report describing the groundwater system modeling is provided in ~~Appendix D~~.

2.5 SURVEYING

A topographical and boundary survey were performed at the site to facilitate the design and construction of the groundwater treatment system. The survey provided detailed information on contours and existing benchmarks and a construction baseline was established. Existing wells were located and top of casing elevations were determined for groundwater modeling and future groundwater monitoring. The topographic map for the site area is presented as part of the construction drawings in Appendix F.

SECTION 3
DESIGN ANALYSIS

This section presents the basis of design and design elements for the groundwater extraction system, the extracted groundwater treatment system, and the treated water discharge system. The technical approach for the interim measures design is also outlined.

3.1 TECHNICAL APPROACH

The technical approach was outlined in the Interim Measures Work Plan. The main objective of the Interim Measures pump-and-treat system is to prevent further migration of impacted groundwater. The proposed system will extract the impacted groundwater, treat the extracted groundwater is a packed tower air stripper, and discharge the treated effluent to the South Branch of the Kishwaukee River. The approximate location of the extraction well, the treatment system building, pipeline path, and point of discharge is shown in Figure 3-1.

The results of groundwater system modeling indicated that the proposed extraction well operating at a rate of 280 gpm can effectively intercept and prevent further migration of the full width of the groundwater plume. To provide for a safety factor, the design operating rate for the proposed extraction well will be 350 gpm. The extraction well will be screened at 50 to 80 feet below grade in the aquifer. Two piezometers will also be installed to determine drawdown induced from the extraction well.

Extracted groundwater will be pumped to the treatment system building using a submersible well pump. The pipeline conveying the extracted groundwater to the treatment system will be high density polyethylene (HDPE) with secondary containment. The double-walled piping will also have a leak detection system.

The extracted groundwater will flow to an aeration/surge tank. The main purpose of this tank is to act as a flow equalization tank and to provide sufficient detention time for

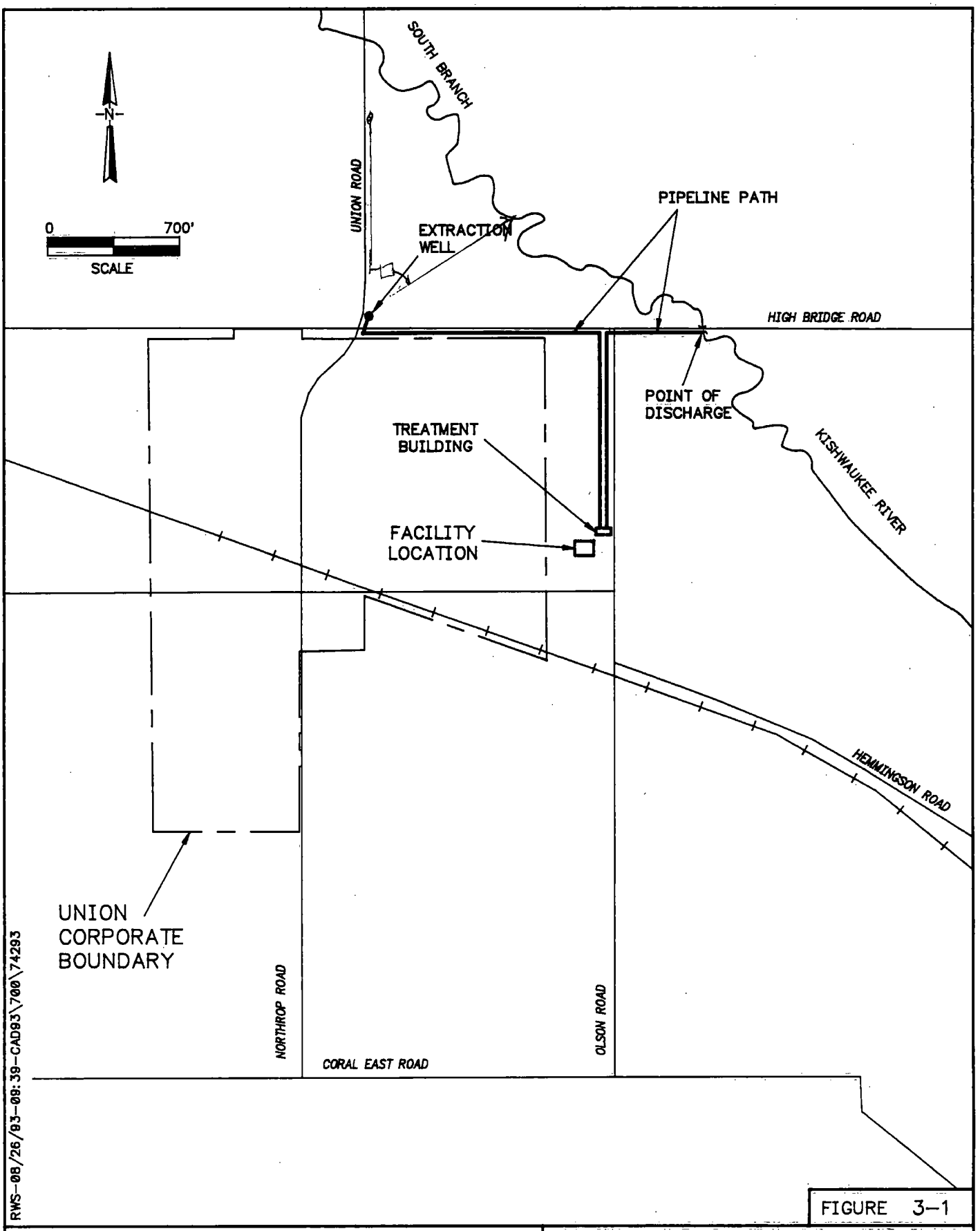

FIGURE 3-1

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

LOCATION of EXTRACTION WELL, TREATMENT BUILDING, PIPELINE & DISCHARGE POINT

TECHALLOY COMPANY, INC.
Union, Illinois

oxidation of iron with the addition of air. Higher oxidation states of iron are insoluble in water. The water will then flow through a system of centrifugal separators and cartridge filters for removal of suspended solids and insoluble iron oxides. The water will then flow through a packed bed air stripper for VOC removal. The air discharge will not contribute to air pollution.

From the air stripper, the water will flow through a cartridge filter for final removal of any metal oxide precipitates and suspended solids to meet Illinois effluent standards. The Illinois effluent standards are presented later in this section. The treated water will be discharged using an effluent pump to the nearby south branch of the Kishwaukee river.

3.2 DESIGN OF GROUNDWATER EXTRACTION SYSTEM

3.2.1 Basis of Design

3.2.1.1 Hydrogeological Data

Hydrogeological data was collected prior to the groundwater flow modeling. Data obtained from direct field measurements was used to the fullest extent possible. Where field data was lacking, hydrogeologic parameters were interpolated from the nearest measured values or estimated. Hydrogeologic data was collected for the following parameters:

- Transmissivity.
- Hydraulic conductivity.
- Aquifer saturated thickness.
- Recharge
- Water level elevations.

WESTON conducted an aquifer pumping test at the Techalloy facility as described in Section 2.3. The test evaluation indicated that the mean transmissivity of the water table aquifer in the area is approximately 7,800 square feet per day (ft^2/day). Based on a measured aquifer saturated thickness of 30 feet, the hydraulic conductivity of the aquifer is approximately 260 ft/day. This hydraulic conductivity is assumed for the entire area.

1990 gpd/ft²

Values for saturated thickness of the aquifer were based on logs from residential wells, in addition to logs from monitoring wells and soil borings from previous Techalloy investigations.

Recharge to the aquifer was estimated as a percentage of annual rainfall, which is approximately 30 inches/year. Recharge is estimated to be ~~10 inches/year~~.

~~The primary sources of water level elevation~~ data were Kishwaukee River and South Branch River elevations obtained from the Marengo North and Marengo South 7.5-minute USGS (United States Geological Survey) quadrangle maps. River gradients were calculated between each set of surface elevation contours that crossed the rivers, and river elevations were interpolated between the contours. Depth-to-water measurements were obtained from seven locations within the area from Techalloy monitoring wells and boreholes, as well as residential well logs. The groundwater elevations were calculated by subtracting the depth-to-water measurements from surface elevations estimated from the topographic maps.

3.2.1.2 Transport Data

Transport data include the following parameters:

- Concentration and rate of constituents.
- Sorption
- Dispersion.

The rate and concentration of constituents introduced into the aquifer at the source area are unknown. Therefore, these parameters were varied within a reasonable range, with the objective of matching the groundwater model output with the existing plume configuration. The groundwater model assumes a ~~0.5 percent~~ concentration of TCE injected at a rate of 15 gallons per day (gpd). 5000 ppm TCA?

The retardation factor for TCE was calculated using the following known parameters:

- Linear sorption distribution coefficient.
- Bulk density of aquifer material.
- Fraction organic carbon.
- Porosity.

The retardation factor for TCE was calculated to be 9.417. The retardation factor for PCE was calculated as 23.507 and TCA was 10.399. The groundwater velocity based on a hydraulic conductivity of 260 ft/day, a gradient of 0.0017 ft/ft and a porosity of 34 percent is 1.3 ft/day. Velocities for these constituents based on these retardation factors are TCE = 0.14 ft/day, PCE = 0.055 ft/day and TCA = .125 ft/day. A more detailed description of sorption is provided in the report attached in Appendix D.

Values for longitudinal and transverse dispersivity were chosen during the groundwater modeling in order to simulate a plume which resembles the existing one. The longitudinal dispersivity set at 250 feet and the transverse dispersivity was set at 1.25 feet.

3.2.1.3 Groundwater Quality Standards

Illinois Administrative Code, Title 35, Subtitle F, Subpart D specifies groundwater quality standards for TCA, TCE and PCE appropriate to the groundwater's use. IEPA has provided Techalloy with groundwater cleanup objectives for VOCs of concern. These cleanup objectives are the same as Class I standards. Class I (Potable Resource Groundwater) standards for 1,1,1-TCA, TCE and PCE for Illinois are listed below:

Chemical	Class I Groundwater Quality Standard (µg/L)
1,1,1-TCA	200
TCE	5
PCE	5

The Class I groundwater quality standards will be used as cleanup objectives for groundwater, and to determine the extent of impacted groundwater. The main objective of the groundwater extraction and treatment system is to prevent further migration of impacted groundwater.

3.2.1.4 Location of Extraction Well and Pumping Rate

The extraction well will be located northeast of the intersection of Non-responsive [redacted] such that it lies near the center of the measured contaminant plume. The pumping rate should be 280 gpm in order to capture the width of the plume.

3.2.2 Design Elements

3.2.2.1 Extraction Well

Design specifications, installation procedures, and construction techniques for the extraction well will comply with American Water Works Association (AWWA) guidelines as set forth in "AWWA Standard for Water Wells" (AWWA A100-84,June,1984). The proposed groundwater extraction well will be constructed and operated using the following design specifications:

- Well casing and screen diameter: 8 inches.
- Well casing specification: 50-foot length, 8-inch diameter, low carbon steel.
- Screen specifications: low carbon steel with 0.020-inch slots, 30 feet in length (approximately 50 to 80 feet below grade).
- Borehole: minimum 16 inches in diameter.
- Gravel pack: gradation, material, grain shape and specific gravity in accordance with AWWA standards.
- Grouting and sealing: completed according to guidelines of AWWA.
- Well development: will apply techniques to achieve the optimal well efficiency, specific capacity, stabilization of aquifer material, and control of suspended solids as specified by AWWA standards.

The extraction well detail is presented in Figure 3-2.

In conjunction with extraction well installation, two piezometers will be installed to determine drawdown induced from the pumping well. One piezometer will be installed approximately 50 feet from the extraction well. The piezometers will be constructed using following design specifications.

- Well casing and screen diameter: 2 inches.
- Well casing specification: 70 feet length, 2 inches diameter, PVC.
- Screen specifications: 2-inch diameter PCV slotted screen, 10 feet in length (approximately 70 to 80 feet below grade).
- Borehole: minimum 8 inches in diameter.
- Gravel pack: gradation, material, grain shape, and specific gravity in accordance with AWWA standards.
- Grouting and sealing: completed according to guidelines of AWWA.
- Well development: will apply techniques to achieve the optional well efficiency, specific capacity, stabilization of aquifer material, and control of suspended solids as specified by AWWA standards.

The piezometer (observation well) detail is shown in Figure 3-3.

In order to define the vertical extent of the contaminant plume within the area of Union and Highbridge Roads, samples will be collected every five feet until the boring reaches 15 feet into the till unit. Samples will be analyzed for grain size and non-aqueous phase liquids. In addition, groundwater samples will be collected at 5-foot intervals using lead screened augers and will be analyzed for VOCs.

To assess the capture zone of the extraction well, one piezometer will be installed near the perimeter of the contaminant plume, either east or west of the extraction well. The piezometer will be screened in the aquifer so that pumping induced drawdown will not pull water down below the screen.

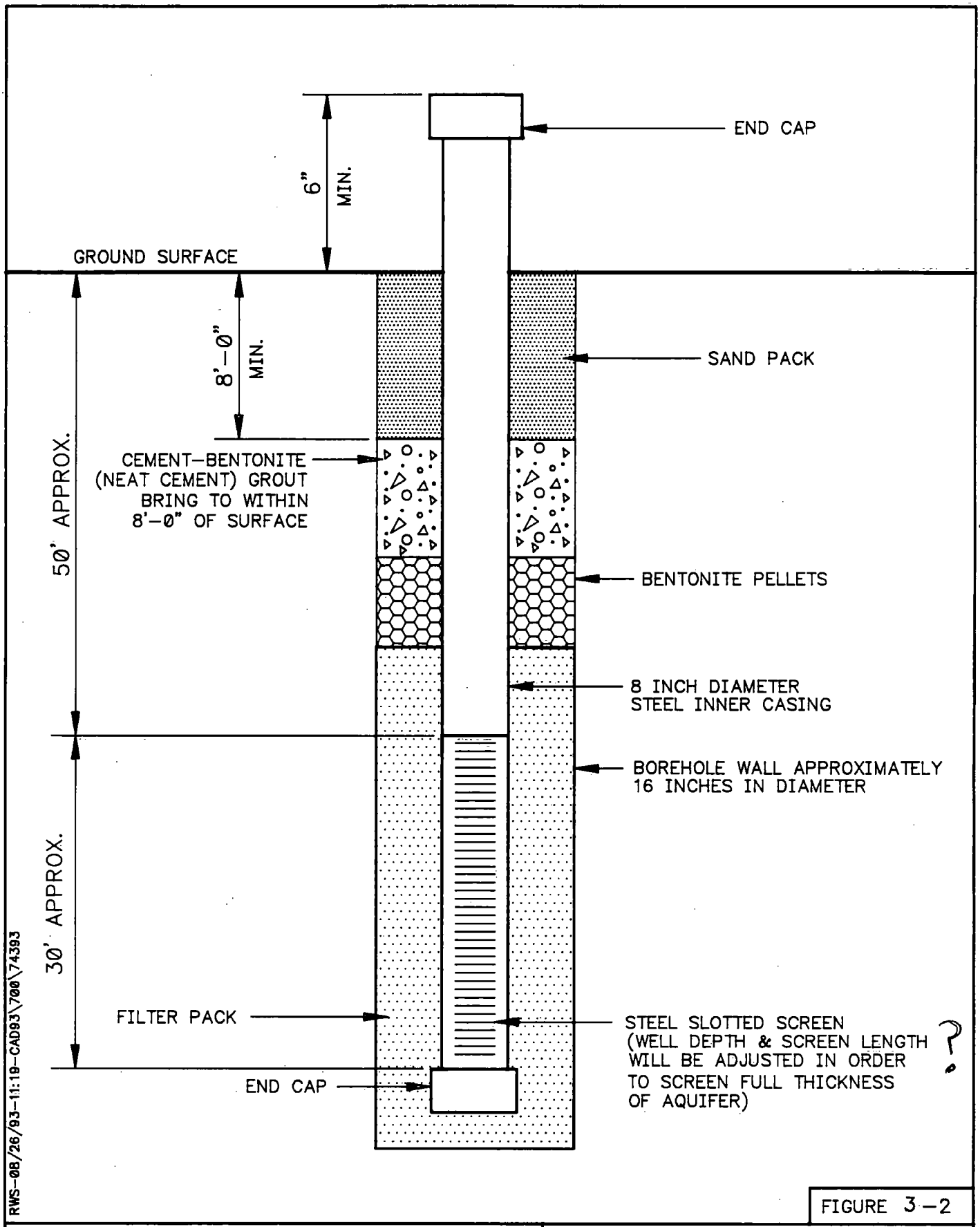

FIGURE 3-2

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

EXTRACTION WELL DETAIL

TECHALLOY COMPANY, INC.
Union, Illinois

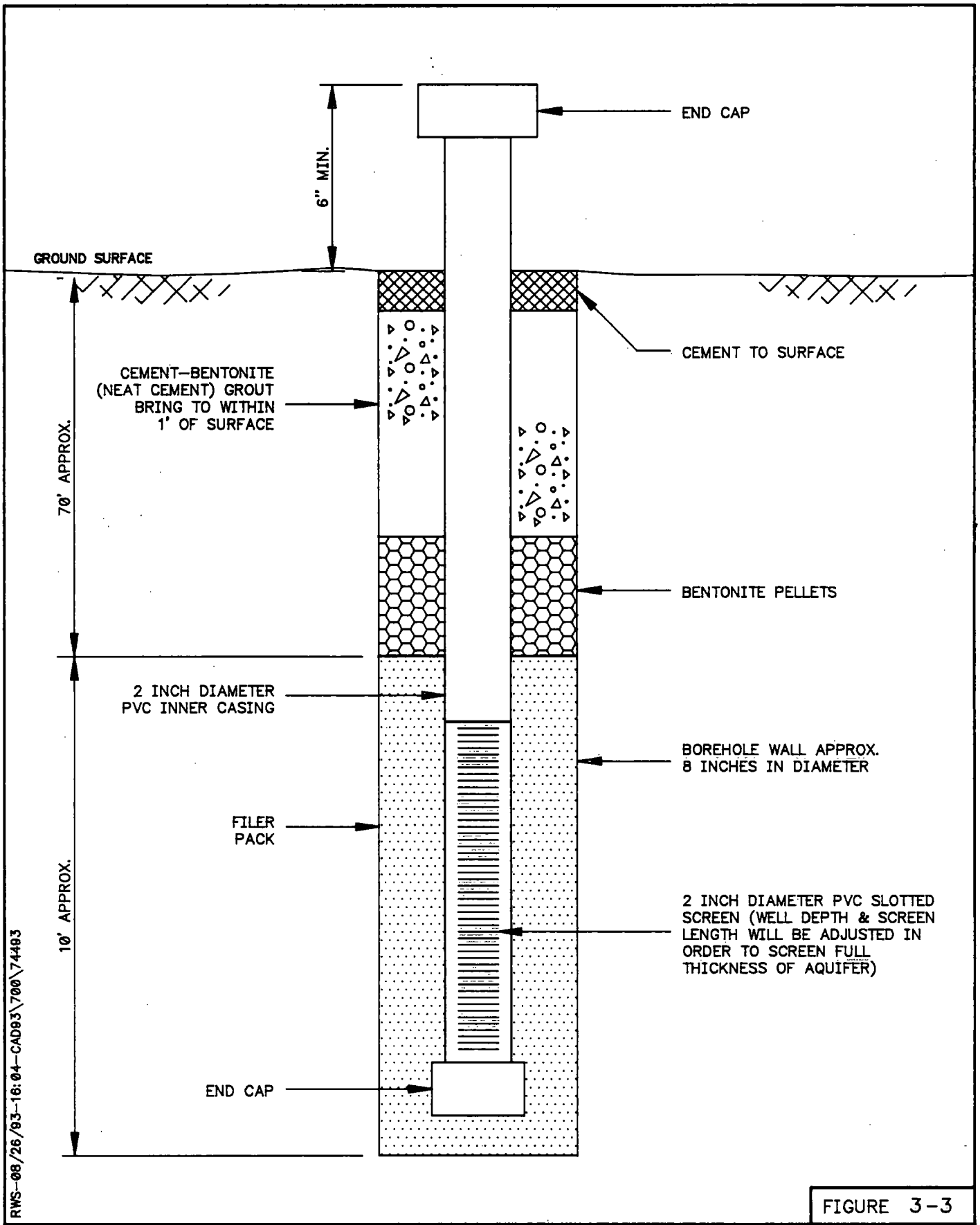

FIGURE 3-3

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

OBSERVATION WELL DETAIL

TECHALLOY COMPANY, INC.
Union, Illinois

3.2.2.2 Extraction System Piping

High density polyethylene (HDPE) was selected as the pipe material best suited to convey raw, untreated groundwater to the treatment plant. HDPE was selected for its inherent advantages of flexibility, resiliency and toughness. It is virtually inert and one of the most chemically resistant plastics commercially available. The pipe is not expected to react with the groundwater contaminants even at their current concentrations therefore providing a substantial estimated "life" of the installed pipeline.

The pipeline will be double walled to provide continuous leak containment along the length of the buried portion of the pipeline. The leak containment system will consist of an eight inch outer pipe and a six inch diameter inner pipe. The selection of the six inch inner pipe was based on a maximum flow condition of 350 gallons per minute. Engineering calculations showing the approximate flow conditions are provided in Appendix E.

The location of the project, in northern Illinois, will require the pipe will be placed at a depth below the normal frost line. Backfill will compensate for traffic loads where the pipeline passes under roadways and joints will be field welded for added strength. Welding also has the additional benefit of reducing the potential for system leaks.

3.2.2.3 Pumping System

Groundwater will be pumped to the surge tank located at the treatment plant using a submersible well pump. The pump has been sized to deliver 350 gallons per minute which is the design condition established by the groundwater flow model plus an additional 25 percent factor of safety. Operating parts in the pump will be chemically resistant to insure adequate life expectancy.

The well pump is equipped with a 15 horsepower motor and has a flow range of 230 to 500 gallons per minute. The size of the pump will require a minimum well size of 8 inches and

will discharge through a 4 inch outlet. A concrete box structure will be constructed at the wellhead to allow access to the pump and associated equipment. Details of the wellhead structure are included in the construction drawings.

The pump will be operated by a controller located in the treatment plant. The pump controller will receive water level information from the well and the surge tank. Liquid level control switches (sensors) installed in the well and surge tank will relay information to the pump controller which will cycle the pump on and off depending on where the water level is in relation to the predetermined sensor elevations. Further explanation of the pump control sequence is provided in Section 3.2.2.4.

3.2.2.4 Control Systems

The extraction well and the discharge piping will be equipped with flow and level gauges and switches to control and monitor the extraction well pumping system.

The operation of the well will be controlled by the water level in the surge tank/aeration tank and the extraction well. Two level switches (floats) will be installed in the surge tank and one switch in the well. These switches will function as follows:

- The switch in the well will not allow the submersible well pump to operate unless the water level in the well is above the switch.
- A high level switch in the surge tank will shut down the well pump in the event that the water level exceeds the high level set point in the surge tank.
- An operating level switch in the surge tank will restart the well pump after the well has been shut off by of the shut-off switches. In automatic operation, once the water level reaches the switch location, the well pump will remain on until it reaches the high level switch in the surge tank or the low level switch in the well.

In addition to the extraction well pump controls, the piping from the well to the treatment system will have secondary containment and a leak detection control system. In the event leakage is detected in the piping secondary containment system, an alarm will be activated.

This alarm condition will be relayed to the operator responsible for the system operation.

Sample ports will be installed at the well. This port can be used to collect groundwater samples representative of the water being withdrawn from the extraction well.

3.2.2.5 Equipment Enclosure

The sampling and control vault provided at the well will provide well protection, control and a place to collect groundwater samples from the well. The vault will be equipped with a lockable cover to prevent unauthorized access, and will be insulated to prevent freezing in winter. It will be of sufficient size to house the discharge valves, sample port, and electrical connections to the well. Details of vault construction and layout are shown in the construction drawings shown in Appendix F of this report.

3.3 DESIGN OF EXTRACTED GROUNDWATER TREATMENT SYSTEM

3.3.1 Basis of Design

3.3.1.1 Extracted (Influent) Water Characteristics

VOC concentrations (1,1,1-TCA, TCE, and PCE) in extracted groundwater from proposed extraction wells were conservatively estimated using analytical results of groundwater samples from monitoring wells MW-HBR and TW-3 (Figure 1-2). The concentrations were averaged out along the plume width (1,200 feet). The estimated average VOC concentrations in extracted groundwater are 1,450 μg/L, 1,1,1-TCA, 150 μg/L TCE, and 110 μg/L PCE. The calculations are presented in Appendix E. The maximum VOC concentrations near the proposed extraction well were observed at MW-HBR (Figure 1-2). The VOC concentration at MW-HBR was 3,700 μg/L 1,1,1-TCA, 24 μg/L TCE, and 310 μg/L PCE.

1450
150
100
1700

Concentration of inorganic constituents in groundwater from proposed extraction well were estimated to be same as concentrations in groundwater from the aquifer pump test well. Analytical data for the aquifer pump test well sample was presented earlier in Table 2-3. The only inorganic constituents detected above general effluent standards were iron and

total suspended solids. Iron was detected at a concentration of 5 mg/L and total suspended solids was detected at a concentration of 94 mg/L.

3.3.1.2 Pretreatment Requirements for Air Stripper

One of the most common problems with air stripping towers is that over time they become fouled with solids, resulting in the loss of efficiency, capacity, and increased pressure drop. The added weight of the entrapped solids can also be a problem for the packing and other internals. The solution to the fouling problem can be found in effective pretreatment, good maintenance practices (cleaning), good monitoring of process conditions, and good overall process design. This subsection describes the basis of design for the pretreatment system.

Groundwater quality data from the site indicates 4.9 mg/L of total iron, and 94 mg/L of total suspended solids. In the air stripper, oxygen from the air will be transferred into the water and this will promote the conversion of iron to oxidation states that are insoluble in water. These insoluble iron oxides will precipitate out of the water and the crystals (precipitate) will attach themselves to packing materials. These crystals become "seeding" sites for other crystals to adhere and grow, and thus causing fouling and plugging of packing materials. Moreover, aerated water also promotes bacterial growth. Bacteria colonies in the water attach themselves to the packing and provide numerous sites for inorganic deposition and vice-versa. Some forms of bacteria even use the iron oxides as a nutrient.

The main purpose of the pretreatment system is to reduce the degree of fouling. Based on the groundwater quality of the site and the process of fouling described above, the design approach for the pretreatment system will be to reduce the total dissolved iron and total suspended solids concentration in water entering into the air stripper. The pretreatment system is described in subsection 3.3.2.1 of this report.

3.3.1.3 Treated (Effluent) Water Requirements

The discharge from the treatment system will meet or be lower than the levels established by IEPA for appropriate parameters under the National Pollution Discharge Elimination System (NPDES) permit. For the purpose of design, Drinking Water Regulations were used to determine effluent water requirements for VOCs of concern. According to Illinois Administration Code (IAC), Title 35, Subtitle F, Subpart F and 40 Code of Federal Regulations (CFR), Part 141, Subpart 6, maximum contaminant levels (MCLs) for VOCs of concern are 200 μg/L 1,1,1-TCA, 5 μg/L TCE and 5 μg/L PCE. The design of the treatment process is intended to achieve these concentrations in the effluent.

The IAC, Title 35, Subtitle C, Part 304, Subpart A, contains general effluent limitations on various constituents that may be discharged to the waters of the state. Table 3-1 presents the Illinois general effluent standards for the effluent stream. The design of the treatment process is intended to achieve these effluent standards. The concentration of iron and total suspected solids will have to be reduced to 2.0 mg/L and 15.0 mg/L, respectively, to meet the effluent standards.

For constituents for which there are no general effluent standards, IEPA will determine water quality criteria for the receiving stream (South Branch of Kishwaukee River). Applicable water quality standards pertaining to discharge to the South Branch of Kishwaukee River were requested from IEPA Division of Water Pollution Control. Mr. Robert C. Mosher of IEPA in a letter dated 16 August 1993, provided WESTON with general guidelines regarding allowance of dilution and water quality criteria for VOCs of concern. According to IEPA, the South Branch of the Kishwaukee River has a 7-day, 10-year low flow of 2.0 cubic feet per second (cfs) at the point of discharge. A dilution ratio of 2.6:1 will exist at the design discharge rate of 350 gpm. According to IEPA mixing zone procedures, 50 percent of this receiving stream can be used for dilution. Based on these characteristics and 35 IAC 302.210 and Subpart F, chronic water quality criteria for VOCs of concern are 393 μg/L 1,1,1-TCA, 940 μg/L TCE and 152 μg/L PCE; and acute water quality criteria for VOCs of concern are 4,910 μg/L 1,1,1-TCA, 11,700 μg/L TCE, and 1,220

Table 3-1

Illinois General Effluent Limitations
Techalloy Company, Inc.
Union, Illinois
(Concentrations in mg/L)

Constituent	General Effluent Standard
Arsenic	0.25
Barium	2.0
Cadmium	0.15
Chromium (hexavalent)	0.1
Chromium (total)	1.0
Copper	0.5
Cyanide	0.10
Fluoride	15.0
Iron (total)	2.0
Lead	0.2
Manganese	1.0
Nickel	15.0
Oils	0.3
Phenols	0.3
Silver	0.1
Zinc	1.0
Total suspended solids	15.0
BOD_5	10.0[a]
Mercury	0.0005

[a]For effluent whose dilution ratio is less than 5 to 1.

μg/L PCE. The design of the treatment process is intended to achieve the more stringent MCL concentrations.

3.3.1.4 Location of the Treatment System Building

The approximate location of the treatment system building is shown in Figure 3-1. The building will be situated on the northeast corner of the Techalloy property, approximately 50 feet west of Olson Road and 75 feet south of a transformer near the Techalloy property. The air stripper tower will be located approximately 5 feet west of the treatment system building. The treatment system building will house a surge/aeration tank, pumps, blowers, centrifugal separator, filter systems, and control systems. The treatment system building details are presented in Subsection 3.3.2.6.

3.3.2 Design Elements

3.3.2.1 Pretreatment System

The pretreatment system will consist of an aeration tank and a filter system. The main purpose of the aeration tank is to oxidize iron in water to oxidation states that are insoluble in water. The aeration tank will also act as a flow stabilizer. The filter system is intended to remove suspended solids and insoluble iron oxides and thus reduce fouling and plugging of packings in the air stripper. The process flow for the pretreatment system is shown in Figure 3-2. A small bench-scale study should be conducted to confirm the effectiveness of this pretreatment system.

wrong

Aeration Tank System

The aeration tank system will consist of a 5,500-gallon tank, a positive displacement reciprocating compressor, a diffuser assembly, and an air vent.

The 5,500-gallon tank will be 17.5 ft. in diameter, 17.8 ft. ft high and be of fiberglass reinforced plastic (FRP) construction. This tank was sized to provide fifteen minutes of residence time for influent water at a design flow rate of 350 gpm. The effectiveness of this

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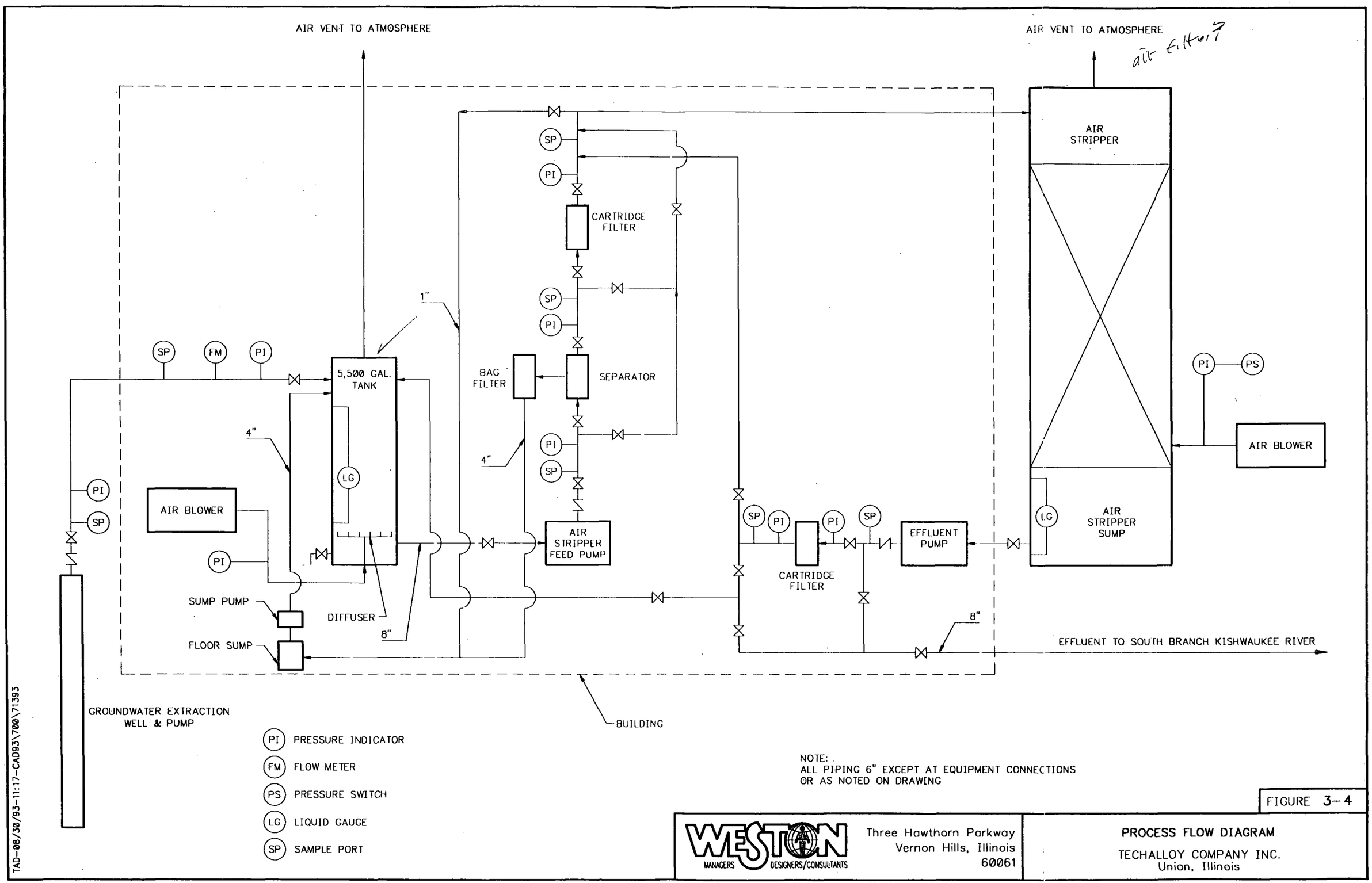
AIR VENT TO ATMOSPHERE
AIR VENT TO ATMOSPHERE
air filter?
AIR STRIPPER
SP
PI
CARTRIDGE FILTER
SP
PI
1"
SP
FM
PI
5,500 GAL. TANK
BAG FILTER
SEPARATOR
PI
PS
AIR BLOWER
4"
LG
PI
SP
4"
PI
SP
AIR BLOWER
AIR STRIPPER FEED PUMP
SP
PI
PI
SP
EFFLUENT PUMP
LG
AIR STRIPPER SUMP
PI
CARTRIDGE FILTER
SUMP PUMP
DIFFUSER
8"
8"
FLOOR SUMP
EFFLUENT TO SOUTH BRANCH KISHWAUKEE RIVER
BUILDING
GROUNDWATER EXTRACTION WELL & PUMP
PI PRESSURE INDICATOR
FM FLOW METER
PS PRESSURE SWITCH
LG LIQUID GAUGE
SP SAMPLE PORT
NOTE:
ALL PIPING 6" EXCEPT AT EQUIPMENT CONNECTIONS
OR AS NOTED ON DRAWING
TAD-08/30/93-11:17-CAD93\700\71393
WESTON
MANAGERS
DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061
PROCESS FLOW DIAGRAM
TECHALLOY COMPANY INC.
Union, Illinois

FIGURE 3-4

residence time should be confirmed during the bench-scale study. The aeration tank will have a top cover and an air vent line going upward to the roof of the treatment system building.

The influent water will enter the aeration tank at the top. The aeration tank will be equipped with an air inlet duct. The air inlet duct will be equipped with a removable air mesh screen to prevent any airborne debris from entering the aeration tank. A diffuser assembly will be provided near the air inlet opening to properly distribute the inlet air throughout the cross sectional area of the aeration tank. The diffuser assembly will be of PVC construction.

The inlet air will be provided with a compressor. The blower will be capable of producing - 20 cfm of air.

Filter System

A separator and a cartridge industrial filter system will be used to provide removal of iron oxide precipitate and suspended solids from water leaving the aeration tank. The separator will remove dense and larger size particles before the water enters the filter. The separator will have a timer that will activate blowdown from the separator in 3-7 second intervals. The timer can be adjusted as desired between blowdowns. The blowdown will go through a bag filter. Solids will be retained by the bag filter and solids-free water will drain by gravity to the floor sump. The floor sump recycles water back to the surge/aeration tank. The cartridge filters are typically compact and requires less floor space than other filters. The filter media in these systems is typically synthetic fiber cartridges. The cartridges are available in different nominal micron sizes and can be easily removed for servicing. Initially, a 10 nominal micron size cartridge is anticipated to provide for required filtration. However, the cartridge size can be changed based on actual solids removal and pressure drop. These parameters will be monitored through sampling ports and pressure gauges provided for this purpose.

3.3.2.2 Air Stripping System

The air stripping system will consist of an air stripper tower and an air stripper blower. The process flow for the air stripper system is shown in Figure 3-2.

The air stripper will utilize a single stage packed bed countercurrent flow scheme. The basic concept behind the packed tower air stripper is to bring the contaminated water in contact with air, so that the volatile compounds undergo a phase change (from liquid phase to vapor phase). Influent water from the pretreatment system will be introduced at the top of the stripping tower utilizing an influent water distribution system. The influent water distribution over the top of the packed bed will minimize channeling and maldistribution. Air will be introduced at the bottom of the tower through a low velocity inlet providing low turbulence air flow to minimize flow straightening and pressure loss requirements prior to entering the packed bed section.

The air stripper tower will be of steel construction and designed to be anchor bolt ring mounted on concrete foundation pad. The tower will be approximately 4 feet in diameter and 29 feet in overall height. The packing height will be approximately 17 feet.

The air will exit the packed bed section and travel upward where final mist elimination and mist removal will take place by impinging the air borne water droplets on the mist eliminator. The treated influent water will exit at the bottom of the air stripper tower to go through a final filtration step before discharge.

3.3.2.3 Effluent Filter System

The purpose of the effluent filter system will be to provide for additional removal of any metal oxide precipitates and suspended solids to meet Illinois effluent standards. The filter system utilized here will be similar to the one used in the pretreatment step. A sampling port will be provided after the filter to monitor effluent quality. If the effluent filter system is not necessary, the effluent water will bypass the effluent filter system.

3.3.2.4 Treatment System Pumping and Piping

Groundwater will be pumped from the surge tank to the air stripper using a air stripper feed pump. The pump has been sized to deliver 350 gallons per minute which is the design condition established by the groundwater flow model plus an additional 25 percent factor of safety. Operating parts in the pump will be chemically resistant to insure adequate life expectancy.

The air stripper supply pump is a centrifugal frame mounted pump also designed to run at 350 gallons per minute at a total head of approximately 100 feet. The pump is equipped with a 15 horsepower motor and an enclosed 10 inch impeller operating at 1750 rpm.

The pump will be operated by a controller located in the treatment plant. The pump controller will receive water level information from the surge tank. Liquid level control switches (sensors) installed in the surge tank will relay information to the pump controller which will cycle the pump on and off depending on where the water level is in relation to the predetermined sensor elevations. Further explanation of the pump control sequence is provided in Subsection 3.3.2.5.

3.3.2.5 Control Systems

The pretreatment and air stripping systems will be equipped with flow, pressure gauges and switches, and level gauges and switches to control and monitor the operation of the extracted groundwater treatment system.

The extraction well and influent piping to the treatment system are controlled by the water levels in the surge tank. The various phases of the treatment system have individual controls but each element of the treatment system is interrelated to other elements. The water levels in the surge tank also control the operation of the air stripper feed pump.

The electrical and mechanical components included to monitor and control the liquid operation of the treatment system are described as follows:

- A flow meter is provided on the inlet to the treatment system to determine the flow rate to the treatment system from the extraction well.
- The air stripper feed pump will be controlled by switches (floats) in the surge tank. A low level switch in the surge tank will shut off the pump so that the pump will not be operated without water. An operating level switch will allow the feed pump to restart after the pump has been shut off by the low-level switch.
- A high level switch in the air stripper sump will override the air stripper feed pump control and shut off the air stripper feed pump.

Other components included to monitor and control the operation of the treatment system are as follows:

- A pressure switch to shut off the blower for the air stripper in the event that excessive pressure develops at the blower discharge. The shut down of the blower by high pressure will result in the activation of the alarm and the shut down of the air stripper feed pump.
- The air flow rate to the surge tank will be measured by an in-line variable area flow meter that will be installed between the compressor and the diffusers in the surge tank.
- Pressure indicators (gauges) will be installed upstream and downstream of the filters in the piping to determine if the filters are becoming clogged.
- Elapsed time meters will be provided for the air stripper feed pump and the effluent pump to determine maintenance requirements for the pumps.

Sample ports will be installed within the treatment system piping. Sampling ports will be installed at the following locations:

- Influent line to the surge tank.
- Effluent line from the surge tank, but before the filter system.
- Influent line to air stripper but after filter.
- Effluent line from air stripper both before and after filter.

In the event adverse operating conditions develop, an alarm will be activated and this will cause the treatment system to shut down. The conditions that will effect an alarm condition include the following:

- Excessive pressure at the blower for the air stripper.
- High level in the air stripper sump for treated water.
- Leak detection in the piping containment system.
- Leak detection in the building basement.

3.3.2.6 Equipment Enclosure

The air stripper feed pump, effluent pump, surge tank, compressor filters, and electrical controls will be housed within a pre-engineering metal building. The building will be constructed in two levels. The lower level (basement area) will act as a secondary containment for the surge tank. The overall height of the first level will be 14 feet to provide access to the surge tank. The building will be accessed by two 3-foot-wide center-locking doors. The building will also be equipped with lights, unit heater to maintain building temperature above freezing during the winter, and ventilation louvre. Details are shown in the construction drawings provided in Appendix F of this report.

3.4 DESIGN OF DISCHARGE SYSTEM

3.4.1 Basis of Design

3.4.1.1 Effluent Water Discharge

After treatment of the contaminated groundwater, effluent will be discharged to the nearby South Branch of the Kishwaukee River. The discharge of treated water to the waters of Illinois requires a permit (NPDES permit) from the IEPA Division of Water Pollution Control. The effluent water quality requirements were presented in subsection 3.3.1.3. The piping and pumping requirements are presented in subsections 3.4.2.1 and 3.4.2.2, respectively.

3.4.1.2 Air Discharge

The contaminated groundwater presently does not affect the air quality. Illinois regulations allow direct discharge of the treatment system's exhaust gases. However, IEPA Division of Air Pollution Control will need to approve the construction and operation of the treatment system. Based on estimated influent concentrations for the air stripper, estimated air emissions are 0.25 pounds per hour (lbs/hr) 1,1,1-TCA, 0.03 lbs/hr TCE, and 0.02 lbs/hr PCE. This is a estimate based on an average VOC concentration in extracted groundwater, and conservatively assuming 100 percent removal efficiency by the air stripper. Per phone conversations with Mr. Michael Costello of IEPA Division of Air Pollution Control, the VOC emissions should not exceed 8.0 lbs/hr. However, this is only a general guideline and site-specific limits will be provided by IEPA after reviewing the operating permit application. At this stage, it is estimated that the air discharge will not contribute to air pollution. Furthermore, chlorinated VOCs have a very short half-life when exposed to the sun. TCE, for example, has a half-life of approximately a day and a half in the atmosphere.

3.4.2 Design Elements

3.4.2.1 Treated Water Discharge Piping

High density polyethylene (HDPE) was selected as the pipe material to convey treated effluent water to the discharge point. HDPE was selected for its inherent advantages of flexibility, resiliency and toughness. It is virtually inert and one of the most chemically resistant plastics commercially available.

Secondary containment with leak detection will not be required for the treated water enabling the use of a single wall pipeline. A pipe diameter of 8 inches was selected in order to provide flow possibilities in excess of 350 gallons per minute for possible future expansion of the treatment facility. Engineering calculations showing the approximate flow conditions are provided in Appendix E.

The location of the project, in northern Illinois, will require the pipe will be placed at a depth below the normal frost line. Backfill will compensate for traffic loads where the pipeline passes under roadways and joints will be field welded for added strength. Welding also has the additional benefit of reducing the potential for system leaks.

3.4.2.2 Treated Water Discharge Pumping System

Groundwater will be pumped from the air stripper sump to the discharge point to the South Branch of the Kishwaukee River using an effluent pump. The pump has been sized to deliver 350 gallons per minute which is the design condition established by the groundwater flow model plus an additional 25 percent factor of safety.

×61 gpm

The effluent pump is a centrifugal frame mounted pump also designed to run at 350 gallons per minute at a total head of approximately 37 feet. The pump is equipped with a 5 horsepower motor and an enclosed 6.5 inch impeller operating at 1750 rpm.

The pump will be operated by a pump controller located in the treatment plant. The pump controller will receive water level information from the air stripper sump. Liquid level control switches (sensors) installed in the sump will relay information to the pump controller which will cycle the pump on and off depending on where the water level is in relation to the predetermined sensor elevations. Further explanation of the pump control sequence is provided in Section 3.4.2.3.

3.4.2.3 Control Systems

Flow, pressure gauges and switches, and level gauges and switches will be used to control and monitor the operation of the treated water discharge system. The effluent pump will be controlled by switches (floats) in the air stripper sump. A low level switch in the sump will shut off the pump. An operating level switch will allow the effluent pump to restart after the pump has been shut off by the low-level switch. Pressure indicators (gauges) will be installed upstream and downstream of the filter in the effluent piping to determine if the

filter is becoming clogged. An elapsed time meter will be provided for the effluent pump to determine maintenance requirements for the pump. Sampling ports will also be installed in the effluent line from the air stripper, both before and after the filter.

SECTION 4
CONSTRUCTION DRAWINGS AND SPECIFICATIONS

4.1 CONSTRUCTION DRAWINGS

Construction drawings of the pump-and-treat system have been prepared as part the Interim Measures Design. A reduced (11- by 17-inch) set of the construction drawings is presented in Appendix F.

4.2 TECHNICAL SPECIFICATIONS

Technical specifications that describe the material, equipment, installation, and testing requirements for the construction of the pump-and-treat system have been prepared as part of the Interim Measures Design. The specification follow the format developed by the Construction Specifications Institute (CSI) master format. The technical specifications are presented in Appendix G.,

SECTION 5
PERMIT REQUIREMENTS

5.1 CONSTRUCTION PERMIT

Illinois Permits and General Air Pollution regulations require a permit for construction of any new emission source or any new air pollution control equipment (Illinois Administration Code, Title 35, Subtitle B, Subpart C 201.142 and Subpart D 201.152). Illinois water pollution regulations also require obtaining a permit for construction of any new treatment works for which an NPDES permit is required (Illinois Administration Code, Title 35, Sections 309.154 and 309.202).

A construction permit application, WPC-PS-1 (Schedule J and N), will be prepared for construction of the treatment system and submitted to IEPA for review and approval. In accordance with the Consent Order, the permit will be prepared after approval of the Interim Measure Final Design.

5.2 AIR OPERATING PERMIT

Illinois Permits and General Air Pollution regulations require a permit for operation of any new emission source or any new pollution control equipment of a type for which construction permit is required (Illinois Administration Code, Title 35, Subtitle B, Subpart C 201.143 and Subpart D 201.157). Forms APC-200 and APC-220 will be prepared and submitted to IEPA Division of Air Pollution Control for review and approval. Form APC-200 is "Application for Permit". It identifies the owner of the emission sources and control equipment, the operator of the equipment, and the location of the equipment. Form APC-220 is for "Process Emission Source". This form is for any emission source that is part of the process.

5.3 NPDES PERMIT

Federal regulations (40 CFR Part 122) require obtaining a NPDES permit for all industrial facilities that discharge wastewater directly into U.S. waters. EPA Forms 3510-1 and 3510-2D will be prepared and submitted to IEPA Division of Water Pollution Control for review and approval. EPA Form 3510-1 is required to be completed by all persons applying for a permit under EPA's Consolidated Permits Program. Form 3510-2D is an application for permit to discharge process wastewater for new sources and new discharges.

SECTION 6
SUPPLEMENTAL DESIGN INFORMATION

Certain supplemental design information has been prepared by WESTON to support interim measures design and implementation. This section presents the operation and maintenance plan for the treatment system, groundwater monitoring plan, estimated construction schedule, and construction quality assurance plan.

6.1 OPERATION AND MAINTENANCE (O & M) PLAN

WESTON has prepared an operation and maintenance (O & M) plan for the pump-and-treat system. The O & M plan is presented in Appendix H. The O & M plan describes the general guidelines to be followed for effective operation and maintenance of the pump-and-treat system. The O & M plan does not incorporate vendor supplied O & M literature on the various equipment items. As part of the construction contract, the construction contractor will be required to compile vendor-supplied detailed O & M information for inclusion as attachments to this O & M plan.

6.2 GROUNDWATER MONITORING PLAN

Monitoring of the VOC concentrations in the extracted groundwater will be performed to assess the ongoing influence of the extraction system. This subsection addresses the rationale and activities to be performed.

The purpose of the interim measures groundwater extraction system is to prevent further migration of the constituent plume. In association with the extraction process, constituent concentrations will be evaluated at the extraction location over the duration of the extraction.

Additional monitoring at the on-site (facility) monitoring wells will not be carried out because the purpose of the extraction system is to control future downgradient migration and not reduce on-site (facility) groundwater constituent concentrations.

Sampling of the residential wells identified in the Private Well Sampling Plan (PWSP) dated May 1993, will not be performed to specifically evaluate the affects of the extraction system; however, these residential wells are located south of the southern fringe of the constituent plume and the results of the semi-annual sampling of these wells will be evaluated to identify any potential affects to these locations by the extraction process.

Sampling of the extraction well will document the level of constituents being removed from the aquifer and will track the effectiveness of the system. The extraction well will be sampled on a monthly basis for the first year, and on a semi-annual basis subsequently. The samples will be analyzed for VOCs by WESTON-Gulf Coast Laboratories located in University Park, Illinois. The extraction well samples will be analyzed following the methodologies outlined in the PWSP and the related SOPs in the Techalloy RCRA facility investigation quality assurance project plan (QAPP). Analysis for all VOCs, except vinyl chloride, will follow U.S. EPA SW-846 Method 8260. Analysis for vinyl chloride will follow SW-846 Method 8010. These methods will be utilized to provide VOC detection limits below the relevant VOC maximum contaminant levels (MCLs).

6.3 CONSTRUCTION SCHEDULE

The construction schedule will be in accordance with the schedule outlined in the consent order. Within 75 days of U.S. EPA's approval of the Interim Measures Final Design, Techalloy will submit all permit applications to the appropriate agencies, as required to implement the approved interim measures. Within 15 days of approval of the permit application, Techalloy will inform U.S. EPA of the date that all permits were approved. Within 270 days of approval of all permits, Techalloy will implement the interim measures approved by U.S. EPA. In addition, within 15 days of startup of the pump-and-treat system, Techalloy will notify U.S. EPA of the system's operational status.

6.4 CONSTRUCTION QUALITY ASSURANCE PLAN

WESTON has prepared a construction quality assurance (CQA) plan to ensure the completion of the groundwater extraction, treatment, and discharge systems in strict accordance with the construction plans and specifications. The CQA plan describes reporting and documentation procedures to be used to verify and certify that construction was completed in accordance with the plans and specifications.

SECTION 7

REFERENCES

U.S. EPA, (Region V), *Administrative Order on Consent in the matter of Techalloy Company, Inc, Union, Illinois;* U.S. EPA I.D. # ILD005178975.

U.S. EPA, *RCRA Corrective Action Plan Interim Final*, EPA/530-SW-88-028, June 1988.

U.S. EPA, *RCRA Corrective Action Interim Measures Guidance Document*, EPA/530-SW-88-029, June 1988.

WESTON, *Phase II Soil and Groundwater Investigation*, Techalloy Company, Inc., Union, Illinois, June 1991.

WESTON, *Private Well Sampling Plan*, Techalloy Company, Inc., Union, Illinois, February 1993.

WESTON, *Interim Measures Work Plan*, Techalloy Company, Inc., Union, Illinois, April 1993.

WESTON, *RFI Work Plan (Draft)*, Techalloy Company, Inc., Union, Illinois, April 1993.

WESTON, *RFI Quality Assurance Project Plan (Draft)*, Techalloy Company, Inc., Union, Illinois, April 1993.

APPENDIX A

RESPONSE TO EPA COMMENTS ON INTERIM MEASURES WORK PLAN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUL 1 1993

REPLY TO THE ATTENTION OF:
HRE-8J

Mr. Henry Lopes
Techalloy Company, Inc.
370 Franklin Turnpike
Mahwah, New, Jersey 07430

Re: Interim Measures Workplan
Techalloy Company, Inc.
ILD 005 178 975

Dear Mr. Lopes:

"The Interim Measures Workplan", dated March 1993, submitted by Techalloy Company in accordance with the Administrative Order on Consent (AOC), Docket No. V-W-007-93, has been reviewed by the United States Environmental Protection Agency (U.S. EPA). This Workplan is hereby approved by U.S. EPA with the following modifications:

- A constant rate aquifer test of sufficient duration, with appropriate pump and observation well design, shall be performed at the site. The test shall be performed and analyzed in accordance with published procedures.

- during well install

  Unless comparable data can be provided from a borehole within 20 feet of the extraction well, undisturbed borehole samples shall be collected at the extraction well. Samples shall be collected at five feet intervals or less, from the water table to bedrock. Grain size analysis shall be performed on all samples to provide a detailed lithologic profile. Samples shall also be tested for non-aqueous phase liquids.

- ibid

  To provide a vertical profile of the ground-water contaminant plume, ground-water samples for volatile organic compound (VOC) analysis shall be collected at the extraction well location. Samples shall be collected at 5 feet intervals or less, from the water-table to bedrock, or at such depth interval that total VOC concentrations are below 20 parts per billion.

- Ground-water samples for NPDES parameter analysis should be collected from the monitoring well MW-HRB (noted as MW-4RB in Workplan).

- Until the RCRA Facility Investigation Quality Assurance Project Plan is approved, ground-water sampling procedures shall follow the procedures prescribed in the Resource Conservation and Recovery Act Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. EPA - September 1986. Bailers should have the bottom delivery design.

Printed on Recycled Paper

- Water level elevations in monitoring well MW-HRB shall be established in conjunction with monitoring wells at the Techalloy facility to determine the hydraulic gradient.

- Figure 6-1 of the Workplan shall be deleted. The schedule given in the AOC shall be followed.

Certain portions of the above mentioned Workplan pertain to design features which are to be included in the Interim Measures Final Design to be submitted pursuant to the AOC. This approval with modifications of the March 1993 Interim Measures Workplan does not constitute approval of any Interim Measures design features.

To expedite the implementation of the Interim Measures, U.S. EPA advises you that in order for U.S. EPA to approve the Interim Measures Final Design, it shall meet the follow requirements:

- Sufficient data shall be included to justify the proposed well screen/casing and pipeline construction materials.

- Records indicate the ground-water to be treated is an F-listed waste. Therefore the water treatment system and the pipeline from the extraction well to the treatment system will need a leak detection and containment system as specified at 35 Ill. Adm. Code Part 724 Subpart J. A contingency plan pursuant to Subpart D will also be required.

- To assess the extent of capture of contaminated ground water, a minimum of two piezometers shall be installed near the extraction well. The piezometers shall be screened at appropriate depths, and one piezometer located near the perimeter of the contaminant plume.

- The ground-water monitoring plan shall include monthly sampling/analysis of the treatment system influent water, for at least one year.

- All relevant hydrologic and geochemical data shall be included in the Final Design submittal. All available aquifer test data for the Union municipal well #3, and any other aquifer test data in the vicinity of the proposed extraction well, shall be included.

- Upon completion of the Interim Measures treatment system a constant rate aquifer test should be performed at the extraction well. Rather than include this data collection in the RFI, it is recommended that this test be performed immediately after completion of the treatment system so that the pump rate can be adjusted accordingly.

If you have any questions call Ron Hewitt at (217) 524-3861 or Kevin Lesko at (217) 524-3271 of the IEPA, or William Buller of the U.S. EPA at (312) 886-4568.

Sincerely yours,

Joseph M. Boyle

Joseph M. Boyle, Chief
RCRA Enforcement Branch

cc: Carlos Sernas, Weston
Kevin Lesko, IEPA

WESTON
MANAGERS DESIGNERS/CONSULTANTS
THREE HAWTHORN PARKWAY, SUITE 400
VERNON HILLS, IL 60061-1450
708-918-4000 • FAX: 708-918-4055

19 July 1993

Mr. William Buller
U.S. Environmental Protection Agency
Region V
RCRA Enforcement Branch (HRE-8J)
77 West Jackson Boulevard
Chicago, IL 60604

Work Order No.: 01989-010-001

Re: Interim Measures - Techalloy Company, Union, Illinois

Dear Mr. Buller:

During our phone conversation on 14 July 1993 you indicated the concern that sampling to bedrock should be conducted to define the vertical extent of the contaminant plume and to define the geology of the glacial till.

During the previous sampling and analysis at the location of Non-responsive [redacted], concentrations were detected at the base of the sandy alluvial aquifer. No sampling was conducted within the clay layer, since this layer is an impermeable aquitard no contamination will be migrating in this unit. WESTON has drilled 7 feet into the clay till unit at well location MW-5. Split-spoon samples collected from within this unit indicate that the till is a silty clay with trace coarse sands and fine gravel. Published information regarding this till unit indicate that the unit is "massive" and impermeable and consists of silty clay to clayey silt with trace amounts of sand and gravel. All information available indicates that the clay unit does not include permeable sand layers of any significance.

Techalloy will agree to defining the vertical extent of the contaminant plume within the area of Non-responsive [redacted] order to supplement existing information. It is proposed that the sampling for grain-size analysis and VOCs be conducted as requested by the U.S. EPA in the letter dated 2 July 1993. However, with regard to depth of the boring it is proposed that sampling be limited to within the first 15 feet of the till unit. This would include 3 grain-size analysis and 3 VOC analysis in order to confirm that the chlorinated constituents have not migrated into the clay unit and the clay is acting as an impermeable boundary preventing any further vertical migration of constituents. Sampling will be conducted using lead screened auger and each interval sampled will be isolated using inflatable packers. This technical approach will satisfy the objectives of the agency as specified in the 2 July 1993 letter from the agency. Attached to this letter is the well log to well MW-5 and two hand-drawn geologic cross-sections prepared by the Illinois State Water Survey. These cross-sections provide excellent information with regard to the massive thickness of the glacial till unit and evidence of the sloping stratigraphic units caused by the occurrence of the glacial outwash valley.

If you have any questions or comments regarding the contents of this letter or wish to further discuss our recommendations, please do not hesitate to contact me at (708) 918-4000.

Very truly yours,

ROY F. WESTON, INC.

Carlos J. Serna, P.G.
Senior Project Manager

CJS:sk

cc: Henry Lopes - Techalloy
Kevin Lesko - IEPA

MW5

GEOLOGIC DRILL LOG

PROJECT NAME AND LOCATION	PAGE NO.	HOL
Techalloy, Union, IL	1 of 3	MV

START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DE
3/27/90	3/29/90	Layne-West.	4.25 I.D. HSA	8"	2" SST	90.0

LOGGER	TOP of CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER · DATE MEASURED
W.L. Niemann			6.25'/'

Deep well at downgradient (North) property line.

SAMPLE NO.	SAMPLE TYPE	RECOVERY "	SAMPLE BLOWS#	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
01	SS	14	4 6 8		1–8			sm sp		SAND: very fine to medium, poorly sorted; some Silt; little fine gravel; medium dense; brown; moist.	
02	SS	18	10 11 10		9–13			sm sp sw		SAND & GRAVEL: medium to coarse Sand, poorly sorted; fine to medium Gravel; medium dense; brown; wet.	
03	SS	18	10 11 11		14–16			sw		As above, fine to coarse Sand.	
04	SS	12	11 15 15		17–23			sp		SAND: fine to medium; well sorted; dense; brown; wet.	
05	SS	0	- - -		24–26			--		No recovery.	
06	SS	14	18 34 32/4"		27–32			sw		SAND & GRAVEL: very fine to coarse Sand, very poorly sorted; fine Gravel; extremely dense; brown; wet.	
07	SS	12	6 14 35		33–35			sp ml		SAND: very fine to medium, poorly sorted; some fine Gravel; dense; brown; wet. Bottom 2": Silt with trace fine Sand.	
08	SS	18			36–38			ml		SILT: very well sorted; some very fine Sand; brown; wet.	
09	SS	14	20 26		39			sw		SAND & GRAVEL: very fine to coarse Sand, very poorly sorted; fine to medium Gravel; very dense; brown;	

*ASTM D1586 ST = SHELBY TUBE
SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
D = DENNISON CT = CUTTINGS BA = BUCKET AUG.

GEOLOGIC DRILL LOG

PROJECT NAME AND LOCATION: Techalloy, Union, IL

PAGE NO.: 2 of 3 | HOLE: MW

SAMPLE NO.	SAMPLE TYPE	RECOVERY "	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
			30		41					wet.	
					42						
					43						
					44						
					45						
					46						
					47						
					48						
10	SS	18	15 56 50/4"		49			sp		SAND: fine to coarse, poorly sorted; little fine Gravel; pounding rock; brown; wet.	
					50						
					51						
					52						
					53						
					54						
					55						
					56						
					57						
					58						
11	SS	4	24 30 48		59			sp		As above: very fine to fine; well sorted; pounding rock in slough material.	
					60						
					61						
					62						
					63						
					64						
					65						
					66						
					67						
					68						
12	SS	6	26 28 22		69			sw		SAND & GRAVEL: very fine to coarse Sand, very poorly sorted; fine to medium Gravel; dense; brown; wet.	
					70						
					71						
					72						
					73						
					74						
					75						
					76						
					77						
					78						
13	SS	6	55/6"		79			sm gm		SAND & SILT: very fine to medium Sand, poorly sorted; some fine to medium Gravel; little Clay; gray to brown; wet.	
					80						
					81						
					82						Driller notes chang in drill pressure at 82 feet (Clay layer)
					83						

*ASTM D1586 ST = SHELBY TUBE
SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
D = DENNISON CT = CUTTINGS BA = BUCKET AUG.

GEOLOGIC DRILL LOG

PROJECT NAME AND LOCATION: Techalloy, Union, IL

HOLE: MW-

SAMPLE NO.	SAMPLE TYPE	RECOVERY "	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
					85						
					86						
					87						
					88						
14	SS	18	15 19 23		89 90			cl ml		SILT & CLAY: trace coarse Sand; trace fine Gravel; hard; gray; wet.	
										End of boring at 90 feet.	

*ASTM D1586 ST = SHELBY TUBE
SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
D = DENNISON CT = CUTTINGS BA = BUCKET AUG.

APPENDIX B

SAMPLING RESULTS (ANALYTICAL DATA)

Inter-Office Memorandum

WESTON
MANAGERS DESIGNERS/CONSULTANTS

TO: Carlos Serna

WB for

FROM: Russell Frye

DATE: 7 June 1993

PROJECT: Tech Alloy

W.O. NO.: 01989-010-001

SUBJECT: **Geotechnical Testing Results**

ACTION:

Geotechnical testing results for the Tech Alloy project are attached. Five (5) soil samples, job number 9305X002 were submitted to WESTON's Environmental Technology Laboratory (ETL) on 24 May 1993 for geotechnical testing.

The geotechnical tests requested are presented in the attached custody transfer/work request.

The geotechnical tests performed including reference method and test number are presented in Table 1.

If you require additional information or have any questions, please call me at (215) 524-6173.

RECEIVED
JUN 9 1993
ROY F. WESTON
VERNON HILLS, IL

Table 1 Geotechnical Tests Performed, Reference Methods and Test Numbers		
Test Parameter	**Method[1]**	**Test Numbers**
Grain Size by Sieve and Hydrometer	D 421/422	5
Natural Moisture Content	D 2216	5
Bulk Density (Undisturbed)	D 2937	5
Total Porosity	D 854/2937	5

[1] All analytical methods derived from the Annual Book of ASTM Standards, Section 4, Volume 4.08, Soil and Rock; Building Stones; Geotextiles, American Society of Testing Materials, Philadelphia, PA, 1991 unless noted otherwise.

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9305 [redacted] 2

Custody Transfer Re[redacted]rd/Lab Work Request

WESTON MANAGERS CONSULTANTS

Page [redacted] 1

Client: TECHALLOY
Est. Final Proj. Sampling Date: 5/20/93
Work Order #: 1989-010-001
Project Contact/Phone #: KOEPSELL / 708-918-4114
AD Project Manager: CARLOS SERNA
QC: 0020388 Del: _____ TAT: _____
Date Rec'd: _____ Date Due: _____
Account #: _____

Refrigerator #																
#/Type Container	Liquid															
	Solid						T	T								
Volume	Liquid					J	U	U	J							
	Solid					A	B	B	A							
Preservatives						R	E	E	R							
ANALYSES REQUESTED →		ORGANIC								INORG						
		VOA	BNA	Pest/PCB	Herb	GSC	BDS	POR	NMC	Metal	CN					

MATRIX CODES:
S = Soil
SE = Sediment
SO = Solid
SL = Sludge
W = Water
O = Oil
A = Air
DS = Drum Solids
DL = Drum Liquids
L = EP/TCLP Leachate
WI = Wipe
X = Other
F = Fish

Lab ID	Client ID/Description	Matrix QC Chosen (✓)	Matrix	Date Collected	VOA	BNA	Pest/PCB	Herb	GSC	BDS	POR	NMC	Metal	CN					
S	SB-01								✓	✓	✓	✓							
	SB-02								✓	✓	✓	✓							
	SB-03								✓	✓	✓	✓							
	SB-04								✓	✓	✓	✓							
	SB-05								✓	✓	✓	✓							

Special Instructions:
JAR SAMPLE - GSC, NMC, SOIL CLASS.
TUBE SAMPLE - POR, BDS, [redacted]

0020388 - SEAL

DATE/REVISIONS:
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

WESTON Analytics Use Only

Samples were:
1) Shipped ___ or Hand Delivered ___
Airbill # _____
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N
COC Record Present Upon Sample Rec't Y or N

Discrepancies Between Samples Labels and COC Record? Y or N
NOTES:

Relinquished by	Received by	Date	Time
DAN	FED EX		
FEDEX	[illegible]	5/24/93	1500

Relinquished by	Received by	Date	Time

RFW 21-21-001/A-8/90 ____ L372 ____ L373 ____ L375 ____ L377 ____ L378 Ref# _____ Cooler# _____ G77-596a

WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

GEOTECHNICAL TESTING DATA AND RESULTS

PROJECT	Tech Alloy	PROJECT SAMPLE I.D.	SB-01	PROJECT ANALYST	WB
JOB NUMBER	9305X002	ETL SAMPLE NUMBER	001	QA/QC ANALYST	RWF
W. O. NUMBER	01989-010-001	DATE RECEIVED	5/24/93	DATE COMPLETED	06/06/93

PARTICLE SIZE DISTRIBUTION

U. S. Standard Sieve Size	Diameter mm	% Finer
3"	75.00	100.0
1 1/2"	37.50	100.0
3/4"	19.00	93.1
3/8"	9.500	78.8
#4	4.750	65.2
#10	2.000	54.0
#20	0.850	43.3
#50	0.300	22.6
#100	0.150	15.6
#200	0.075	12.7
HYDROMETER	0.0464	8.8
	0.0333	7.9
	0.0238	7.0
	0.0172	5.6
	0.0127	4.7
	0.0091	3.8
	0.0065	3.3
	0.0046	2.9
	0.0033	1.9
	0.0023	1.9
	0.0013	1.9
	0.0010	1.5

EFFECTIVE SIZES

% Finer	Diameter mm
60	3.464
30	0.498
10	NA
Uniformity Coefficient	Gradation Coefficient
NA	NA

NATURAL MOISTURE CONTENT, % dry basis

9.3

SAMPLE DESCRIPTION

light brown gravelly silty or clayey SAND with 35% gravel and 13% silt or clay

Unified Soil Classification System (USCS) Group Symbol

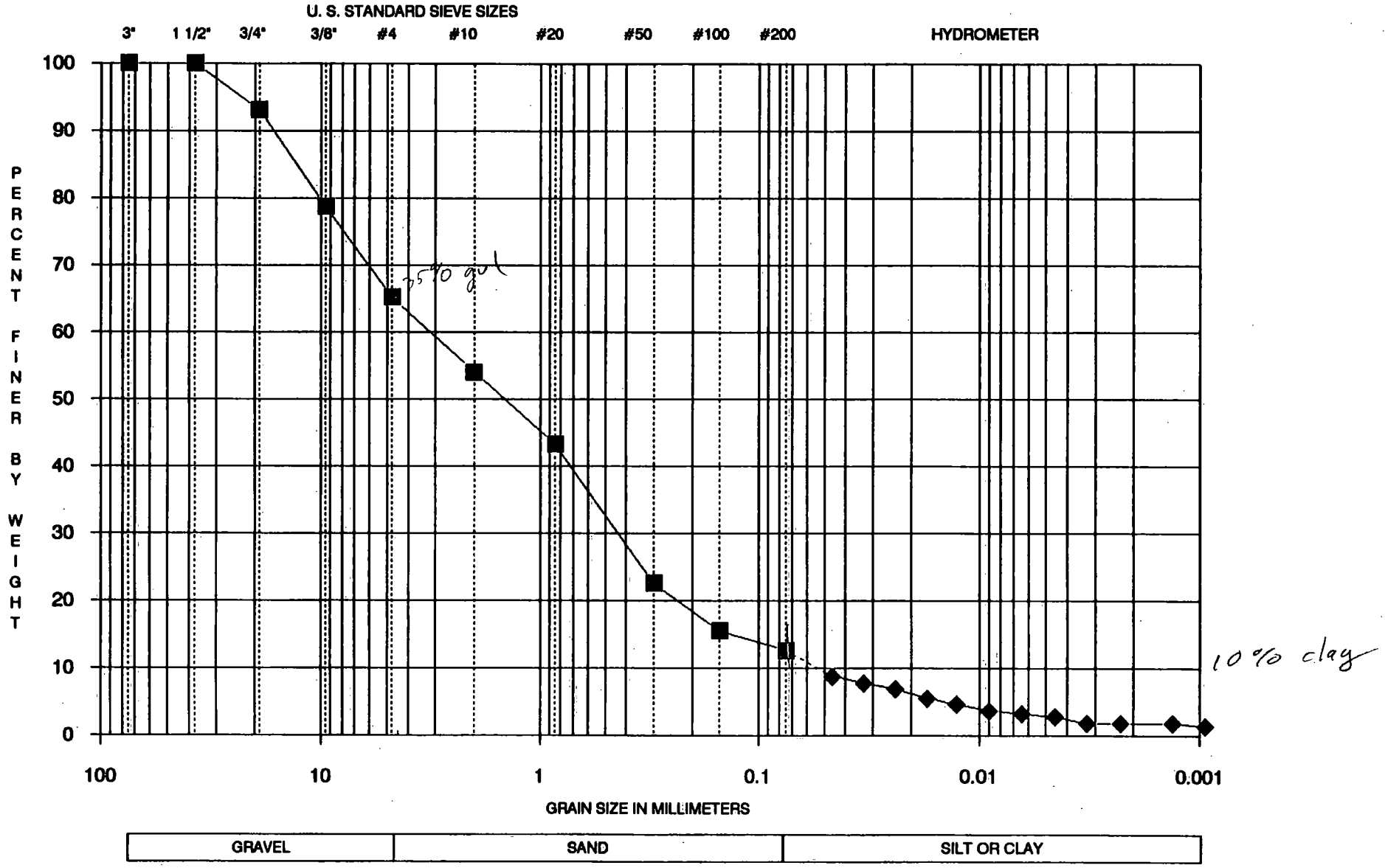
SM or SC

NOTES

NA=NOT APPLICABLE

WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

PARTICLE-SIZE DISTRIBUTION CURVE FOR
TECH ALLOY PROJECT SAMPLE SB-01, ETL SAMPLE # 9305X002-001



WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

GEOTECHNICAL TESTING DATA AND RESULTS

PROJECT	Tech Alloy	PROJECT SAMPLE I.D.	SB-02	PROJECT ANALYST	WB
JOB NUMBER	9305X002	ETL SAMPLE NUMBER	002	QA/QC ANALYST	RWF
W. O. NUMBER	01989-010-001	DATE RECEIVED	5/24/93	DATE COMPLETED	06/06/93

PARTICLE SIZE DISTRIBUTION

U. S. Standard Sieve Size	Diameter mm	% Finer
3"	75.00	100.0
1 1/2"	37.50	100.0
3/4"	19.00	99.1
3/8"	9.500	90.1
#4	4.750	82.2
#10	2.000	72.8
#20	0.850	61.3
#50	0.300	26.5
#100	0.150	13.8
#200	0.075	10.6
HYDROMETER	0.0446	15.5
	0.0322	13.8
	0.0232	12.0
	0.0168	10.2
	0.0125	8.4
	0.0090	6.6
	0.0064	6.0
	0.0046	4.3
	0.0033	3.1
	0.0023	3.1
	0.0013	3.1
	0.0010	2.5

EFFECTIVE SIZES

% Finer	Diameter mm
60	0.829
30	0.355
10	NA
Uniformity Coefficient	Gradation Coefficient
NA	NA

NATURAL MOISTURE CONTENT, % dry basis

11.1

SAMPLE DESCRIPTION

light brown gravelly silty or clayey SAND with 18% gravel and 11% silt or clay

Unified Soil Classification System (USCS) Group Symbol

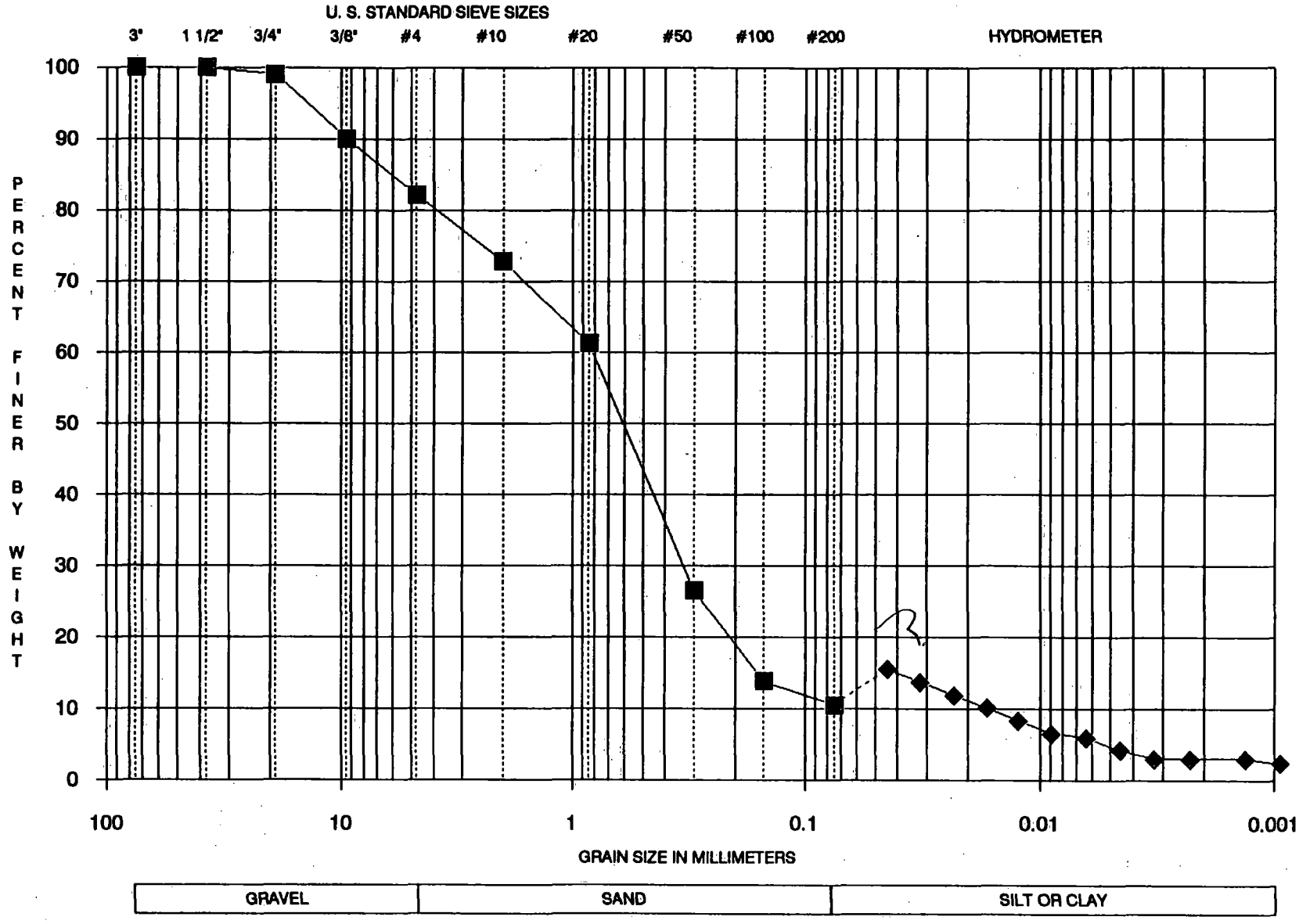
SP/SM or SP/SC

NOTES

NA=NOT APPLICABLE

WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

PARTICLE-SIZE DISTRIBUTION CURVE FOR
TECH ALLOY PROJECT SAMPLE SB-02, ETL SAMPLE # 9305X002-002



WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

GEOTECHNICAL TESTING DATA AND RESULTS

PROJECT	Tech Alloy	PROJECT SAMPLE I.D.	SB-03	PROJECT ANALYST	WB
JOB NUMBER	9305X002	ETL SAMPLE NUMBER	003	QA/QC ANALYST	RWF
W. O. NUMBER	01989-010-001	DATE RECEIVED	5/24/93	DATE COMPLETED	06/04/93

PARTICLE SIZE DISTRIBUTION

U. S. Standard Sieve Size	Diameter mm	% Finer
3"	75.00	100.0
1 1/2"	37.50	100.0
3/4"	19.00	89.2
3/8"	9.500	75.0
#4	4.750	63.3
#10	2.000	48.2
#20	0.850	38.4
#50	0.300	21.9
#100	0.150	13.7
#200	0.075	11.0
HYDROMETER	0.0465	8.1
	0.0333	7.2
	0.0238	6.3
	0.0172	5.0
	0.0127	4.1
	0.0091	3.2
	0.0064	2.8
	0.0046	1.9
	0.0033	1.9
	0.0023	1.4
	0.0013	1.0
	0.0010	1.0

EFFECTIVE SIZES

% Finer	Diameter mm
60	4.154
30	0.571
10	NA
Uniformity Coefficient	Gradation Coefficient
NA	NA

NATURAL MOISTURE CONTENT, % dry basis

10.7

SAMPLE DESCRIPTION

light brown gravelly silty or clayey SAND with 37% gravel and 11% silt or clay

Unified Soil Classification System (USCS) Group Symbol

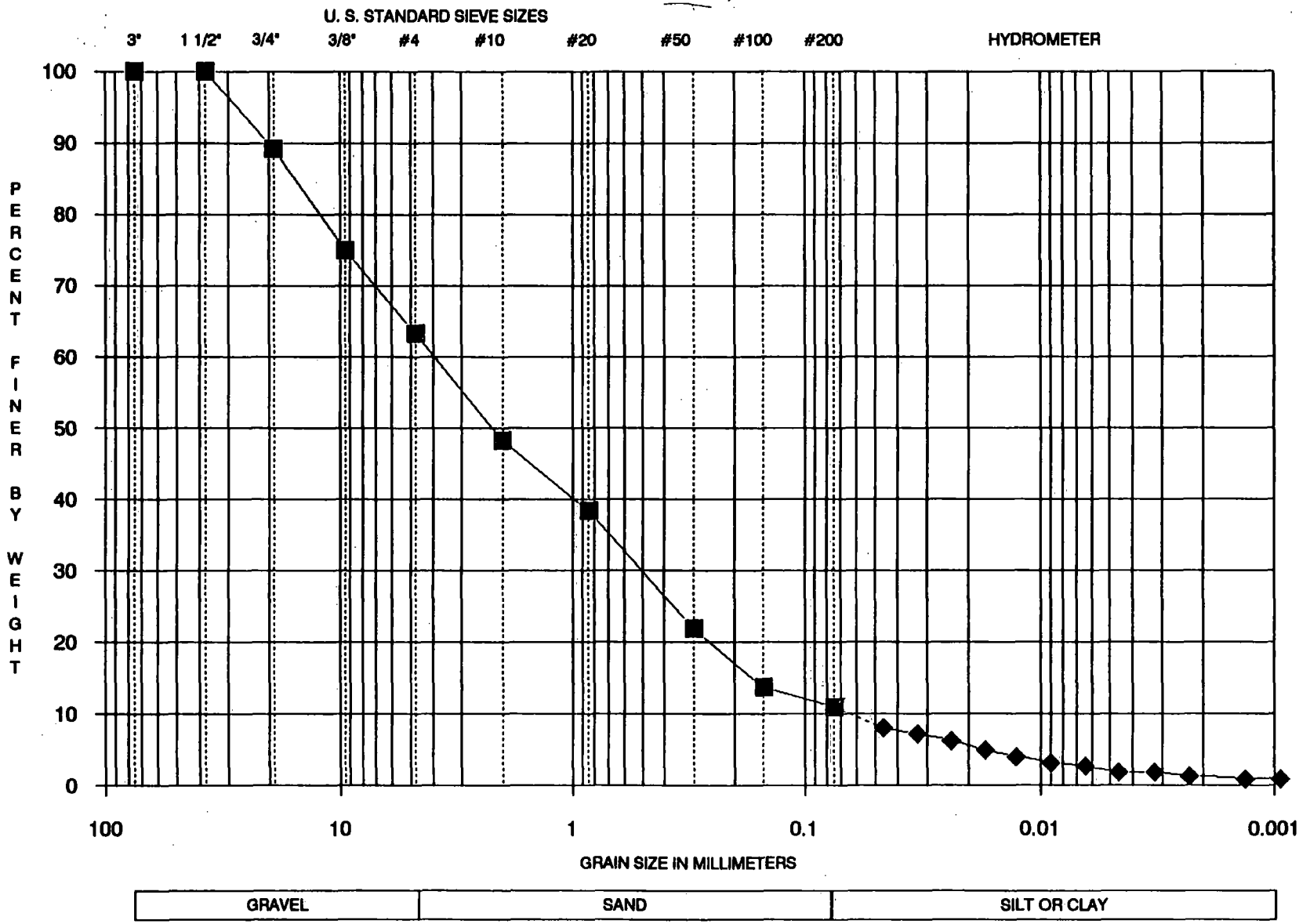
SP/SM or SP/SC

NOTES

NA=NOT APPLICABLE

WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

PARTICLE-SIZE DISTRIBUTION CURVE FOR TECH ALLOY PROJECT SAMPLE SB-03, ETL SAMPLE # 9305X002-003



WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

GEOTECHNICAL TESTING DATA AND RESULTS

PROJECT	Tech Alloy	PROJECT SAMPLE I.D.	SB-04	PROJECT ANALYST	WB
JOB NUMBER	9305X002	ETL SAMPLE NUMBER	004	QA/QC ANALYST	RWF
W. O. NUMBER	01989-010-001	DATE RECEIVED	5/24/93	DATE COMPLETED	06/04/93

PARTICLE SIZE DISTRIBUTION

U. S. Standard Sieve Size	Diameter mm	% Finer
3"	75.00	100.0
1 1/2"	37.50	100.0
3/4"	19.00	95.6
3/8"	9.500	79.6
#4	4.750	64.8
#10	2.000	51.1
#20	0.850	40.2
#50	0.300	22.7
#100	0.150	16.3
#200	0.075	13.6
HYDROMETER	0.0444	11.0
	0.0323	9.2
	0.0231	8.3
	0.0168	6.4
	0.0125	5.1
	0.0089	4.6
	0.0063	4.2
	0.0045	3.3
	0.0032	2.4
	0.0023	1.9
	0.0013	1.5
	0.0009	1.5

EFFECTIVE SIZES

% Finer	Diameter mm
60	3.780
30	0.530
10	NA
Uniformity Coefficient	Gradation Coefficient
NA	NA

NATURAL MOISTURE CONTENT, % dry basis

7.5

SAMPLE DESCRIPTION

light brown gravelly silty or clayey SAND with 35% gravel and 14% silt or clay

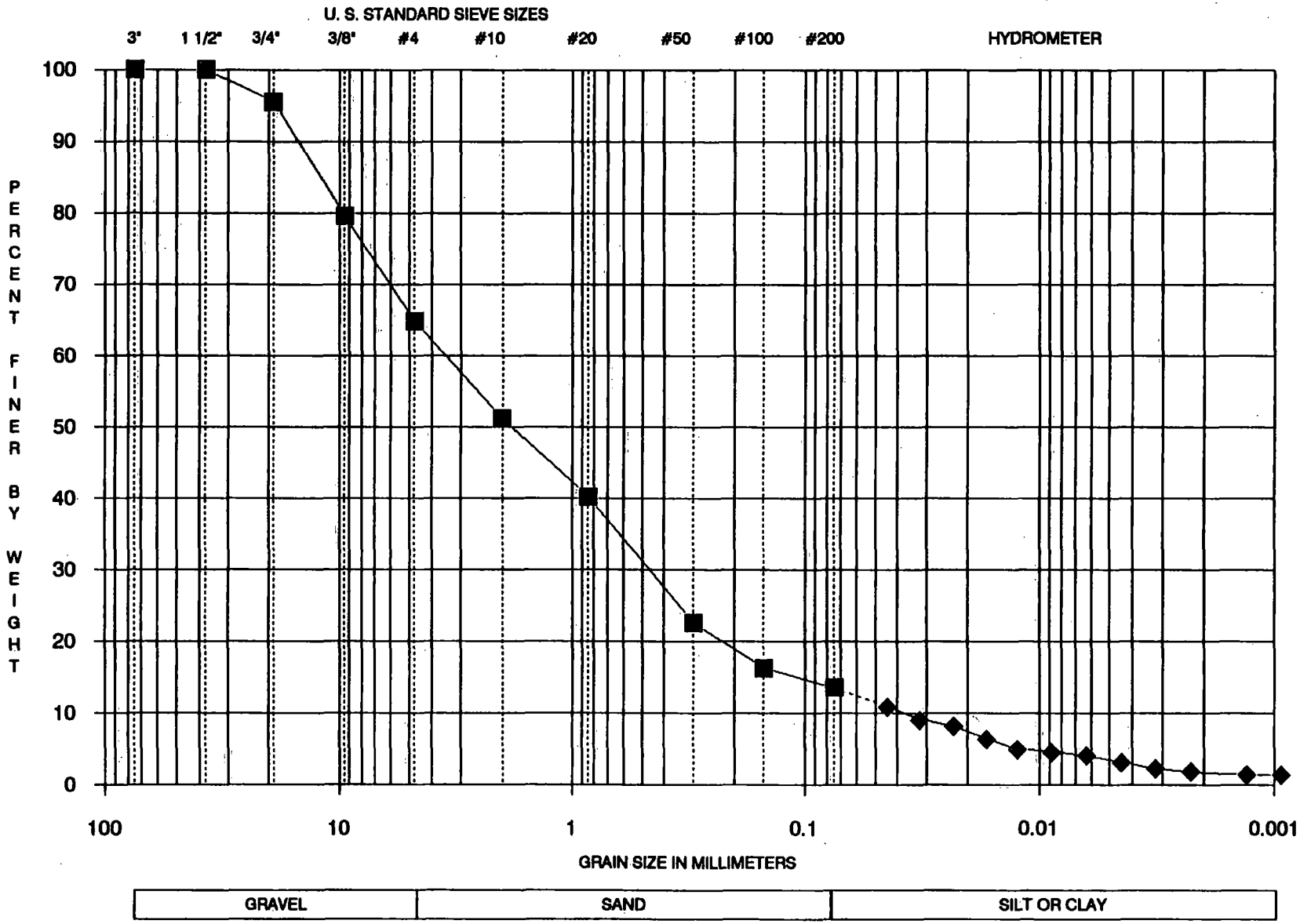
Unified Soil Classification System (USCS) Group Symbol

SM or SC

NOTES

NA=NOT APPLICABLE

PARTICLE-SIZE DISTRIBUTION CURVE FOR
TECH ALLOY PROJECT SAMPLE SB-04, ETL SAMPLE # 9305X002-004



WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

GEOTECHNICAL TESTING DATA AND RESULTS

PROJECT	Tech Alloy	PROJECT SAMPLE I.D.	SB-05	PROJECT ANALYST	WB
JOB NUMBER	9305X002	ETL SAMPLE NUMBER	005	QA/QC ANALYST	RWF
W. O. NUMBER	01989-010-001	DATE RECEIVED	5/24/93	DATE COMPLETED	06/04/93

PARTICLE SIZE DISTRIBUTION

U. S. Standard Sieve Size	Diameter mm	% Finer
3"	75.00	100.0
1 1/2"	37.50	100.0
3/4"	19.00	98.7
3/8"	9.500	95.3
#4	4.750	86.2
#10	2.000	66.9
#20	0.850	50.2
#50	0.300	20.9
#100	0.150	11.1
#200	0.075	8.5
HYDROMETER	0.0481	8.0
	0.0346	6.2
	0.0246	5.6
	0.0175	5.0
	0.0129	4.4
	0.0092	3.1
	0.0065	3.1
	0.0046	2.5
	0.0033	1.9
	0.0023	1.9
	0.0013	1.3
	0.0010	1.3

EFFECTIVE SIZES

% Finer	Diameter mm
60	1.526
30	0.470
10	0.119
Uniformity Coefficient	Gradation Coefficient
12.8	1.2

NATURAL MOISTURE CONTENT, % dry basis

15.0

SAMPLE DESCRIPTION

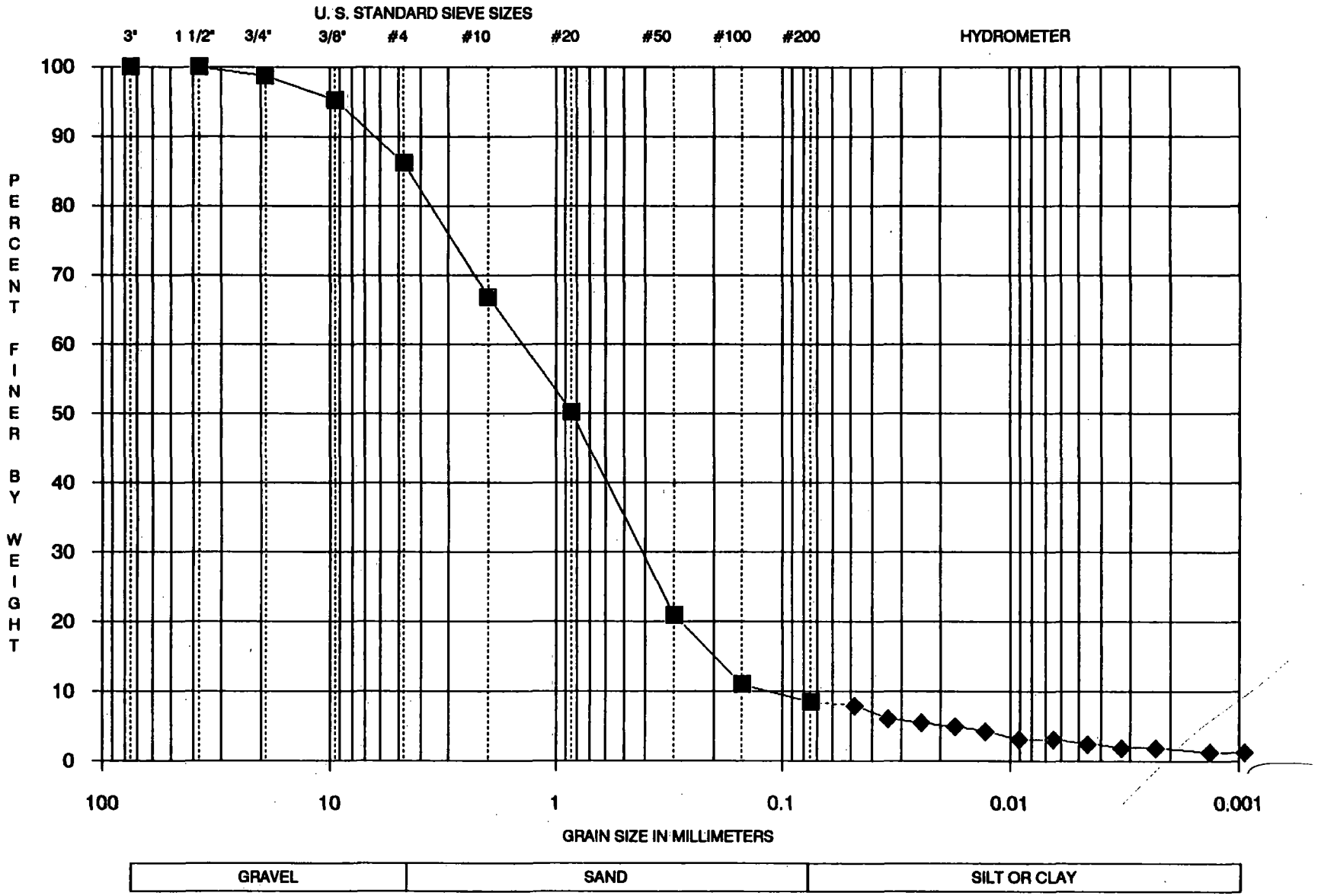
light brown well graded SAND
with 14% gravel and 9% silt or clay

Unified Soil Classification System (USCS) Group Symbol

SW/SM or SW/SC

NOTES

PARTICLE-SIZE DISTRIBUTION CURVE FOR TECH ALLOY PROJECT SAMPLE SB-05, ETL SAMPLE # 9305X002-005



WESTON ENVIRONMENTAL TECHNOLOGY LABORATORY

TOTAL POROSITY TEST DATA AND RESULTS

PROJECT	JOB NUMBER	W. O. NUMBER	ANALYST	DATE	BALANCE	OVEN	OVEN TEMP., C	
Tech Alloy	9305X002	01989-010-001	WB	5/26/93	XL3K	VWR	105	

SAMPLE DATA								
ETL Sample Number	001	002	003	004	005			
Project I. D.	SB-01	SB-02	SB-03	SB-04	SB-05			

MOISTURE CONTENT								
Moisture Content, % dry	9.3	11.1	10.7	7.5	15.0			
Moisture Content, % wet	8.5	10.0	9.6	7.0	13.1			
Total Solids, % wet	91.5	90.0	90.4	93.0	86.9			

UNIT WEIGHT								
Bulk Density, g/cc	2.15	1.89	2.00	2.07	1.94			
Wet Unit Wt., pcf	133.9	117.6	124.8	129.2	121.3			
Dry Unit Wt., pcf	122.5	105.9	112.8	120.2	105.5			

SPECIFIC GRAVITY								
Specific Gravity	2.74	2.72	2.76	2.78	2.75			

POROSITY								
Void Ratio	0.40	0.60	0.53	0.44	0.63			
Porosity, %	28.4	37.6	34.5	30.7	38.5			
Saturation, %	64.6	49.9	55.8	46.9	66.0			

WESTON
MANAGERS DESIGNERS/CONSULTANTS
WESTON-GULF COAST, INC.
2417 BOND STREET
UNIVERSITY PARK, ILLINOIS 60466-3182
708-534-5200 • 219-886-7077 • 815-723-7533
FAX: 708-534-5211

FACSIMILE TRANSMITTAL
WESTON-Gulf Coast, Inc.
FAX # (708) 534-5211

TO: Carlos Serna
Techalloy

FROM: Jane Huber

Recipient's Telecopy Telephone # _____
Recipient's Confirmation Telephone # _____

(708) 534-5200
Originator's Telephone #

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WESTON
MANAGERS DESIGNERS/CONSULTANTS

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Tuesday May 25th, 1993

RE: PW-01
Project # 01989-006-004-0000
Lab ID: 93056912-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Iron, Total	5.0	mg/L	0.030
Manganese, Total	0.30	mg/L	0.010

WESTON
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UNIVERSITY PARK, ILLINOIS 60466-3182
708-534-5200 • 219-885-7077 • 815-723-7533
FAX: 708-534-5211

FACSIMILE TRANSMITTAL
WESTON-Gulf Coast, Inc.
FAX # (708) 534-5211

TO: Carlos Serna
Technology

FROM: Jane Huber

Recipient's Telecopy Telephone # _____
Recipient's Confirmation Telephone # _____

(708) 534-5200
Originator's Telephone #

TOTAL PAGES: 2 (including cover sheet)

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KATHY MERKLE
(Sent By)
(708) 534-5200
(Sender's Telephone #)
6 - 2 - 93 2:05
(Date) (Time)

COMMENTS:

#9305G912 - Wet Chem

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2417 Bond St., University Park, Illinois 60466
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Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Wednesday June 2nd, 1993

RE: ~~PW-01~~
Project # 01989-006-004-0000
Lab ID: 93056912-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Alkalinity	352	mg/L	10.0
Total Organic Carbon	7.8	mg/L	1.0
TOC Test 2	5.5	mg/L	1.0

WESTON-GULF COAST, INC.
2417 BOND STREET
UNIVERSITY PARK, ILLINOIS 60466-3182
708-534-5200 • 219-885-7077 • 815-723-7533
FAX: 708-534-5211

4 June 1993

6/8/93

Mr. Carlos Serna
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Work Order No. 01989-006-004-0000

RE: Techalloy Analytical Results
RFW Batch 9305G913

Dear Mr. Serna:

Please find enclosed the Analytical Report for the Project and RFW Batch Number listed above. If you have any questions, please do not hesitate to contact me.

Very truly yours,

WESTON-GULF COAST, INC.

Jane D. Huber
Project Manager

jb

Enclosures

Approved By:

Michael J. Healy
Laboratory Manager

WESTON

STANDARD - GLOSSARY OF DATA QUALIFIERS AND ABBREVIATIONS

Inorganic Data Qualifiers

U	Analyte was not detected at or above the reporting limit
X	Result obtained indirectly through calculation based on results from other analyses

Organic Data Qualifiers

B	Compound was found in the blank and the sample
D	Surrogate or matrix spike recoveries were not obtained because the extract was diluted for analysis
E	Concentration exceeds the instrument calibration range and was subsequently diluted
I	Appears on the "results spreadsheet" to indicate an interference
J	Result is an estimated value below the reporting limit or a tenatively identified compound (TIC)
T	Compound was found in the TCLP extraction blank and the sample
U	Compound was not detected at or above the reporting limit

Abbreviations

BS	Blank Spike: spike analysis was conducted on reagent grade water or a matrix free from the analyte(s) of interest.
BSD	Blank Spike Duplicate
BRL	Below Reporting Limit
CD	Calculation Factor used by the laboratory's Information Management System (LIMS)
DF	Dilution Factor
DL	Appears in the sample ID to indicate a secondary dilution was performed
LCS	or (LC) denotes Laboratory Control Standard
MB	Method Blank or (PB) preparation blank
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NR	Not Required
NS	Not Spiked
RE	Appears in the sample ID to indicate a Re-analysis
REP	Replicate analysis
REPREP	Sample was reprepared and then reanalyzed
RFW#	Equivalent to the laboratory sample identification (LAB ID)
RPD	Relative Percent Difference of duplicate analyses
RRF	Relative Response Factor
RT	Retention Time
RTW	Retention Time Window

NOTES:

One or a combination of these data qualifiers and abbreviations may appear in the analytical report.
Soil, sediment and sludge results are reported on a dry weight basis except when analyzed for landfill disposal or incineration parameters. All other results on a solid matrix are reported on an "as received" basis unless noted differently.
Reporting limits are adjusted for preparation sample size, sample dilutions and sample moisture content if analyzed on a dry weight basis.

Revised 12/02/92

[redacted]ESTO[redacted]alytic[redacted] Onl[redacted]

930[redacted]913

Custody Transfer Re[redacted]rd/Lab Work Request

WE[redacted]N MANAGERS [redacted]S CONSULTANTS

Page 2 of 1

Client: Techalloy
Est. Final Proj. Sampling Date
Work Order # 1989-08-01
Project Contact/Phone #
AD Project Manager Serna / 4002
QC Del TAT
Date Rec'd Date Due
Account #

Refrigerator #																				
#/Type Container	Liquid						1/G	1/P	2/P	1/P		3/P	2/G	3/P	1/P	1/P				
	Solid																			
Volume	Liquid						1l?	150-1	1l	1l		1l	1l?	1l	1l	250-1				
	Solid																			
Preservatives							Y		✓	✓		Y	Y	N	Y	Y				
ANALYSES REQUESTED →		ORGANIC								INORG										
		VOA	BNA	Pest/PCB	Herb		Phenols	FC	Nitrate	Metal	CN	Nutrients	FOG	General Inorg	Sulfide	TOC				

MATRIX CODES: S - Soil; SD - Sediment; SO - Solid; SL - Sludge; W - Water; O - Oil; A - Air; DS - Drum Solids; DL - Drum Liquids; L - EP/TCLP Leachate; W - Wipe; X - Other; F - Fish

Lab ID	Client ID/Description	Matrix QC Chosen (✓)	Matrix	Date Collected															
001	PW-01		W	5/20/93						✓	✓	✓	✓		✓	✓	✓	✓	✓

Special Instructions:

DATE/REVISIONS:

1.
2.
3.
4.
5.
6.

WESTON Analytics Use Only

Samples were:
1) Shipped ___ or Hand Delivered X
Airbill # ___
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N
COC Record Present Upon Sample Rec't Y or N

Discrepancies Between Samples Labels and COC Record? Y or N
NOTES:

Relinquished by	Received by	Date	Time
P Sedgwick	D Wardwell	5/20/93	1530
D Wardwell	K Schultz	5/20/93	1830

Relinquished by	Received by	Date	Time

RFW 21-21-001/A-8/90 ___ L372 ___ L373 ___ L375 ___ L377 ___ L378 Ref# ___ Cooler# ___ G77-596a

WESTON

SAMPLE DISCREPANCY REPORT (SDR

Revision 04: Dated 09/04/

Initiator: J. Huber
Date: 5/21/93
Client: Techalloy
Contact: Scott Koepsell
Phone #: 1-30X-918-4141
RFW #: 93056-790913 kmc 5/21/93
Samples:

Parameter: CN, MBAS
Matrix: H2O
Prep Batch:
Internal Request ☐ External Request ☐

Category for Discrepancy
- ___ Log-In
- ___ LIMS
- ___ Analysis/Sample
- ___ Project Revision
- ___ COC
- ___ Data Entry
- ___ Billing
- ___ Other: ___

A. REASON FOR SDR:

A1a.
Requires Verification by (circle): Log-In or Prep Group

		A2. Verified By (circle): Log-In or Prep Group (initials)	(date)
___	Sample ID Discrepancies		
___	Missing Sample/Extract		
___	Improper Bottle Type		
___	Container Broken		
X	Improper Preservative		
___	Received Past Hold Time		
X	Insufficient Sample		
___	Label ID's Illegible		
___	Data Package Correction	(See Reverse Side)	
___	Date Discrepancies		
___	Bubbles in VOA Vials		
X	Other, explain		

No CN bottle rec'd

A1b.
- ___ Re-Log: Tech Profile Error..Client Changed Request.. Sampler Error on C-O-C..Transcription Error.. Wrong Test Code, Re-Log As ___
- ___ Re-Leach: Metals/Inorg/VOA/BNA/Pest/Herb/___
- ___ Re-Digest: AA/ICP/HG/___
- ___ Re-Extract: BNA/PEST/___
- ___ Hold Time Exceeded: Prep/Analysis/Report
- ___ Correct Report/Case Narrative/Raw Data
- ___ Other, explain

B. PM Instruction
Signature: Jerry D. Huber Date: 5-21-9

- X Cancel MBAS, CN ___ Add ___ Subout Analysis
- ___ Place on Hold ___ Take Off Hold
- ___ Change W.O. # to: ___
- ___ MS/MSD on Sample ___, if enough sample: ORG/INORG
- ___ MS/DUP on Sample ___, if enough sample: ORG/INORG
- ___ Change Client name to : ___
- ___ Wrong Test Code, Change To ___
- ___ Include in Narrative
- ___ Change Due Date
- X Other, explain:

No CN bottle preserved insufficient sample to pour off and preserve per S. Koepsell, cancel CN, they will sample —

Per B. Karlovitz — cancel MBAS as it will be analyzed past HT — JDH

C. FINAL ACTION: a clear description of what was done for resolution, when it was done, and by whom it was done Action Taken:

- X Revision To Chain-Of-Custody Completed
- X LIMS Corrections Completed
- ___ Data Package Corrections Completed
- ___ Responded to Client
  - a. Phone b. Mail c. FAX d. In Person
- X Other, explain

Action By (name/date) KMSchulz 5/21/93

D. Distribution of Completed SDR (include name):

- ___ Initiator: ___
- ___ Lab Manager: Michael J. Healy
- ___ Project Manager: J. Huber
- ___ Section Manager: ___
- ___ QA*
- ___ Worksheet (Original)*
- ___ Report Generation
- ___ Billing: Tammy Coleman
- ___ ___
- ___ ___

*Original SDR attached to Worksheet; Copy SDR to QA

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G913

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
PW-01							
FECAL COLIFORM	001	W	93GBA971	05/20/93	05/20/93	05/20/93	05/21/93
BOD 5 DAY	001	W	93GBD187	05/20/93	05/20/93	05/21/93	05/21/93
BOD 5 DAY	001 REP	W	93GBD187	05/20/93	05/20/93	05/21/93	05/21/93
BOD 5 DAY	001 MS	W	93GBD187	05/20/93	05/20/93	05/21/93	05/21/93
BROMIDE	001	W	93GMA046	05/20/93	05/20/93	05/29/93	06/02/93
BROMIDE	001 REP	W	93GMA046	05/20/93	05/20/93	05/29/93	06/02/93
BROMIDE	001 MS	W	93GMA046	05/20/93	05/20/93	05/29/93	06/02/93
CHEMICAL OXYGEN DEMA	001	W	93GCD048	05/20/93	05/20/93	05/25/93	05/25/93
CHEMICAL OXYGEN DEMA	001 REP	W	93GCD049	05/20/93	05/20/93	05/28/93	06/01/93
CHEMICAL OXYGEN DEMA	001 MS	W	93GCD048	05/20/93	05/20/93	05/25/93	05/25/93
COLOR	001	W	93GMA042	05/20/93	05/20/93	05/21/93	05/21/93
COLOR	001 REP	W	93GMA042	05/20/93	05/20/93	05/21/93	05/21/93
FLUORIDE	001	W	93GFL039	05/20/93	05/20/93	05/29/93	05/29/93
AMMONIA DISTILLED	001	W	93GAM076	05/20/93	05/20/93	06/01/93	06/02/93
NITRITE	001	W	93GNI069	05/20/93	05/20/93	05/21/93	05/21/93
NITRATE	001	W	93GNN034	05/20/93	05/20/93	05/26/93	05/26/93
TOTAL ORGANIC NITROG	001	W	93GTK021	05/20/93	05/20/93	06/02/93	06/02/93
PHOSPHORUS	001	W	93GPS064	05/20/93	05/20/93	05/27/93	05/28/93
TOTAL PHENOLICS	001	W	93GPE028	05/20/93	05/20/93	05/22/93	05/25/93
SULFIDE	001	W	93GSF074	05/20/93	05/20/93	05/26/93	05/26/93
SULFATE	001	W	93GSA041	05/20/93	05/20/93	06/01/93	06/01/93
TOTAL SUSPENDED SOLI	001	W	93GSS068	05/20/93	05/20/93	05/25/93	05/25/93

LAB QC:

BOD 5 DAY	LCS BS	W	93GBD187	N/A	N/A	05/21/93	05/21/93
BOD 5 DAY	LCS BSD	W	93GBD187	N/A	N/A	05/21/93	05/21/93
BOD 5 DAY	MB1	W	93GBD187	N/A	N/A	05/21/93	05/21/93
BROMIDE	LCS BS	W	93GMA046	N/A	N/A	05/29/93	06/02/93
BROMIDE	LCS BSD	W	93GMA046	N/A	N/A	05/29/93	06/02/93
BROMIDE	MB1	W	93GMA046	N/A	N/A	05/29/93	06/02/93
CHEMICAL OXYGEN DEMA	LCS BS	W	93GCD048	N/A	N/A	05/25/93	05/25/93
CHEMICAL OXYGEN DEMA	LCS BSD	W	93GCD048	N/A	N/A	05/25/93	05/25/93
CHEMICAL OXYGEN DEMA	MB1	W	93GCD048	N/A	N/A	05/25/93	05/25/93
CHEMICAL OXYGEN DEMA	LCS BS	W	93GCD049	N/A	N/A	05/28/93	06/01/93
CHEMICAL OXYGEN DEMA	LCS BSD	W	93GCD049	N/A	N/A	05/28/93	06/01/93
CHEMICAL OXYGEN DEMA	MB1	W	93GCD049	N/A	N/A	05/28/93	06/01/93

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G913

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
FLUORIDE	LCS BS	W	93GFL039	N/A	N/A	05/29/93	05/29/93
FLUORIDE	LCS BSD	W	93GFL039	N/A	N/A	05/29/93	05/29/93
FLUORIDE	MB1	W	93GFL039	N/A	N/A	05/29/93	05/29/93
AMMONIA DISTILLED	LCS BS	W	93GAM076	N/A	N/A	06/01/93	06/02/93
AMMONIA DISTILLED	LCS BSD	W	93GAM076	N/A	N/A	06/01/93	06/02/93
AMMONIA DISTILLED	MB1	W	93GAM076	N/A	N/A	06/01/93	06/02/93
NITRITE	LCS BS	W	93GNI069	N/A	N/A	05/21/93	05/21/93
NITRITE	LCS BSD	W	93GNI069	N/A	N/A	05/21/93	05/21/93
NITRITE	MB1	W	93GNI069	N/A	N/A	05/21/93	05/21/93
PHOSPHORUS	MB1	W	93GPS064	N/A	N/A	05/27/93	05/28/93
PHENOLICS	LCS BS	W	93GPE028	N/A	N/A	05/22/93	05/25/93
PHENOLICS	LCS BSD	W	93GPE028	N/A	N/A	05/22/93	05/25/93
TOTAL PHENOLICS	MB1	W	93GPE028	N/A	N/A	05/22/93	05/25/93
SULFIDE	LCS BS	W	93GSF074	N/A	N/A	05/26/93	05/26/93
SULFIDE	LCS BSD	W	93GSF074	N/A	N/A	05/26/93	05/26/93
SULFIDE	MB1	W	93GSF074	N/A	N/A	05/26/93	05/26/93
SULFATE	LCS BS	W	93GSA041	N/A	N/A	06/01/93	06/01/93
LFATE	LCS BSD	W	93GSA041	N/A	N/A	06/01/93	06/01/93
LFATE	MB1	W	93GSA041	N/A	N/A	06/01/93	06/01/93
TOTAL SUSPENDED SOLI	LCS BS	W	93GSS068	N/A	N/A	05/25/93	05/25/93
TOTAL SUSPENDED SOLI	LCS BSD	W	93GSS068	N/A	N/A	05/25/93	05/25/93
TOTAL SUSPENDED SOLI	MB1	W	93GSS068	N/A	N/A	05/25/93	05/25/93

SIGNATURE Diane L. Harper DATE 6-3-93

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: **Techalloy**
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: **Mr. Carlos Serna**

Date: Friday June 4th, 1993

RE: **PW-01**
Project # 01989-006-004-0000
Lab ID: **9305G913-001**
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Silver, Total	0.030	u	mg/L	0.030
Aluminum, Total	2.7		mg/L	0.20
Arsenic, Total	0.0029		mg/L	0.0020
Boron, Total	0.050	u	mg/L	0.050
Barium, Total	0.41		mg/L	0.050
Beryllium, Total	0.0050	u	mg/L	0.0050
Cadmium, Total	0.0050	u	mg/L	0.0050
Cobalt, Total	0.020	u	mg/L	0.020
Chromium, Total	0.020	u	mg/L	0.020
Copper, Total	0.025		mg/L	0.020
Iron, Total	4.9		mg/L	0.030
Mercury, Total	0.00020	u	mg/L	0.00020
Magnesium, Total	68.3		mg/L	0.20
Molybdenum, Total	0.10	u	mg/L	0.10
Nickel, Total	0.020	u	mg/L	0.020
Lead, Total	0.050	u	mg/L	0.050
Antimony, Total	0.10	u	mg/L	0.10

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ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Friday June 4th, 1993

RE: PW-01
Project # 01989-006-004-0000
Lab ID: 9305G913-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Selenium, Total	0.0020	u	mg/L	0.0020
Tin, Total	0.10	u	mg/L	0.10
Titanium, Total	0.085		mg/L	0.010
Thallium, Total	0.50	u	mg/L	0.50
Zinc, Total	0.044		mg/L	0.010

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ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Thursday June 3rd, 1993

RE: PW-01
Project # 01989-006-004-0000
Lab ID: 9305G913-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Fecal Coliform	10	u	C/100ml	10
BOD 5 Day	2	u	mg/L	2
Bromide	5.0	u	mg/L	5.0
COD	17		mg/L	5
Color	20.0		CU	5.0
Fluoride	0.14		mg/L	0.10
Ammonia, as Nitrogen	0.31		mg/L	0.10
Nitrite, as N	0.022		mg/L	0.020
Nitrate, as N	1.8		mg/L	0.10
Total Organic Nitroge	0.10	u	mg/L	0.10
Phosphorus	0.46		mg/L	0.050
Total Phenolics	0.0050	u	mg/L	0.0050
Sulfide	1.0	u	mg/L	1.0
Sulfate	69.2		mg/L	25.0
Total Suspended Solid	94		mg/L	5

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ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Thursday June 3rd, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G913

Inorganic Method Blank Data Report

Sample	Lab ID	Parameter	Result		Units	Reporting Limit
Blank 1	93GBD187-MB1	BOD 5 Day	2	u	mg/L	2
Blank 1	93GMA046-MB1	Bromide	5.0	u	mg/L	5.0
Blank 1	93GCD048-MB1	COD	5	u	mg/L	5
Blank 1	93GCD049-MB1	COD	5	u	mg/L	5
Blank 1	93GFL039-MB1	Fluoride	0.10	u	mg/L	0.10
Blank 1	93GAM076-MB1	Ammonia, as Nitrogen	0.10	u	mg/L	0.10
Blank 1	93GNI069-MB1	Nitrite, as N	0.020	u	mg/L	0.020
Blank 1	93GPS064-MB1	Phosphorus	0.050	u	mg/L	0.050
Blank 1	93GPE028-MB1	Total Phenolics	0.0050	u	mg/L	0.0050
Blank 1	93GSF074-MB1	Sulfide	1.0	u	mg/L	1.0
Blank 1	93GSA041-MB1	Sulfate	5.0	u	mg/L	5.0
Blank 1	93GSS068-MB1	Total Suspended Solid	5	u	mg/L	5

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ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Thursday June 3rd, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G913

Inorganic Laboratory Control Standards Report

Lab ID	Parameter	Spiked Amount	Units	Spike #1 % Recov.	Spike #2 % Recov.	RPD
93GBD187-LCS	BOD 5 Day	200	mg/L	89.1	98.1	9.6
93GMA046-LCS	Bromide	35.0	mg/L	94.5	95.0	0.50
93GCD048-LCS	COD	25	mg/L	113	111	1.8
93GCD049-LCS	COD	25	mg/L	114	108	5.7
93GFL039-LCS	Fluoride	1.0	mg/L	100	100	0.40
93GAM076-LCS	Ammonia, as N	2.5	mg/L	97.8	100	2.6
93GNI069-LCS	Nitrite, as N	0.10	mg/L	98.0	95.0	2.5
93GPE028-LCS	Phenolics	0.10	mg/L	100	97.1	2.9
93GSF074-LCS	Sulfide	4.0	mg/L	96.0	93.8	2.2
93GSA041-LCS	Sulfate	20.0	mg/L	97.2	102	5.1
93GSS068-LCS	Tot Susp Solids	200	mg/L	101	98.0	2.7

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G913

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
PW-01							
SILVER, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
SILVER, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
SILVER, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ALUMINUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ALUMINUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ALUMINUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ARSENIC, TOTAL	001	W	93GF797	05/20/93	05/20/93	05/24/93	05/26/93
BORON, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BORON, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BORON, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BARIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BARIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BARIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BERYLLIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BERYLLIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
BERYLLIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
CADMIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
CADMIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
CADMIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
COBALT, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
COBALT, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
COBALT, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
CHROMIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
CHROMIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
CHROMIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
COPPER, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
COPPER, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
COPPER, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
IRON, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
IRON, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
IRON, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
MERCURY, TOTAL	001	W	93HG204	05/20/93	05/20/93	05/25/93	05/26/93
MAGNESIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
MAGNESIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
MAGNESIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
MOLYBDENUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
MOLYBDENUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G913

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
MOLYBDENUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
NICKEL, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
NICKEL, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
NICKEL, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
LEAD, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
LEAD, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
LEAD, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ANTIMONY, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ANTIMONY, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ANTIMONY, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
SELENIUM, TOTAL	001	W	93GF797	05/20/93	05/20/93	05/24/93	05/28/93
TIN, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
TIN, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
TIN, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
TITANIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
TITANIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
TITANIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
THALLIUM, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
THALLIUM, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
THALLIUM, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ZINC, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ZINC, TOTAL	001 REP	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
ZINC, TOTAL	001 MS	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93

LAB QC:

SILVER LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
ALUMINUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
BORON LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
BARIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
BERYLLIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
CADMIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
COBALT LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
CHROMIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
COPPER LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
IRON LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
MAGNESIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
MOLYBDENUM LABORATOR	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
NICKEL LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
LEAD LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93

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INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G913

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
ANTIMONY LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
TIN LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
TITANIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
THALLIUM LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
ZINC LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
SILVER LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
ALUMINUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
BORON LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
BARIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
BERYLLIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
CADMIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
COBALT LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
CHROMIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
COPPER LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
IRON LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
MAGNESIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
MOLYBDENUM LABORATOR	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
NICKEL LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
LEAD LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
ANTIMONY LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
TIN LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
TITANIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
THALLIUM LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
ZINC LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
SILVER, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
ALUMINUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
BORON, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
BARIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
BERYLLIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
CADMIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
COBALT, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
CHROMIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
COPPER, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
IRON, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
MAGNESIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
MOLYBDENUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
NICKEL, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
LEAD, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
ANTIMONY, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
TIN, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G913

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
TITANIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
THALLIUM, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
ZINC, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
ARSENIC LABORATORY	LC1 BS	W	93GF797	N/A	N/A	05/24/93	05/26/93
LEAD LABORATORY	LC1 BS	W	93GF797	N/A	N/A	05/24/93	05/31/93
SELENIUM LABORATORY	LC1 BS	W	93GF797	N/A	N/A	05/24/93	05/28/93
ARSENIC LABORATORY	LC2 BS	W	93GF797	N/A	N/A	05/24/93	05/26/93
LEAD LABORATORY	LC2 BS	W	93GF797	N/A	N/A	05/24/93	05/31/93
SELENIUM LABORATORY	LC2 BS	W	93GF797	N/A	N/A	05/24/93	05/28/93
ARSENIC, TOTAL	MB1	W	93GF797	N/A	N/A	05/24/93	05/26/93
LEAD, TOTAL	MB1	W	93GF797	N/A	N/A	05/24/93	05/31/93
SELENIUM, TOTAL	MB1	W	93GF797	N/A	N/A	05/24/93	05/28/93
MERCURY LABORATORY	LC1 BS	W	93HG204	N/A	N/A	05/25/93	05/26/93
MERCURY LABORATORY	LC2 BS	W	93HG204	N/A	N/A	05/25/93	05/26/93
MERCURY, TOTAL	MB1	W	93HG204	N/A	N/A	05/25/93	05/26/93

SIGNATURE [illegible] DATE 6/4/93

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Friday June 4th, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G913

Inorganic Method Blank Data Report

Sample	Lab ID	Parameter	Result		Units	Reporting Limit
Blank 1	93GI318-MB1	Silver, Total	0.030	u	mg/L	0.030
		Aluminum, Total	0.20	u	mg/L	0.20
		Boron, Total	0.050	u	mg/L	0.050
		Barium, Total	0.050	u	mg/L	0.050
		Beryllium, Total	0.0050	u	mg/L	0.0050
		Cadmium, Total	0.0050	u	mg/L	0.0050
		Cobalt, Total	0.020	u	mg/L	0.020
		Chromium, Total	0.020	u	mg/L	0.020
		Copper, Total	0.020	u	mg/L	0.020
		Iron, Total	0.041		mg/L	0.030
		Magnesium, Total	0.20	u	mg/L	0.20
		Molybdenum, Total	0.10	u	mg/L	0.10
		Nickel, Total	0.020	u	mg/L	0.020
		Lead, Total	0.050	u	mg/L	0.050
		Antimony, Total	0.10	u	mg/L	0.10
		Tin, Total	0.10	u	mg/L	0.10
		Titanium, Total	0.010	u	mg/L	0.010

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2417 Bond St., University Park, Illinois 60466
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ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Friday June 4th, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G913

Inorganic Method Blank Data Report

Sample	Lab ID	Parameter	Result		Units	Reporting Limit
Blank 1	93GI318-MB1	Thallium, Total	0.50	u	mg/L	0.50
		Zinc, Total	0.010	u	mg/L	0.010
Blank 1	93GF797-MB1	Arsenic, Total	0.0020	u	mg/L	0.0020
		Lead, Total	0.0020	u	mg/L	0.0020
		Selenium, Total	0.0020	u	mg/L	0.0020
Blank 1	93HG204-MB1	Mercury, Total	0.00020	u	mg/L	0.00020

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Fax: (708) 534-5211

ANALYTICAL REPORT

To: **Techalloy**
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: **Mr. Carlos Serna**

Date: Friday June 4th, 1993

Project # 01989-006-004-0000
Lab Batch: **9305G913**

Inorganic Laboratory Control Standards Report

Lab ID	Parameter	Spiked Amount	Units	Spike #1 % Recov.	Spike #2 % Recov.	RPD
93GI318-LC1	Silver, LCS	0.050	mg/L	88.4	90.2	2.0
	Aluminum, LCS	2.0	mg/L	88.9	90.7	2.0
	Boron, LCS	1.0	mg/L	96.1	97.2	1.2
	Barium, LCS	2.0	mg/L	91.6	92.3	0.66
	Beryllium, LCS	0.050	mg/L	93.2	94.8	1.7
	Cadmium, LCS	0.050	mg/L	99.2	94.6	4.7
	Cobalt, LCS	0.50	mg/L	94.2	95.8	1.6
	Chromium, LCS	0.20	mg/L	95.0	96.8	1.9
	Copper, LCS	0.25	mg/L	91.7	93.8	2.2
	Iron, LCS	1.0	mg/L	97.7	99.3	1.5
	Magnesium, LCS	10.0	mg/L	92.2	93.9	1.8
	Molybdenum, LCS	1.0	mg/L	93.2	94.2	1.1
	Nickel, LCS	0.50	mg/L	95.5	96.1	0.65
	Lead, LCS	0.50	mg/L	95.6	98.4	2.8
	Antimony, LCS	0.50	mg/L	95.6	94.9	0.74
	Tin, LCS	1.0	mg/L	94.1	96.2	2.2
	Titanium, LCS	1.0	mg/L	94.5	95.3	0.82

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2417 Bond St., University Park, Illinois 60466
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Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Friday June 4th, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G913

Inorganic Laboratory Control Standards Report

Lab ID	Parameter	Spiked Amount	Units	Spike #1 % Recov.	Spike #2 % Recov.	RPD
93GI318-LC1	Thallium, LCS	2.0	mg/L	88.9	92.8	4.3
	Zinc, LCS	0.50	mg/L	90.1	92.5	2.7
93GF797-LC1	Arsenic, LCS	0.040	mg/L	95.8	95.0	0.79
	Lead, LCS	0.020	mg/L	101	100	0.50
	Selenium, LCS	0.010	mg/L	92.0	89.0	3.3
93HG204-LC1	Mercury, LCS	0.0020	mg/L	90.0	86.3	4.2

WESTON
MANAGERS DESIGNERS/CONSULTANTS
WESTON-GULF COAST, INC.
2417 BOND STREET
UNIVERSITY PARK, ILLINOIS 60466-3182
708-534-5200 • 219-885-7077 • 815-723-7533
FAX: 708-534-5211

1 June 1993

Mr. Carlos Serna
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Work Order No. 01989-006-004-0000

RE: Techalloy Analytical Results
RFW Batch 9305G914

Dear Mr. Serna:

Please find enclosed the Analytical Report for the Project and RFW Batch Number listed above. If you have any questions, please do not hesitate to contact me.

Very truly yours,

WESTON-GULF COAST, INC.

Jane D. Huber
Project Manager

jb

Enclosures

Approved By:

Michael J. Healy
Laboratory Manager

WESTON Analytics Use Only

Custody Transfer Record/Lab Work Request

WESTON MANAGERS DESIGNERS/CONSULTANTS

Page 1 of 1

Client: [illegible]
Est. Final Proj. Sampling Date: [illegible]
Work Order #: 178[illegible] [illegible] 001
Project Contact/Phone #: [illegible]
AD Project Manager: [illegible]
QC: _____ Del: _____ TAT: _____

Date Rec'd: _____ Date Due: _____
Account #: _____

Refrigerator #																	
#/Type Container	Liquid																
	Solid																
Volume	Liquid																
	Solid																
Preservatives																	
ANALYSES REQUESTED →		ORGANIC										INORG					
		VOA	BNA	Pest/PCB	Herb	TOC						Metal	CN				

MATRIX CODES:
S - Soil
SE - Sediment
SO - Solid
SL - Sludge
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquids
L - EP/TCLP Leachate
WI - Wipe
X - Other
F - Fish

Lab ID	Client ID/Description	Matrix QC Chosen (✓)	Matrix	Date Collected	VOA	BNA	Pest/PCB	Herb	TOC				Metal	CN				
S	SB-01		S	5/20					✓									
S	SB-05		S	5/20					✓									

Special Instructions:
TOC = TOTAL ORGANIC CARBON
[illegible] QA

DATE/REVISIONS:
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

WESTON Analytics Use Only

Samples were:
1) Shipped ___ or Hand Delivered ___ Airbill # _____
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N
COC Record Present Upon Sample Rec't Y or N

Discrepancies Between Samples Labels and COC Record? Y or N
NOTES:

Relinquished by	Received by	Date	Time	Relinquished by	Received by	Date	Time
[illegible]	[illegible]	5/21	1300				

RFW 21-[illegible] [illegible] L372 [illegible] L373 [illegible] L377 [illegible] L378 [illegible] Ref# [illegible] Cooler# [illegible] G77-50[illegible]

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Tuesday June 1st, 1993

RE: SB-01
Project # 01989-006-004-0000
Lab ID: 9305G914-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Total Organic Carbon	0.66	**	%	0.050

** Analysis performed at Huffman Laboratories, Inc.

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Tuesday June 1st, 1993

RE: SB-05
Project # 01989-006-004-0000
Lab ID: 9305G914-002
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Total Organic Carbon	1.2 **	%	0.050

** Analysis performed at Huffman Laboratories, Inc.

HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403
Phone: (303) 278-4455 • FAX: (303) 278-7012

CUSTOMER #:
[illegible]113

DATE 5/27/93
LAB# 184093
P.O.
RECD 05/24/93

ANALYSIS REPORT

JANE HUBER
WESTON GULF COAST, INC.
2417 BOND ST.
UNIVERSITY PAR IL 60466

SEQUENCE/ SAMPLE ID	01 SB-01	02 SB-05
CARBONATE C---%	2.53	3.13
TOTAL CARBON--%	3.19	4.36
ORGANIC C-----%	0.66	1.23

[illegible]SAMPLES ARE NOT HOMOGENEOUS.

WESTON-GULF COAST, INC.
2417 BOND STREET
UNIVERSITY PARK, ILLINOIS 60466-3182
708-534-5200 • 219-885-7077 • 815-723-7533
FAX: 708-534-5211

4 June 1993

Mr. Carlos Serna
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Work Order No. 01989-006-004-0000

RE: Techalloy Analytical Results
RFW Batch 9305G912

Dear Mr. Serna:

Please find enclosed the Analytical Report for the Project and RFW Batch Number listed above. If you have any questions, please do not hesitate to contact me.

Very truly yours,

WESTON-GULF COAST, INC.

Jane D. Huber
Project Manager

jb

Enclosures

Approved By:

Michael J. Healy
Laboratory Manager

WESTON

STANDARD - GLOSSARY OF DATA QUALIFIERS AND ABBREVIATIONS

Inorganic Data Qualifiers

U	Analyte was not detected at or above the reporting limit
X	Result obtained indirectly through calculation based on results from other analyses

Organic Data Qualifiers

B	Compound was found in the blank and the sample
D	Surrogate or matrix spike recoveries were not obtained because the extract was diluted for analysis
E	Concentration exceeds the instrument calibration range and was subsequently diluted
I	Appears on the "results spreadsheet" to indicate an interference
J	Result is an estimated value below the reporting limit or a tenatively identified compound (TIC)
T	Compound was found in the TCLP extraction blank and the sample
U	Compound was not detected at or above the reporting limit

Abbreviations

BS	Blank Spike: spike analysis was conducted on reagent grade water or a matrix free from the analyte(s) of interest.
BSD	Blank Spike Duplicate
BRL	Below Reporting Limit
CD	Calculation Factor used by the laboratory's Information Management System (LIMS)
DF	Dilution Factor
DL	Appears in the sample ID to indicate a secondary dilution was performed
LCS	or (LC) denotes Laboratory Control Standard
MB	Method Blank or (PB) preparation blank
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NR	Not Required
NS	Not Spiked
RE	Appears in the sample ID to indicate a Re-analysis
REP	Replicate analysis
REPREP	Sample was reprepared and then reanalyzed
RFW#	Equivalent to the laboratory sample identification (LAB ID)
RPD	Relative Percent Difference of duplicate analyses
RRF	Relative Response Factor
RT	Retention Time
RTW	Retention Time Window

NOTES:

One or a combination of these data qualifiers and abbreviations may appear in the analytical report.
Soil, sediment and sludge results are reported on a dry weight basis except when analyzed for landfill disposal or incineration parameters. All other results on a solid matrix are reported on an "as received" basis unless noted differently.
Reporting limits are adjusted for preparation sample size, sample dilutions and sample moisture content if analyzed on a dry weight basis.

Revised 12/02/92

WESTON Analytics Use Only

9305[redacted]12

Custody Transfer Re[redacted]rd/Lab Work Request

WESTON MANAGERS [redacted] CONSULTANTS

Page [redacted] of 1

Del TAT

Date Rec'd _____ Date Due _____

Account # _____

Refrigerator #																	
#/Type Container	Liquid																
	Solid																
Volume	Liquid																
	Solid																
Preservatives																	
ANALYSES REQUESTED →		ORGANIC								INORG							
		VOA	BNA	Pest/PCB	Herb					Metal	CN						

Lab ID	Client ID/Description	Matrix QC Chosen (✓)	Matrix	Date Collected													
01	PW-01		W	5/20/93					✓	✓	✓	✓	✓			✓	

Special Instructions:

DATE/REVISIONS:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

WESTON Analytics Use Only

Samples were:
1) Shipped ___ or Hand Delivered X
Airbill # _____
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N
COC Record Present Upon Sample Rec't Y or N

Discrepancies Between Samples Labels and COC Record? Y or N
NOTES:

Relinquished by	Received by	Date	Time
F. Sobanick	D. Wardwell	5/20/93	1530
D. Wardwell	[illegible]	5/20/93	1830

Relinquished by	Received by	Date	Time

RFW 21-21-001/A-8/90 ____ L372 ____ L373 ____ L375 ____ L377 ____ L378 Ref# _____ Cooler# _____ G77-596a

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G912

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
PW-01							
ALKALINITY	001	W	93GAK050	05/20/93	05/20/93	05/25/93	05/25/93
TOTAL ORGANIC CARBON	001	W	93GTC061	05/20/93	05/20/93	05/27/93	05/27/93
TOTAL ORGANIC CARBON	001	W	93GTC061	05/20/93	05/20/93	05/27/93	05/27/93
LAB QC:							
ALKALINITY	LCS BS	W	93GAK050	N/A	N/A	05/25/93	05/25/93
ALKALINITY	LCS BSD	W	93GAK050	N/A	N/A	05/25/93	05/25/93
ALKALINITY	MB1	W	93GAK050	N/A	N/A	05/25/93	05/25/93
TOTAL ORGANIC CARBON	LCS BS	W	93GTC061	N/A	N/A	05/27/93	05/27/93
TOTAL ORGANIC CARBON	LCS BSD	W	93GTC061	N/A	N/A	05/27/93	05/27/93
TOTAL ORGANIC CARBON	MB1	W	93GTC061	N/A	N/A	05/27/93	05/27/93

SIGNATURE Diane L. Harper DATE 6-3-93

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Wednesday June 2nd, 1993

RE: PW-01
Project # 01989-006-004-0000
Lab ID: 9305G912-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Alkalinity	352		mg/L	10.0
Total Organic Carbon	7.8	J	mg/L	1.0
TOC Test 2	5.5	J	mg/L	1.0

LK 6/8/93

ROY F. WESTON, INC.
GULF COAST LABORATORY
WET CHEMISTRY CASE NARRATIVE

Client: Techalloy
RFW #: 9305G912
SDG #: NA

W.O. #:01989-006-004-0000
Date Rec'd: 05/20/93

Please note that the TOC replicates reported have a Relative Percent Difference (RPD) of 34.6. The laboratory's acceptance limit for TOC replicates is an RPD of </= 20. The analysis of this sample was repeated in replicate, with similar variation resulting from an apparent matrix-specific interference.

Diane L. Harper
Wet Chemistry Section Manager

6-3-93
Date

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Wednesday June 2nd, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G912

Inorganic Method Blank Data Report

Sample	Lab ID	Parameter	Result		Units	Reporting Limit
Blank 1	93GAK050-MB1	Alkalinity	10.0	u	mg/L	10.0
Blank 1	93GTC061-MB1	Total Organic Carbon	1.0	u	mg/L	1.0

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
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Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Wednesday June 2nd, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G912

Inorganic Laboratory Control Standards Report

Lab ID	Parameter	Spiked Amount	Units	Spike #1 % Recov.	Spike #2 % Recov.	RPD
93GAK050-LCS	Alkalinity	100	mg/L	115	115	0.00
93GTC061-LCS	TOC	5.0	mg/L	105	103	1.4

Roy F. Weston, Inc. - Gulf Coast Laboratories
INORGANIC ANALYTICAL DATA PACKAGE FOR
Techalloy

LABORATORY CHRONICLE

RFW LOT # :9305G912

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTN	DATE REC	EXT/PREP	ANALYSIS
PW-01							
IRON, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
MANGANESE, TOTAL	001	W	93GI318	05/20/93	05/20/93	05/24/93	05/25/93
LAB QC:							
IRON LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
MANGANESE LABORATORY	LC1 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
IRON LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
MANGANESE LABORATORY	LC2 BS	W	93GI318	N/A	N/A	05/24/93	05/25/93
IRON, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93
MANGANESE, TOTAL	MB1	W	93GI318	N/A	N/A	05/24/93	05/25/93

SIGNATURE Lydia S. Ryan DATE 5/26/93

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Tuesday May 25th, 1993

RE: PW-01
Project # 01989-006-004-0000
Lab ID: 9305G912-001
Sample Date: 05/20/93
Date Received: 05/20/93

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Iron, Total	5.0	mg/L	0.030
Manganese, Total	0.30	mg/L	0.010

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: **Techalloy**
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: **Mr. Carlos Serna**

Date: Tuesday May 25th, 1993

Project # 01989-006-004-0000
Lab Batch: **9305G912**

Inorganic Method Blank Data Report

Sample	Lab ID	Parameter	Result		Units	Reporting Limit
Blank 1	93GI318-MB1	Iron, Total	0.041		mg/L	0.030
		Manganese, Total	0.010	u	mg/L	0.010

WESTON-GULF COAST, INC.
2417 Bond St., University Park, Illinois 60466
Phones: (708) 534-5200 (219) 885-7077 (815) 723-7533
Fax: (708) 534-5211

ANALYTICAL REPORT

To: Techalloy
Roy F. Weston, Incorporated
3 Hawthorn Parkway, Suite 400
Vernon Hills, IL 60061

Attn: Mr. Carlos Serna

Date: Tuesday May 25th, 1993

Project # 01989-006-004-0000
Lab Batch: 9305G912

Inorganic Laboratory Control Standards Report

Lab ID	Parameter	Spiked Amount	Units	Spike #1 % Recov.	Spike #2 % Recov.	RPD
93GI318-LC1	Iron, LCS	1.0	mg/L	97.7	99.3	1.5
	Manganese, LCS	0.50	mg/L	93.1	94.1	1.0

APPENDIX C

AQUIFER PUMPING TEST DATA

APPENDIX C
AQUIFER PUMPING TEST DATA

In order to estimate the hydraulic conductivity at the Techalloy site, a pumping test was performed using a 6-inch diameter pumping well and a 2-inch diameter observation well. The observation well was set 9 feet from the pumping well so that the well could be pumped at 50 gpm and still create drawdown in the observation well. ~~Both wells are fully penetrating~~. An In-Situ Hermit SE1000B Data Logger equipped with two electronic pressure transducers was used to record the water levels in the pumping and observation wells.

The pumping test data was analyzed using the method described by Boulton (USGS Professional Paper 708). This technique is applicable to unconfined aquifers with vertical movement. The observation well time-drawdown data was plotted on a logarithmic scale and analyzed using overlays. All calculations and the time-drawdown plot are attached.

WESTON MANAGERS DESIGNERS/CONSULTANTS

SHEET 1 of ___

CLIENT/SUBJECT TEZHALLOY W.O. NO. ___

TASK DESCRIPTION PUMP TEST DATA EVALUATION TASK NO. ___

PREPARED BY WLN DEPT 535 DATE 5-26-93

MATH CHECK BY ___ DEPT ___ DATE ___

METHOD REV. BY ___ DEPT ___ DATE ___

APPROVED BY ___ DEPT ___ DATE ___

(DELAYED YIELD)

FROM EQUATION (109), USGS PROF. PAPER 708, PLATE 8

MATCH PT #1 (EARLY TIME DATA):

$$T = \frac{(1.0)Q}{4\pi s} = \frac{(1.0)(50\ gpm)}{4\pi(0.1\ ft)} = \frac{(1.0)(0.11\ ft^3/s)}{4\pi(0.1\ ft)}$$

$$= 0.088\ ft^2/s \sim 7{,}600\ ft^2/day = 56{,}800\ gpd/ft$$

$$K = T/b = 7{,}600\ ft^2/day / 30\ ft = 253\ ft/day$$

$$\sim 8.9 \times 10^{-2}\ cm/sec$$

FROM EQ. (110):

$$S_e = \frac{4Tt}{r^2(1.0)} = \frac{4(0.088\ ft^2/s)(1.5\ secs)}{(9.0\ ft)^2(1.0)}$$

$$= 6.5 \times 10^{-3} = 0.0065$$

MATCH PT #2 (LATE TIME DATA):

$$T = \frac{(1.0)Q}{4\pi s} = \frac{(1.0)(0.11\ ft^3/s)}{4\pi(0.12)} = 0.073\ ft^2/s \sim 6{,}300\ ft^2/day$$

$$K = T/b = 6{,}300\ ft^2/day / 30\ ft = 210\ ft/day$$

$$K \sim 7.4 \times 10^{-2}\ cm/s$$

RFW 10-05-003/A-5/85
512-5643

WESTON MANAGERS DESIGNERS/CONSULTANTS

SHEET 2 of ___

CLIENT/SUBJECT TECHALLOY W.O. NO. ___

TASK DESCRIPTION PUMP TEST DATA EVALUATION TASK NO. ___

PREPARED BY WLN DEPT 535 DATE 5-26-93

MATH CHECK BY ___ DEPT ___ DATE ___

METHOD REV. BY ___ DEPT ___ DATE ___

APPROVED BY ___ DEPT ___ DATE ___

MATCH PT. #2 (CONT.)

FROM EQ. 110:

$$S_\ell = \frac{4Tt}{r^2(1.0)} = \frac{4(0.073\ ft^2/s)(420\ secs)}{(9.0\ ft)^2\ (1.0)}$$

$$= 1.51$$

FROM USGS P.P. 708, PLATE 6C

FROM EQ. (105):

$$T = 1.0\ \frac{Q}{s} = \frac{(1.0)(0.11\ ft^3/s)}{0.53\ ft} = 0.21\ ft^2/s$$

$$\sim 18{,}100\ ft^2/day \qquad 135{,}400\ gpd/ft$$

$$K_x = T/b = 18{,}100/30 = 603\ ft/day$$

$$\sim 2.1 \times 10^{-1}\ cm/sec$$

FROM EQ. (106):

$$S = \frac{Tt}{1.0\ r^2} = \frac{(0.21\ ft^2/s)(6\ secs)}{(1.0)(9.0)^2} = 0.016$$

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 3 of ___

CLIENT/SUBJECT TECHALLOY W.O. NO. ___

TASK DESCRIPTION PUMP TEST DATA EVALUATION TASK NO. ___

PREPARED BY WLW DEPT 535 DATE 5-26-93

MATH CHECK BY ___ DEPT ___ DATE ___

METHOD REV. BY ___ DEPT ___ DATE ___

APPROVED BY ___ DEPT ___ DATE ___

FROM EQ. (102):

$$\psi = \frac{r}{b}\sqrt{\frac{K_z}{K_r}}$$

$$0.0345 = \frac{9.0\ ft}{30\ ft}\sqrt{\frac{K_z}{603\ ft/day}}$$

$$K_z = (0.0345)^2 \cdot \frac{(30\ ft)^2}{(9.0\ ft)^2} \cdot (603\ ft/day)$$

$$K_z = 7.97\ ft/day \sim 8.0\ ft/day$$

$$\frac{K_r}{K_z} = \frac{603}{8} \sim 75$$

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 4 of ___

CLIENT/SUBJECT TECHALLOY ~~PUMP TE~~ W.O. NO. ___

TASK DESCRIPTION PUMP TEST DATA EVALUATION TASK NO. ___

PREPARED BY WLN DEPT 535 DATE 5-27-93

MATH CHECK BY ___ DEPT ___ DATE ___

METHOD REV. BY ___ DEPT ___ DATE ___

APPROVED BY ___ DEPT ___ DATE ___

FROM USGS P.P. 708, PLATE 6D

FROM EQ. (105):

$$T = 1.0\,\frac{Q}{s} = \frac{(1.0)(0.11\ ft^2/s)}{(1.0\ ft)} = 0.11\ ft^2/s$$

$$\sim 9{,}500\ ft^2/day$$

$$K_x = T/b = 9{,}500/30 = 317\ ft/day$$

$$\sim 1.1 \times 10^{-1}\ cm/sec$$

FROM EQ. (106):

$$S = \frac{Tt}{1.0r^2} = \frac{(0.11\ ft^2/s)(240\ sec)}{(1.0)(9.0)^2} = 0.326$$

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 5 of ___

CLIENT/SUBJECT TECHALLOY W.O. NO. ___

TASK DESCRIPTION PUMP TEST DATA EVALUATION TASK NO. ___

PREPARED BY WLN DEPT ___ DATE 5-27-93

MATH CHECK BY ___ DEPT ___ DATE ___

METHOD REV. BY ___ DEPT ___ DATE ___

APPROVED BY ___ DEPT ___ DATE ___

$T_1 = 0.088\ ft^2/sec$ $K_1 = 253\ ft/day$

$T_2 = 0.073\ ft^2/sec$ $K_2 = 210\ ft/day$

$T_3 = 0.21\ ft^2/sec$ $K_3 = 603\ ft/day$

$T_4 = 0.11\ ft^2/sec$ $K_4 = 317\ ft/day$

ARITHMETIC MEANS

$\overline{T} = 0.09\ ft^2/sec$ $\overline{K} = 260\ ft/day$

GEOMETRIC MEANS

$\overline{T} = 0.09\ ft^2/sec$ $\overline{K} = 256\ ft/day$

NOTE: VALUES FOR T_3 AND K_3 WERE NOT USED IN COMPUTATION OF MEANS BECAUSE THE SOLUTION GIVEN FOR PLATE 6D IS A MORE APPROPRIATE TYPE CURVE THAN PLATE 6C.

TERRALOY

Observation Well

MATCH PT., PLATE 6C, USGS PP. 708

$Tt/r^2S = 1$

$sT/Q = 1$

$s = 0.53$ ft

$t = 0.1$ mins $= 6$ secs

$\psi = 0.0345$

MATCH PT., PLATE 6D

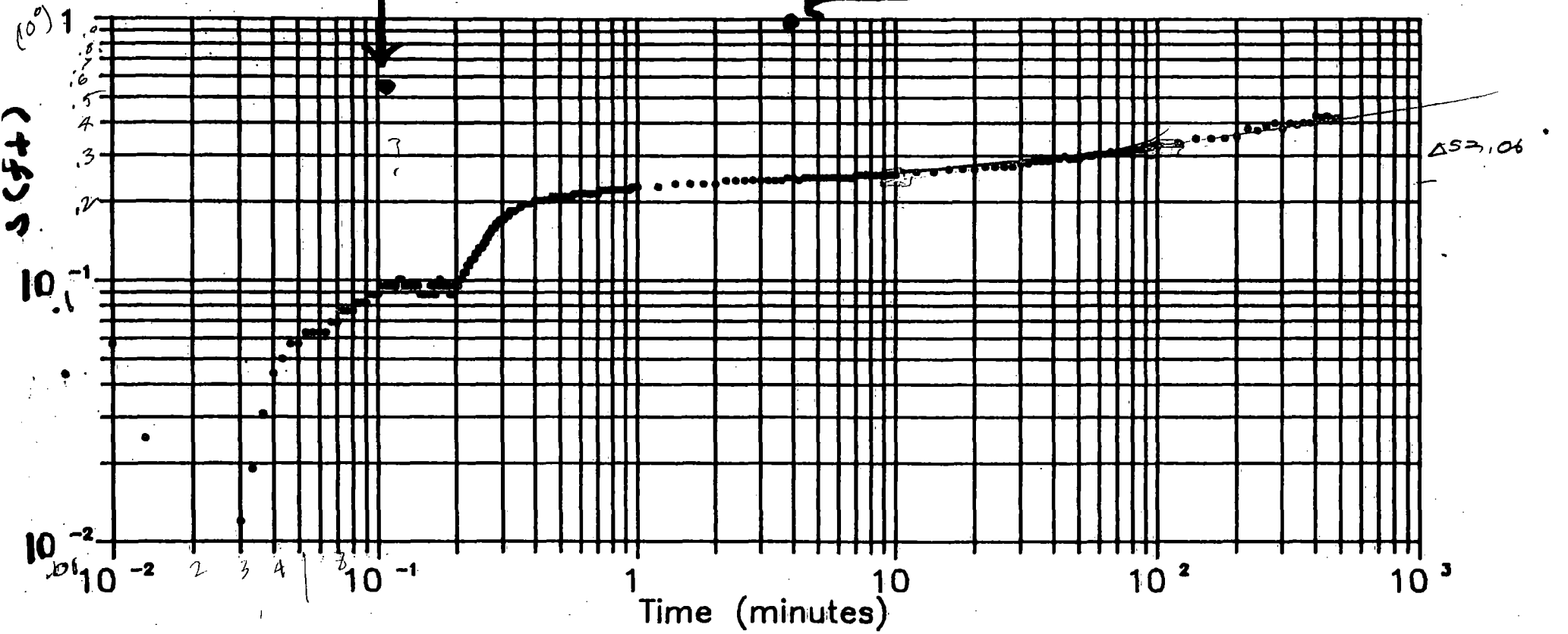
$Tt/r^2S = 1$

$sT/Q = 1$

$s = 1.0$

$t = 4$ min. $= 240$ secs

$\psi = 0.154$



MATCH [illegible] PL[illegible] [illegible] UES [illegible] 308

TECHNOLOGY

Obser[illegible]ion Well

EARLY TIME:

MATCH PT #1

$4Tt/r^2 S_e = 1$

$4\pi Ts/Q = 1$

$s = 0.1$ ft

$t = 0.025$ ~~secs~~ mins

$= 1.5$ secs

LATE TIME:

MATCH PT #2

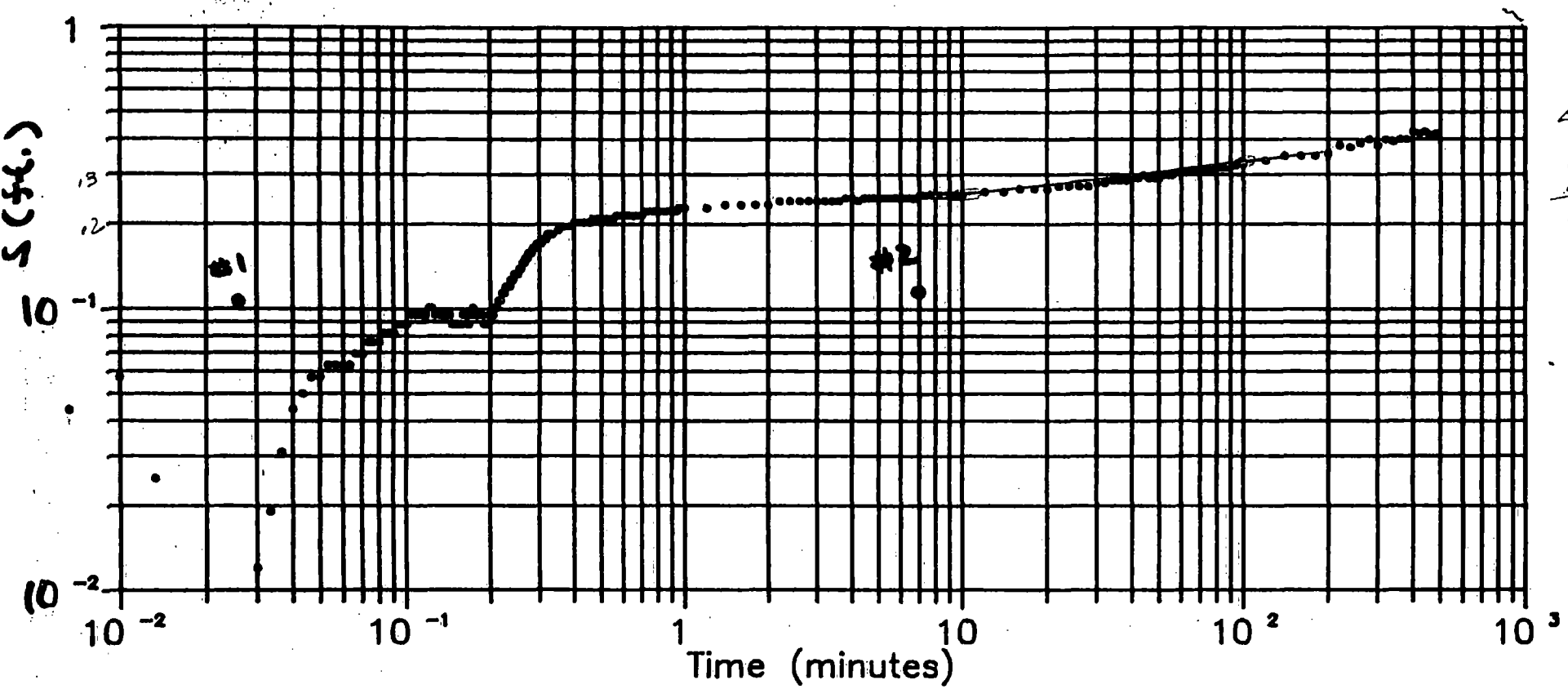
$4Tt/r^2 S_l = 1$

$4\pi Ts/Q = 1$

$s = 0.12$

$t = 7$ ~~secs~~ mins

$= 420$ secs



Δs

.32

.26

.06

APPENDIX D

GROUNDWATER SYSTEM MODELING REPORT

APPENDIX D

GROUNDWATER MODELING METHODS AND RESULTS IN SUPPORT OF INTERIM MEASURES TECHALLOY COMPANY, INC. UNION, ILLINOIS

Prepared for

TECHALLOY COMPANY, INC.
Union, Illinois

August 1993

Prepared by

ROY F. WESTON, INC.
Three Hawthorn Parkway
Vernon Hills, Illinois 60061

Work Order No. 01989-010-001

APPENDIX D

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SECTION 1
INTRODUCTION

1.1 GROUNDWATER MODELING SCOPE

Roy F. Weston, Inc. (WESTON®) is currently designing Interim Measures at the Techalloy Company facility located in Union, Illinois (Figure 1-1). In preparation for the concept design of the Interim Measures groundwater recovery and treatment system, WESTON used the Method-of-Characteristics (MOC) groundwater model (Konikow and Bredehoeft, 1989) to simulate groundwater flow in the area of Techalloy. The objectives of the MOC modeling were to create a model that could accomplish the following:

- Simulate groundwater flow in the water table aquifer.
- Simulate proposed Interim Measures capture zone of the recovery well.

Figures 1-2 is a contour map of measured groundwater elevations in the model area. Figure 1-3 shows the measured contaminant plume, based on previous groundwater investigation.

1.2 METHOD-OF-CHARACTERISTICS MODEL

The MOC is a two-dimensional numerical groundwater analytical model capable of simulating flow and solute transport model. The model computes changes in concentration over time caused by the processes of advective transport, hydrodynamic dispersion, chemical sorption, and mixing from fluid sources. MOC couples the groundwater flow equation with the solute-transport equation, using finite-difference approximations to solve the groundwater flow equation and the MOC to solve the transport equations (Konikow and Bredehoeft, 1989).

FIGURE 1-1

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

SITE LOCATION MAP

TECHALLOY
Union, Illinois

RWS-08/10/93-16:28-CAD93\600\60893

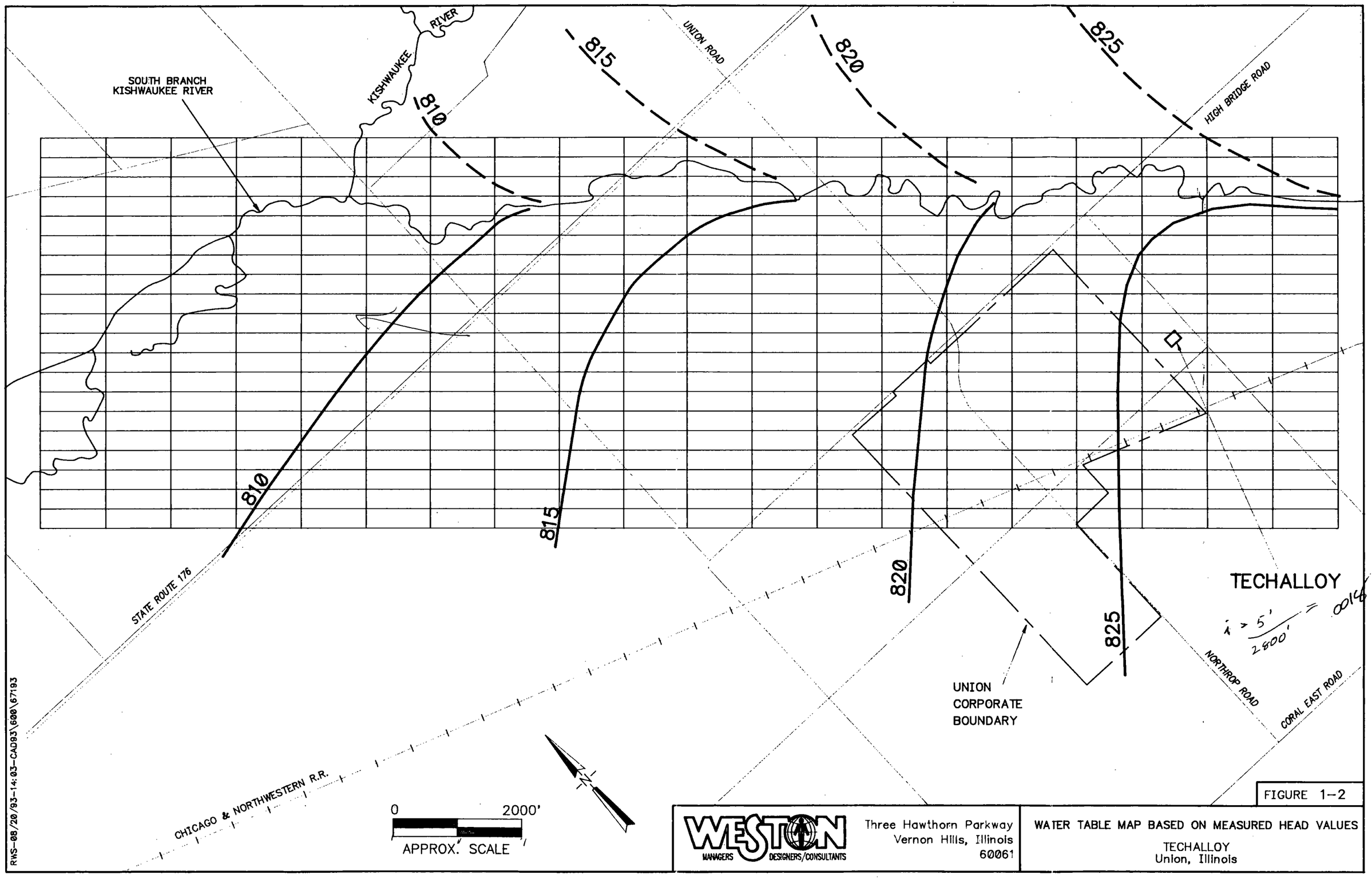


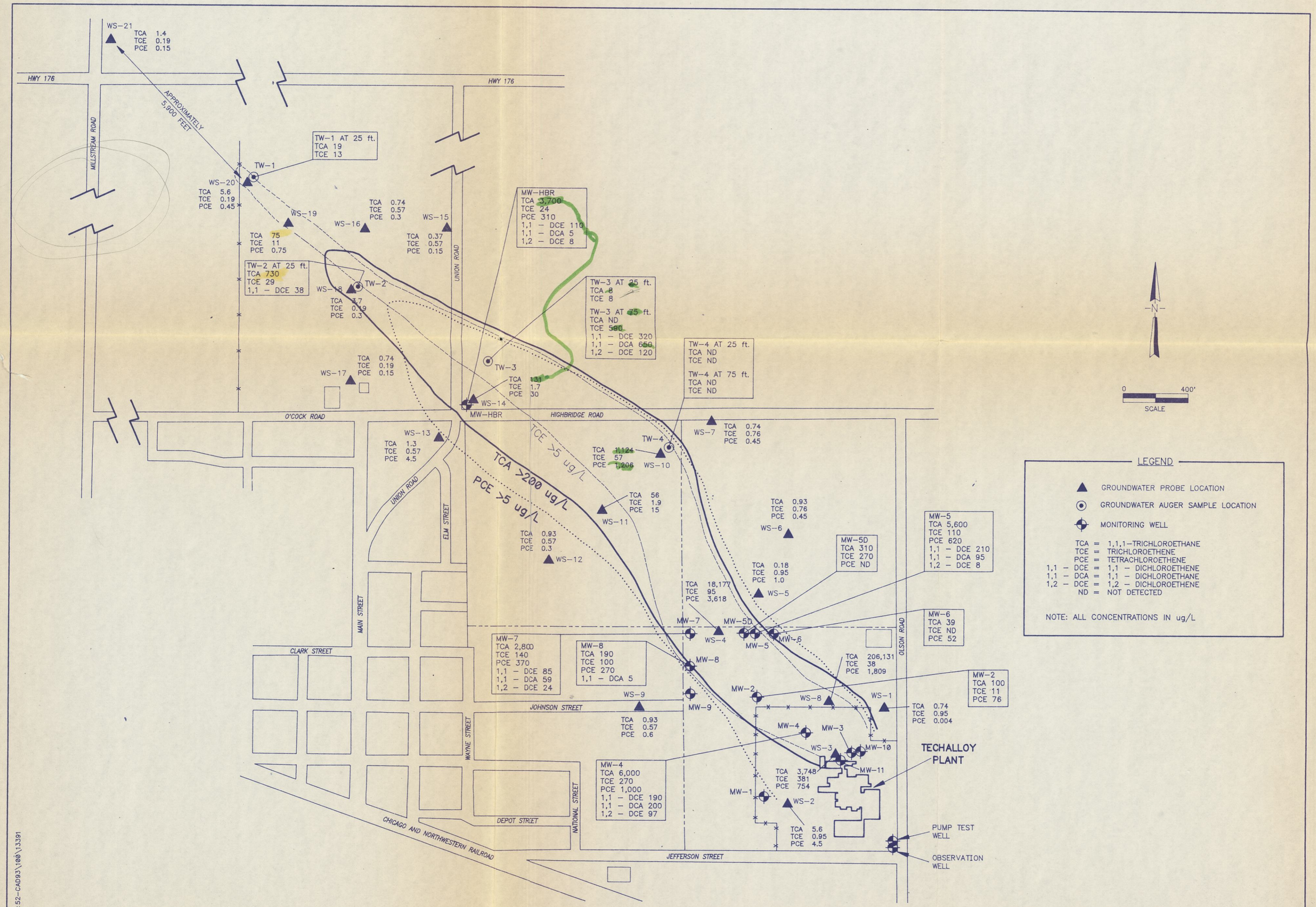
FIGURE 1-2

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

WATER TABLE MAP BASED ON MEASURED HEAD VALUES

TECHALLOY
Union, Illinois



RJB-08/27/93-13:52-CAD93\100\13391

FIGURE 1-3

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

MEASURED PLUME EXTENT

TECHALLOY COMPANY, INC.
Union, Illinois

SECTION 2
GROUNDWATER FLOW MODELING METHODS

2.1 FLOW MODEL DESIGN AND INPUT PARAMETERS

2.1.1 Grid Design

The model area measures 20,000 feet by 6,000 feet and encompasses an area of 120 million square feet (Figure 1-1). The long axis of the area is aligned northwest-southeast, parallel to the dominant direction of flow in the water table aquifer. The initial grid superimposed on the model area consisted of a 20 by 20 mesh, with each [redacted] measuring 1000 feet by 300 feet. To better simulate contaminant transport, the grid was later subdivided into a 60 by 60 mesh, with each [redacted] measuring 333 feet by 100 feet.

2.1.2 Boundary Conditions

2.1.2.1 Fixed Head Boundaries

Based on site and regional hydrogeologic data, groundwater in the water table aquifer is known to flow generally to the northwest. Accordingly, the northeastern and northwestern boundaries of the model area coincided with the hydrologic boundaries represented by the Kishwaukee and South Branch rivers, respectively. A convenient hydrologic boundary did not exist southeast (upgradient) of the model area. Therefore this boundary was established as a fixed head boundary with the elevations interpolated between the South Branch River to the northeast and measured groundwater elevations to the southwest. Figure 2-1 shows the model boundaries.

2.1.2.2 No-Flow Boundaries

The southwestern model edge was established as a no-flow boundary based on observed groundwater flow which is generally parallel to this boundary (Figure 2-1).

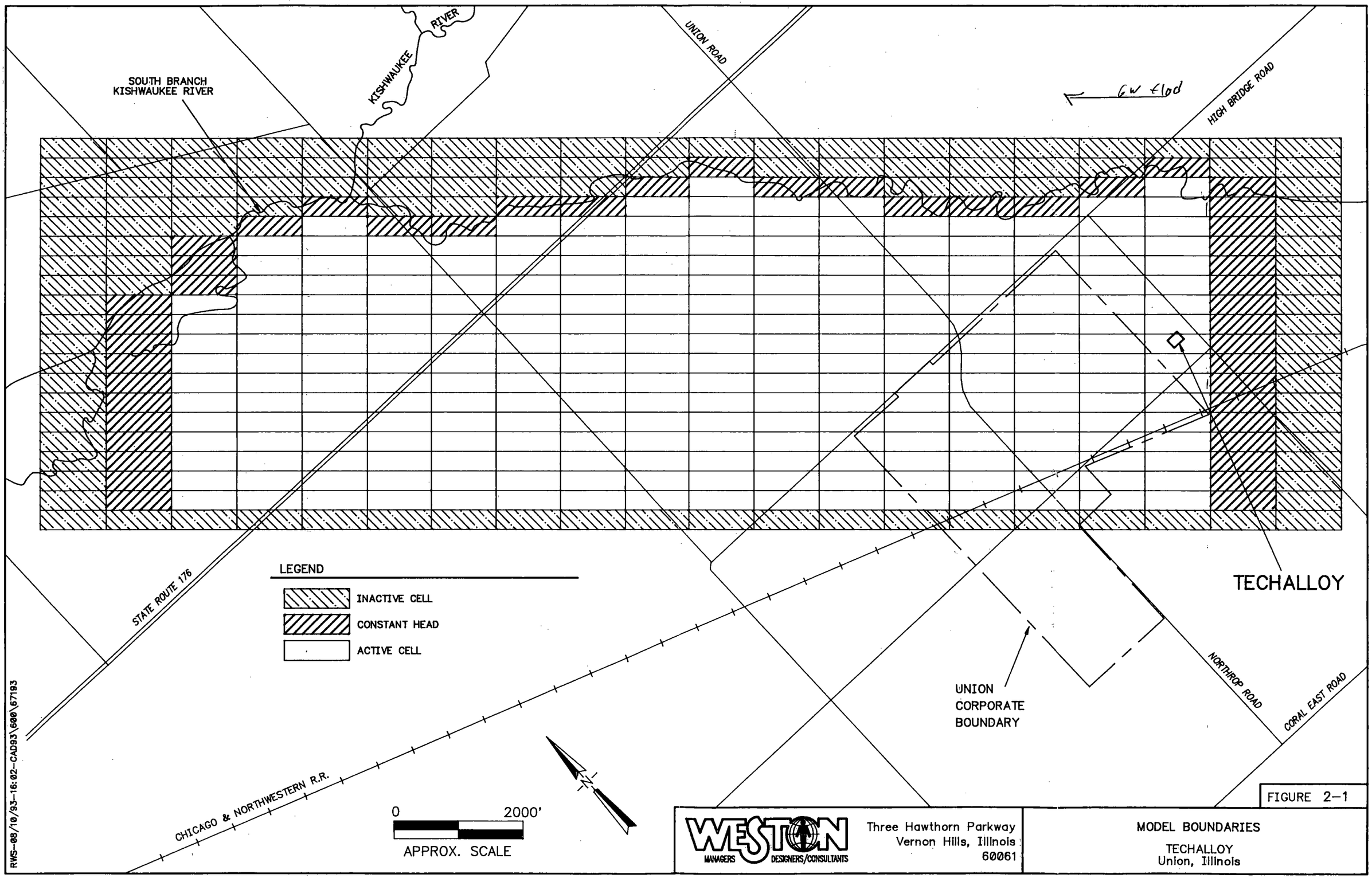

SOUTH BRANCH
KISHWAUKEE RIVER
KISHWAUKEE
RIVER
UNION ROAD
GW Flow
HIGH BRIDGE ROAD
STATE ROUTE 176
LEGEND
INACTIVE CELL
CONSTANT HEAD
ACTIVE CELL
TECHALLOY
UNION
CORPORATE
BOUNDARY
NORTHROP ROAD
CORAL EAST ROAD
CHICAGO & NORTHWESTERN R.R.
0
2000'
APPROX. SCALE
RWS-08/10/93-16:02-CAD93\600\67193
WESTON
MANAGERS
DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061
MODEL BOUNDARIES
TECHALLOY
Union, Illinois

FIGURE 2-1

SECTION 2
GROUNDWATER FLOW MODELING METHODS

2.1 FLOW MODEL DESIGN AND INPUT PARAMETERS

2.1.1 Grid Design

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2.1.2.2 No-Flow Boundaries

The southwestern model edge was established as a no-flow boundary based on observed groundwater flow which is generally parallel to this boundary (Figure 2-1).

2.1.3 Sources of Hydrogeological Data

Data obtained from direct field measurements were used as model input to the fullest extent possible. Where field data was lacking, input parameters were interpolated from the nearest measured values or estimated. The following subsections describe the sources of input data for transmissivity, recharge, water level elevations, and saturated thickness of the aquifer.

2.1.3.1 Transmissivity from Aquifer Pumping Test

WESTON conducted an aquifer pumping test at the Techalloy facility on 21 May 1993. The test evaluation indicated that the mean transmissivity (**T**) of the water table aquifer in this area is approximately 7,800 square feet per day (ft^2/day). Based on a measured aquifer (saturated) thickness of 30 feet, a **T** value of 7,800 ft^2/day corresponds to a hydraulic conductivity (**K**) of approximately 260 ft/day. This **K** value was assumed for the entire model area. **T** values were variable over the model area due to variable aquifer thickness (see Subsection 2.1.3.4).

2.1.3.2 Recharge from Rainfall Data

Uniform recharge was simulated for the entire model area. The magnitude was estimated as a percentage of the annual rainfall, which is approximately 30 inches per year. Recharge over the entire model in the model input was 10 inches per year.

2.1.3.3 Water Level Elevations

The primary sources of water level elevation data were Kishwaukee River and South Branch River elevations obtained from the Marengo North and Marengo South 7.5 minute USGS (United States Geological Survey) quadrangle maps. River gradients were calculated between each set of surface elevation contours that crossed the rivers, and river elevations were interpolated between the contours. The river elevations were used to establish fixed head elevations along the northwestern and northeastern model boundaries. Fixed head

values along the northeastern (upgradient) model boundary, where reliable measured values did not exist, were lowered during the model calibration in order to better match the observed flow direction to the northwest.

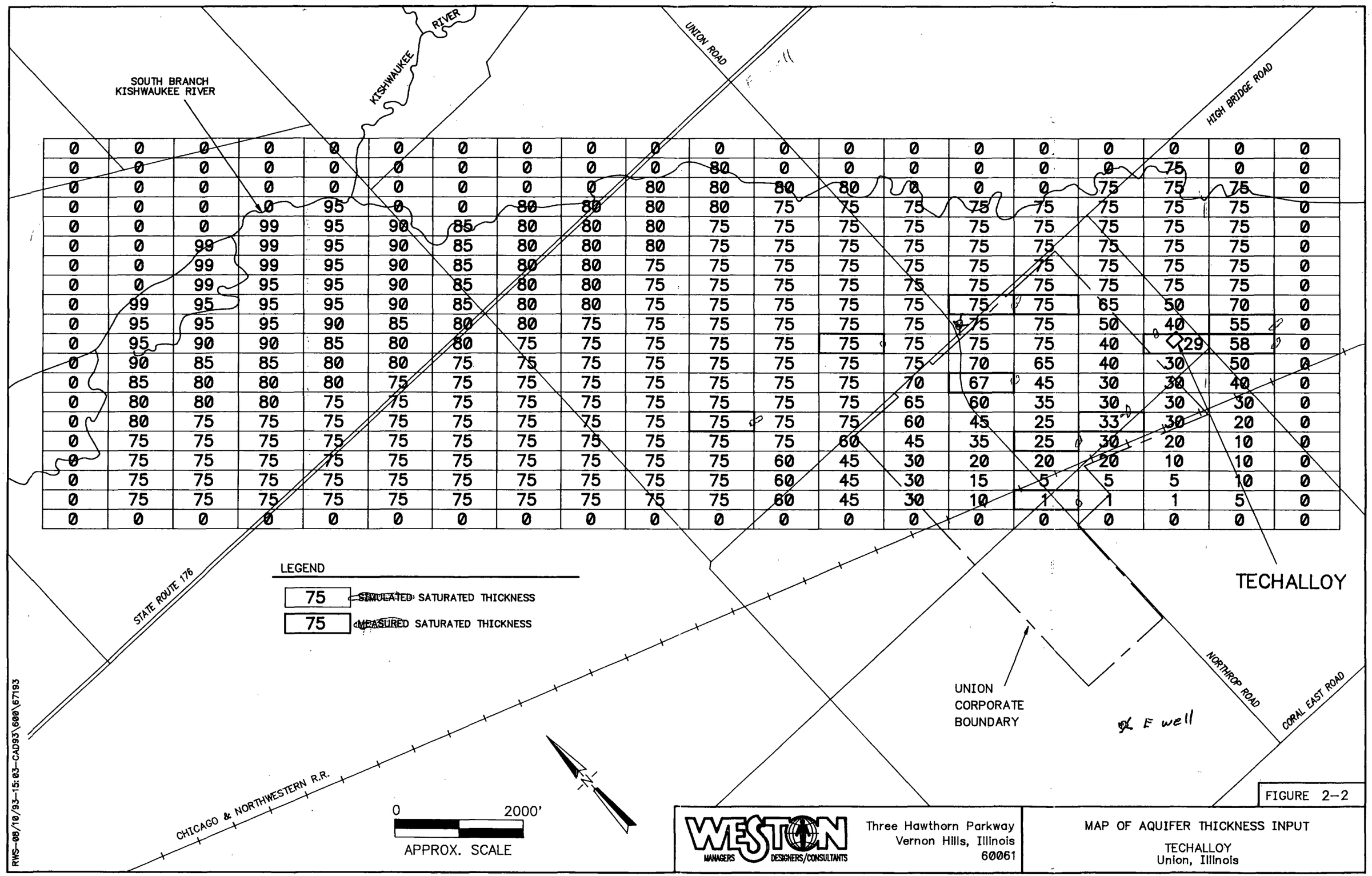
Depth-to-water measurements were obtained for seven locations within the model area from Techalloy monitoring wells and boreholes, as well as residential well logs. The groundwater elevations were calculated by subtracting the depth-to-water measurements from surface elevations estimated from the topographic maps. The measured groundwater elevations were used to evaluate the accuracy of the flow model calibration, as discussed in Subsection 2.2.

2.1.3.4 Aquifer Thickness

Values used in the model for saturated thickness of the aquifer were based on logs from residential wells, in addition to logs from monitoring wells and soil borings from previous Techalloy investigations (Figure 2-2). The maximum measured thickness was ~~75 feet~~. Based on communication with the Illinois State Water Survey (1993, personal communication, S. Meyer), the actual aquifer thickness near the axis of the Kishwaukee River may approximate 100 feet. Therefore, the maximum thickness used in the model input varied between 75 and 99 feet. 75' at E well

2.2 FLOW MODEL CALIBRATION

The goal of flow model calibration was to obtain the best possible match between measured and simulated groundwater elevations, particularly along the axis of the contaminant plume. In order to achieve this goal, the hydrologic parameters were varied as described in Subsections 2.1.3.1 through 2.1.3.4. Table 2-1 summarizes input used in the calibrated flow model. A map of the aquifer thickness used in the calibrated model is shown in Figure 2-2. A map of the transmissivity values used in the calibrated model is shown in Figure 2-3.



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0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	75	0	0
0	0	0	0	0	0	0	0	0	80	80	80	80	0	0	0	75	75	75	0
0	0	0	0	95	0	0	80	80	80	80	75	75	75	75	75	75	75	75	0
0	0	0	99	95	90	85	80	80	80	75	75	75	75	75	75	75	75	75	0
0	0	99	99	95	90	85	80	80	80	75	75	75	75	75	75	75	75	75	0
0	0	99	99	95	90	85	80	80	75	75	75	75	75	75	75	75	75	75	0
0	0	99	95	95	90	85	80	80	75	75	75	75	75	75	75	75	75	75	0
0	99	95	95	95	90	85	80	80	75	75	75	75	75	75	75	65	50	70	0
0	95	95	95	90	85	80	80	75	75	75	75	75	75	75	75	50	40	55	0
0	95	90	90	85	80	80	75	75	75	75	75	75	75	75	75	40	29	58	0
0	90	85	85	80	80	75	75	75	75	75	75	75	75	70	65	40	30	50	0
0	85	80	80	80	75	75	75	75	75	75	75	75	70	67	45	30	30	40	0
0	80	80	80	75	75	75	75	75	75	75	75	75	65	60	35	30	30	30	0
0	80	75	75	75	75	75	75	75	75	75	75	75	60	45	25	33	30	20	0
0	75	75	75	75	75	75	75	75	75	75	75	60	45	35	25	30	20	10	0
0	75	75	75	75	75	75	75	75	75	75	60	45	30	20	20	20	10	10	0
0	75	75	75	75	75	75	75	75	75	75	60	45	30	15	5	5	5	10	0
0	75	75	75	75	75	75	75	75	75	75	60	45	30	10	1	1	1	5	0
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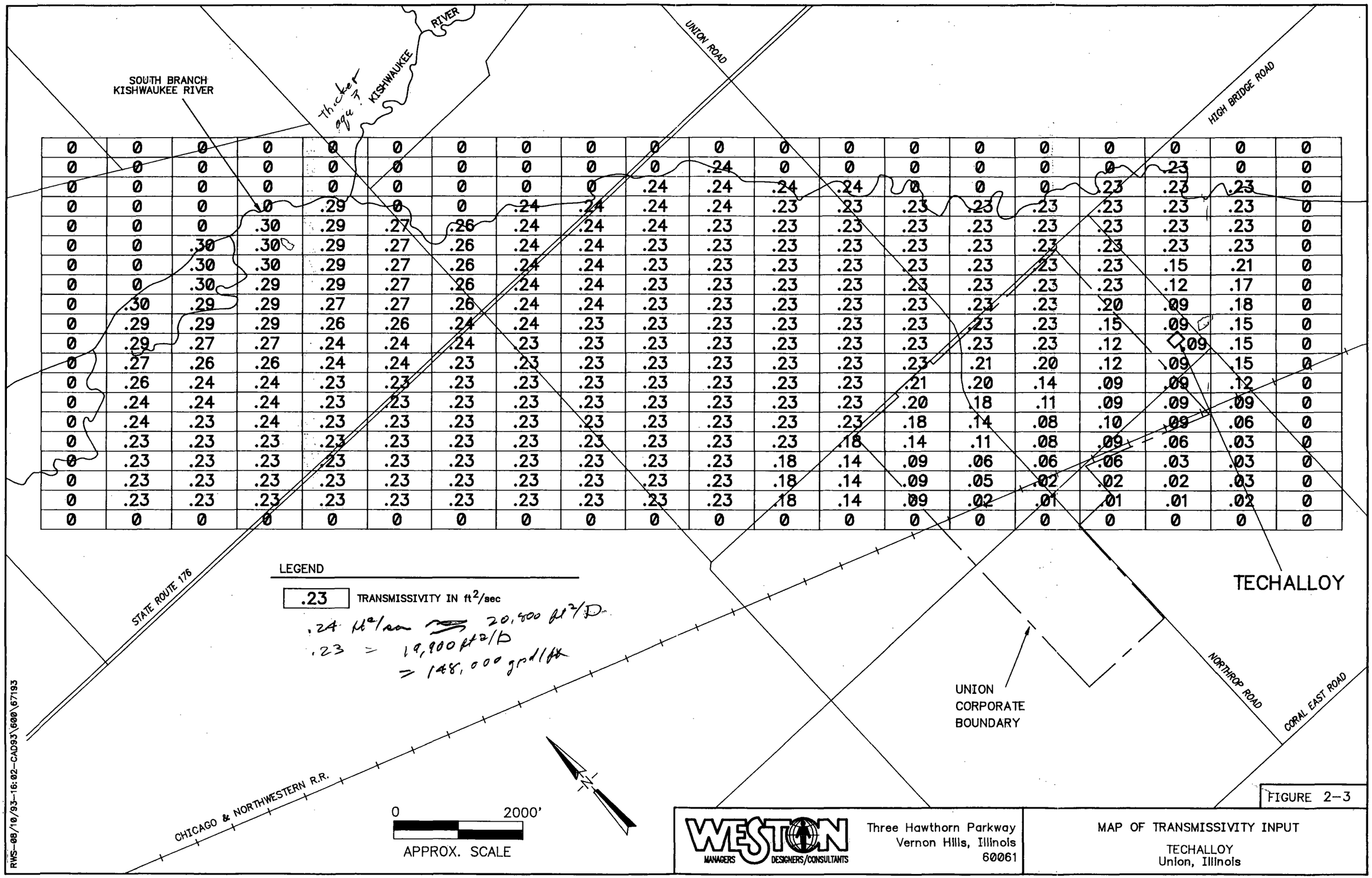

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	.24	0	0	0	0	0	0	.23	0	0
0	0	0	0	0	0	0	0	0	.24	.24	.24	.24	0	0	0	.23	.23	.23	0
0	0	0	0	.29	0	0	.24	.24	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	0
0	0	0	.30	.29	.27	.26	.24	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.23	0
0	0	.30	.30	.29	.27	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	0
0	0	.30	.30	.29	.27	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.15	.21	0
0	0	.30	.29	.29	.27	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.12	.17	0
0	.30	.29	.29	.27	.27	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.20	.09	.18	0
0	.29	.29	.29	.26	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.15	.09	.15	0
0	.29	.27	.27	.24	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.23	.12	.09	.15	0
0	.27	.26	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.21	.20	.12	.09	.15	0
0	.26	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.23	.21	.20	.14	.09	.09	.12	0
0	.24	.24	.24	.23	.23	.23	.23	.23	.23	.23	.23	.23	.20	.18	.11	.09	.09	.09	0
0	.24	.23	.24	.23	.23	.23	.23	.23	.23	.23	.23	.23	.18	.14	.08	.10	.09	.06	0
0	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.18	.14	.11	.08	.09	.06	.03	0
0	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.18	.14	.09	.06	.06	.06	.03	.03	0
0	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.18	.14	.09	.05	.02	.02	.02	.03	0
0	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.18	.14	.09	.02	.01	.01	.01	.02	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-1

Summary of Input Data for Flow Model
Techalloy Co.
Union, Illinois

Parameter	Value	Units
Hydraulic conductivity	260	Feet per day
Recharge*	10	Inches per year
Aquifer thickness	~~1-99~~	Feet

*Estimated from annual rainfall data.

The measured water level elevations described in Subsection 2.1.3.3 and shown in Figure 2-4 were used as calibration points for the flow model. Differences between the estimated and simulated values, known as "residuals," were calculated throughout the calibration process. Special attention was given to the residuals at points close to the long axis of the contaminant plume. The residuals for the calibrated flow model ranged between 1 and 5 feet (Figure 2-5). Along the long axis of the plume, the residuals ranged between 1 and 2 feet. The simulated head distribution from the calibrated flow model is illustrated on Figure 2-6.

The simulated hydraulic gradient in the calibrated flow model ranged between 0.0014 and 0.0017 foot/foot, compared to the measured gradient at Techalloy of 0.0023 foot/foot. The variations between simulated and measured values for head and gradient were judged to be acceptable based on the following rationale:

- **The lack of accuracy in the measured groundwater elevations.** The degree of accuracy is probably no better than ± 3 feet, due to the long time span over which depth-to-water measurements were taken and the need to estimate reference elevations from the topographic maps.

- **The small area covered by the facility's monitoring wells relative to the model area.** Because the facility's monitoring wells cover only a small area, the gradient measured there may not be representative of the model area gradient.

- **The high degree of confidence in the measured river gradients.** The rivers are the primary control, both in the field and in the model, on the regional water table configuration. The river gradients, which are based on measured river elevations, show that the local water table gradient measured at Techalloy is larger than the regional water table gradient. Therefore, the calibrated flow model is sufficiently accurate to simulate flow throughout the model area.

2.3 FLOW MODEL SENSITIVITY ANALYSIS

A qualitative evaluation was made of the sensitivity of the flow model to changes in the hydrologic parameters required as model input (see Subsection 2.1.3 for a discussion of the flow model input parameters). The objective of the flow model sensitivity analysis was to

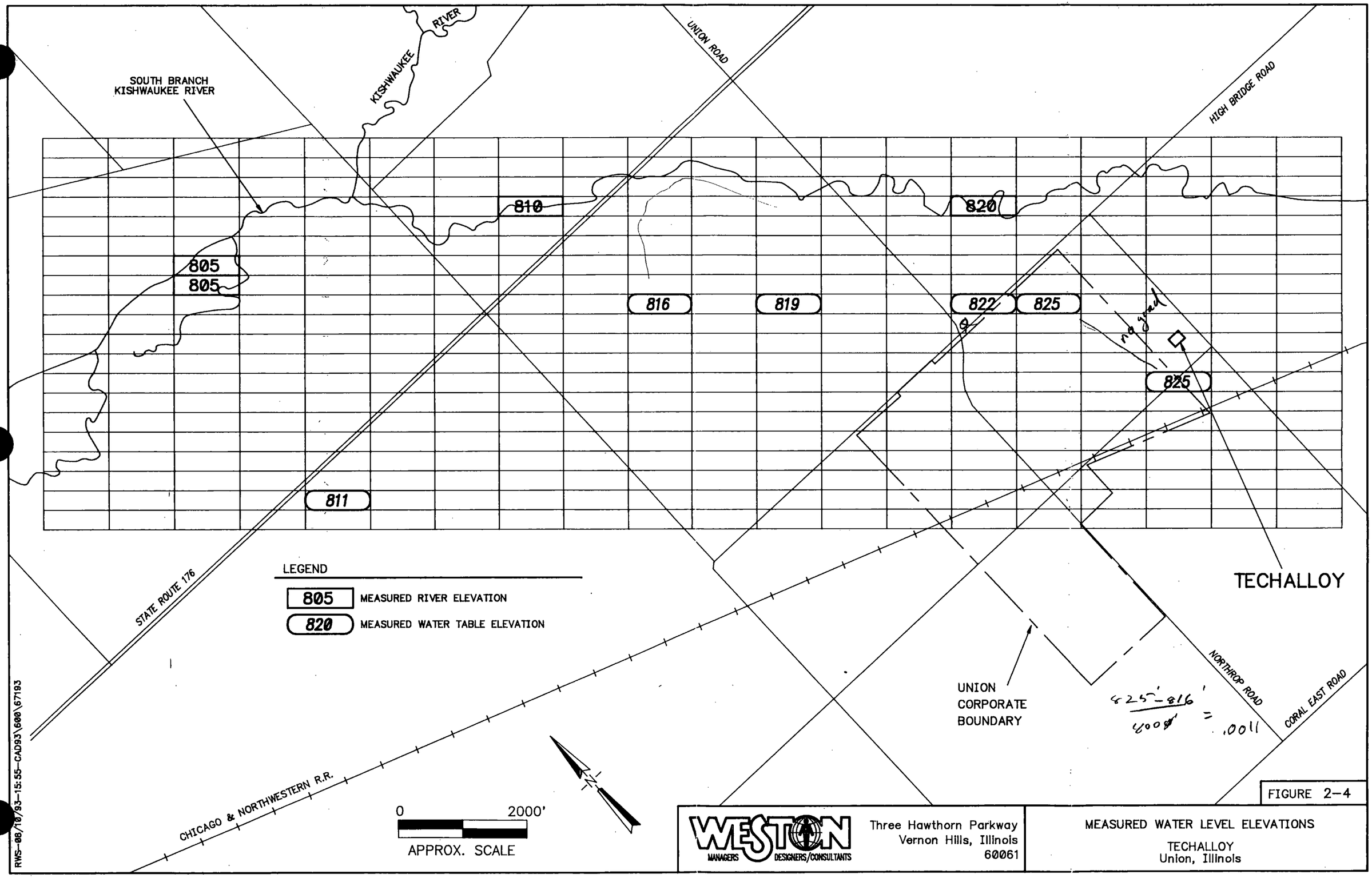

FIGURE 2-4

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

MEASURED WATER LEVEL ELEVATIONS

TECHALLOY
Union, Illinois

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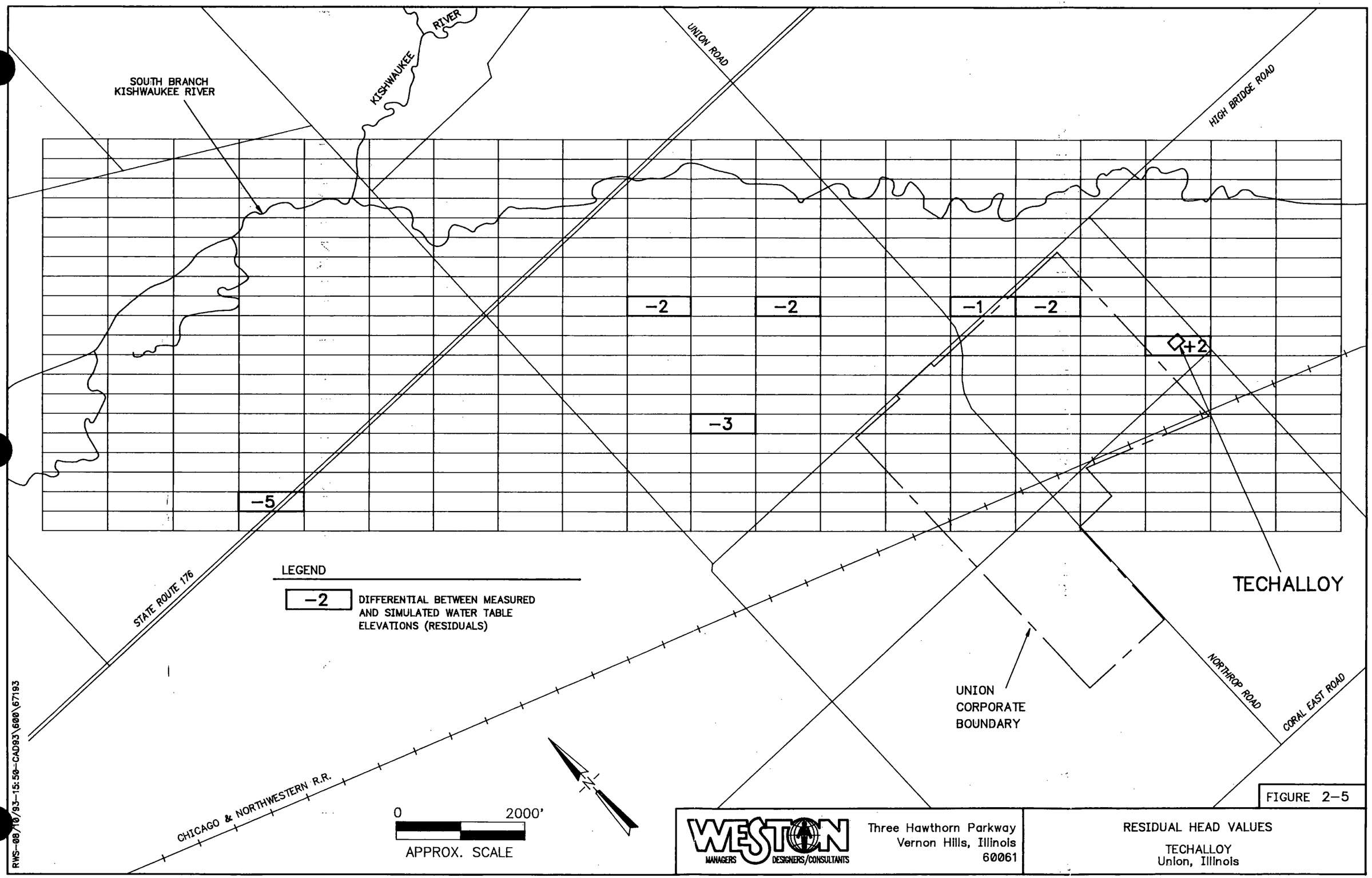

SOUTH BRANCH
KISHWAUKEE RIVER
KISHWAUKEE
RIVER
UNION ROAD
HIGH BRIDGE ROAD
-2
-2
-1
-2
+2
-3
-5
STATE ROUTE 176
LEGEND
-2
DIFFERENTIAL BETWEEN MEASURED AND SIMULATED WATER TABLE ELEVATIONS (RESIDUALS)
TECHALLOY
UNION
CORPORATE
BOUNDARY
NORTHROP ROAD
CORAL EAST ROAD
CHICAGO & NORTHWESTERN R.R.
0
2000'
APPROX. SCALE
N
WESTON
MANAGERS
DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061
RESIDUAL HEAD VALUES
TECHALLOY
Union, Illinois
FIGURE 2-5
RWS-08/10/93-15:50-CAD93\600\67193

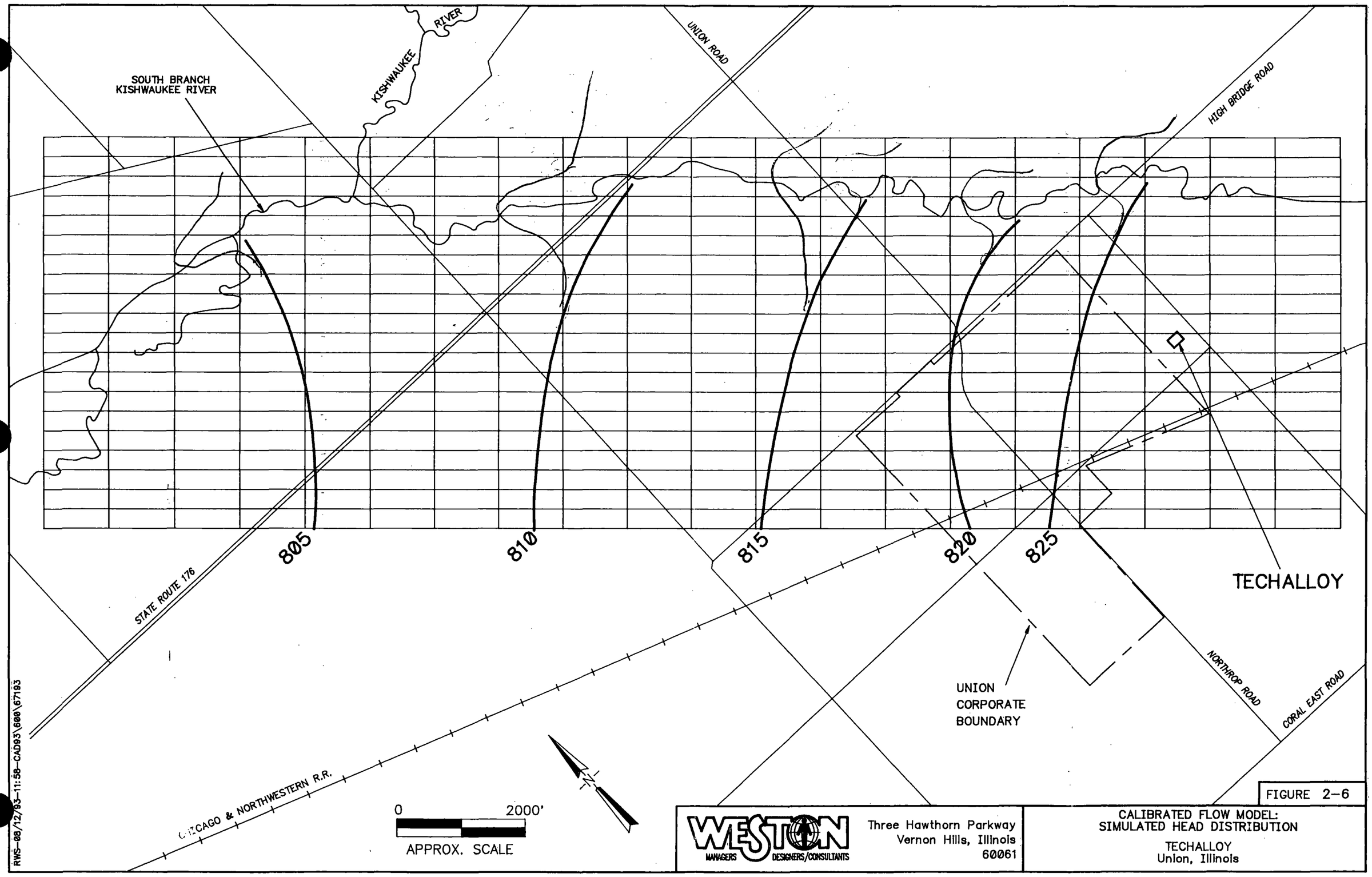


FIGURE 2-6

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

CALIBRATED FLOW MODEL:
SIMULATED HEAD DISTRIBUTION

TECHALLOY
Union, Illinois

identify parameters which, when altered, had a significant effect on the model results. If the flow model proved sensitive to changes in a parameter that was not based primarily on measured values, the results of simulations using the calibrated flow model would need to be appropriately qualified.

2.3.1 Effect from Variations in Hydraulic Conductivity

In order to assess the model response to variations in **K**, values within the range of 26 to 520 feet/day were tested. Values within the range 130 to 520 feet/day had little effect on the head distribution. At **K** values less than or equal to one-fifth (52 feet/day) the measured value, the resulting head distribution contained hydraulic gradients predominantly northeastward, in the direction of the South Branch River. That direction is approximately 90° removed from the northwestward gradient actually observed.

2.3.2 Effect from Variations in Recharge

As previously discussed, recharge was varied between 5 and 20 inches per year. This range is equivalent to approximately 16.5 percent to 66 percent of the 30 inches of rain that northern Illinois receives as annual rainfall. Changes in recharge within this range had no appreciable effect on the resulting head distribution.

2.3.3 Effect of Variations in Fixed Head Boundaries

The fixed head boundaries were the major control on head distribution in the model output. Consequently, the model proved sensitive to changes in these values. Fixed head values representative of river elevations were not varied because of the high degree of confidence in these measured values. Altering fixed head values along the southeastern model boundary resulted in changes to the magnitude and direction of groundwater flow at this edge of the model area.

2.3.4 Effects from Variations in Aquifer Thickness

Two aquifer thickness scenarios were simulated, as described in Subsection 2.1.3.4. The first scenario consisted of variable thickness up to a maximum value of 99 feet. The second scenario consisted of variable thickness up to a maximum value of 75 feet. In both scenarios, thickness values between 1 and 75 feet were used for the southeastern (upgradient) portion of the model area. There was no appreciable difference in the resulting head distribution for these two scenarios.

2.4 CAPTURE ZONE ANALYSIS

A capture zone analysis was performed for the proposed Interim Measures recovery well near the intersection of Non-responsive [redacted] Both analytical and finite-difference solutions were employed to determine the extraction rate necessary to recover the full width of the contaminant plume emanating from the source area. The analytical Well Head Protection Area (WHPA) model (U.S. EPA, 1991) was used to obtain an analytical solution. As a check on the analytical solution, the head output file from MOC was imported into WHPA and subjected to a general particle tracking analysis, thereby providing a finite-difference solution. The results of the capture zone analysis are discussed in Section 3.

SECTION 3
FLOW MODELING RESULTS

The calibrated flow model is shown in Figure 2-6. Once calibrated, the flow model was used as one of two methods to simulate the head distribution resulting from pumping at the Interim Measures recovery well, as described in Subsection 2.4. The capture zone analysis indicated that an extraction rate of 280 gpm will produce a capture zone width of between 1,000 and 1,050 feet, measured transverse to groundwater flow (Figure 3-1). This capture zone will provide a margin of safety of approximately ~~800~~ 100 feet.? The margin of safety will allow for unexpected conditions, such as a plume width greater than 800 feet or values for hydraulic conductivity or hydraulic gradient higher than the previously measured values.

100' / side

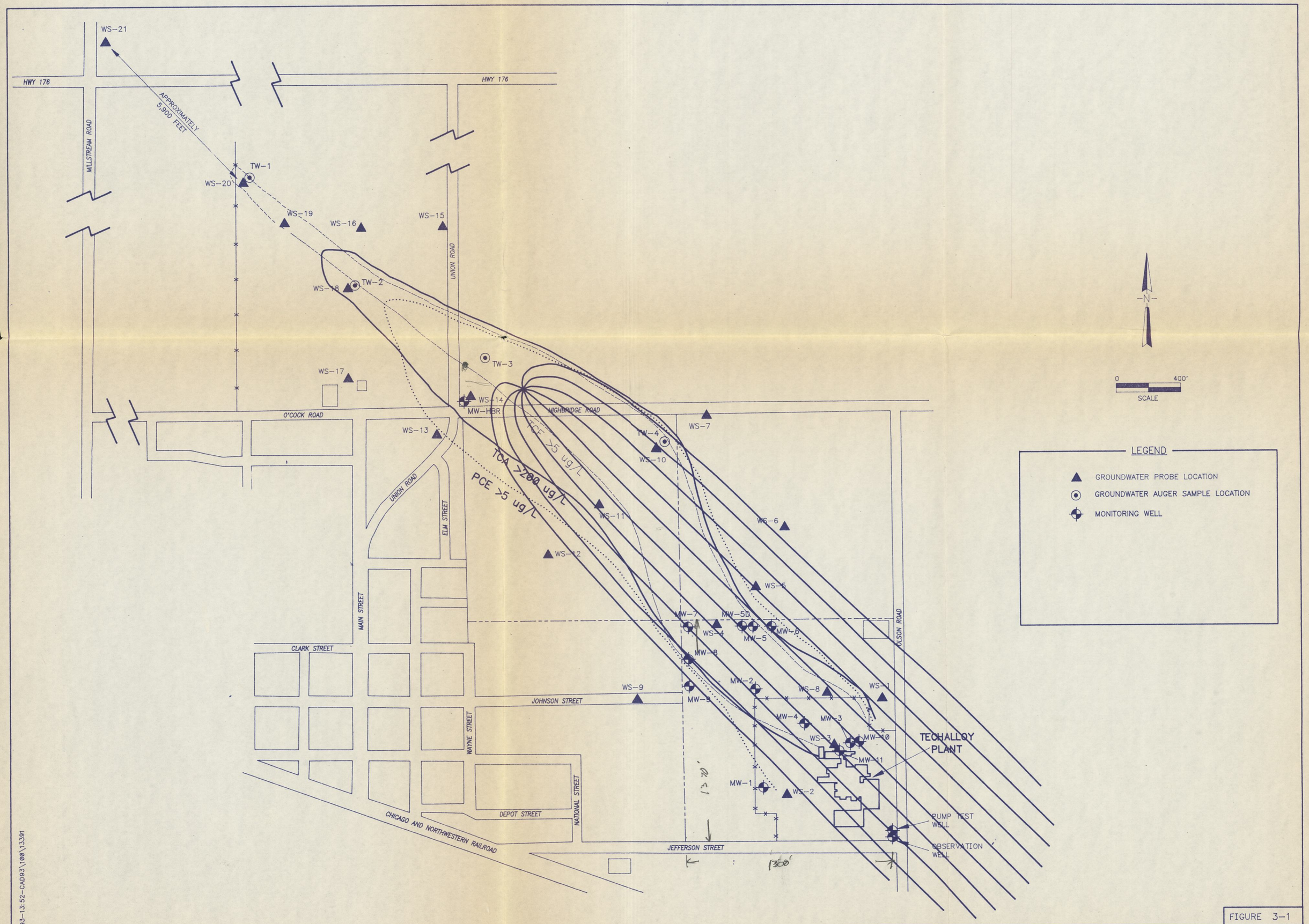


FIGURE 3-1

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

SIMULATED CAPTURE ZONE
FOR INTERIM MEASURES AFTER 5 YEARS

TECHALLOY COMPANY, INC.
Union, Illinois

RJB-08/27/93-13:52-CAD93\100\13391

SECTION 4
CONCLUSIONS

The MOC model was used to simulate groundwater flow in the water table aquifer underlying the Techalloy facility and surrounding area. Confidence in the model results was gained through the maximum possible use of measured data for model input and from calibration and sensitivity analyses of the flow model output.

The results of the flow modeling indicate that the proposed Interim Measures recovery well, to be located near the intersection of Non-responsive [redacted] can effectively intercept and prevent further migration of the full width of the contaminant plume emanating from the source area. The results of the capture zone analysis predict that the recovery well would have to be operated at a rate of 280 gpm to attain a capture zone width of between 1,000 and 1,050 feet.

APPENDIX E

SAMPLE CALCULATIONS

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 1 of ____

CLIENT/SUBJECT TEHALLOY W.O. NO. ____

TASK DESCRIPTION WELL PUMP TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

$Q = 2.449\, V D^2$

Q = gpm

V = Velocity (ft/sec)

D = I.D. (inches)

$350 = 2.449\,(4)\,(D)^2$

D = 5.97 in or 6 inches

$$\Delta P_{100} = \frac{452\, Q^{1.85}}{C^{1.85}\, D^{4.86}}$$

$$\Delta P_{100} = \frac{452\,(350)^{1.85}}{(155)^{1.85}\,(5.421)^{4.86}} = 0.552 \text{ psi}$$

$0.552 \text{ psi} \times 0.433 \text{ feet/psi} = 0.24 \text{ feet}/100 \text{ ft.}$

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 2 of ____

CLIENT/SUBJECT TEKHALLOY W.O. NO. ____

TASK DESCRIPTION WELL PUMP TASK NO. ____

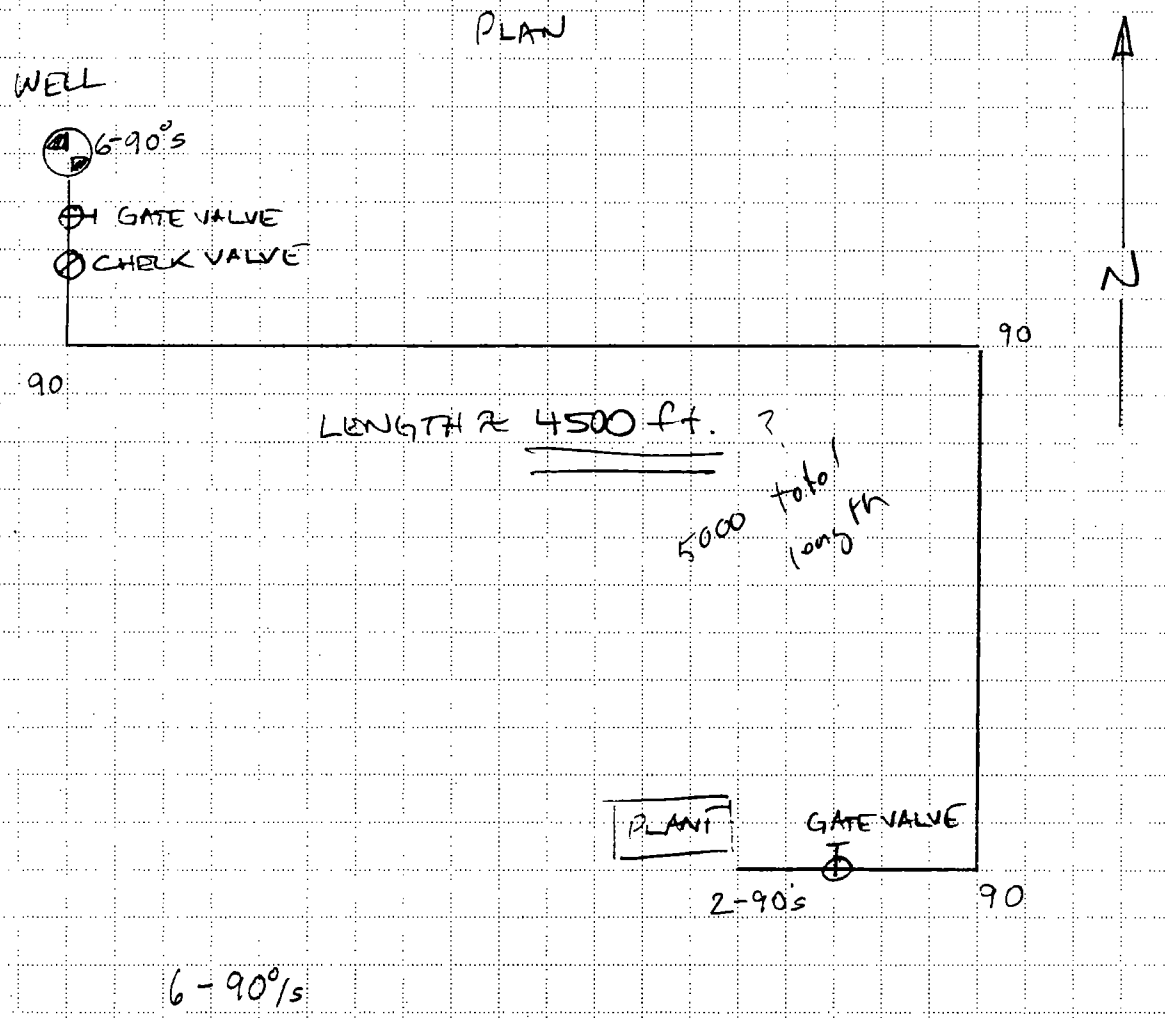
PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

PLAN



LENGTH ≈ 4500 ft. ?

5000 total length

EQUIVALENT LENGTH OF PIPE D = 0.5'

90° = 30D = 15 ft per elbow x 11 = 165 ft.

GATE VALVES = 2 @ 15D = 2(7.5) = 15 ft

CHECK VALVE = 100D = 50 ft

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 3 of ____

CLIENT/SUBJECT: TELHALLOY — W.O. NO. ____

TASK DESCRIPTION: WELL PUMP — TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

	100 gpm	200 gpm	300 gpm	400 gpm	500 gpm
6" PIPE 4500'					
90° ELBOWS 165'					
GATE VALVES 15'					
CHECK VALVE 50'					
TOTAL 4730'	8	29	61	105	159
* MULTIPLIER TO CORRECT TABLES	0.5	0.5	0.5	0.5	0.5
HEAD LOSS	4	15	31	53	80

* "C" IN TABLES = 100
* "C" HDPE = 150

RFW 10-05-003/A-5/85
512-5643

TEHALLOY
WELL PUMP

> C < head loss

Friction losses in pipes carrying water

Among the many empirical formulae for friction losses that have been proposed, that of Williams and Hazen has been most widely used. In a convenient form it reads:

$$f = .2083\left(\frac{100}{C}\right)^{1.85} \frac{q^{1.85}}{d^{4.8655}}$$

in which
f = friction head in ft of liquid per 100 ft of pipe (if desired in lb per sq in. multiply f × .433 × sp gr)
d = inside dia of pipe in inches
q = flow in gal per min
C = constant accounting for surface roughness

This formula gives accurate values only when the kinematic viscosity of the liquid is about 1.1 centistokes or 31.5 SSU, which is the case with water at about 60F. But the viscosity of water varies with the temperature from 1.8 at 32F to .29 centistokes at 212F. The tables are therefore subject to this error, which may increase the friction loss as much as 20% at 32F and decrease it as much as 20% at 212F. Note that the tables may be used for any liquid having a viscosity of the same order as indicated above.

Values of C for various types of pipe are given below together with the corresponding multiplier which should apply to the tabulated values of the head loss, f, as given on pages 28 to 47.

TYPE OF PIPE	VALUES OF C: Range — High = best, smooth, well laid — Low = poor or corroded	Average value for good, clean, new pipe	Commonly used value for design purposes
[illegible]nt—Asbestos	160–140	150	140
[illegible]	—	150	140
[illegible]astic-enamel-lined iron or steel centrifugally applied	160–130	148	140
[illegible]ment-lined iron or steel centrifugally applied	—	150	140
Copper, brass, lead, tin or glass pipe and tubing	150–120	140	130
Wood-stave	145–110	120	110
Welded and seamless steel	150–80	140	100
Continuous-interior riveted steel (no projecting rivets or joints	—	139	100
Wrought-iron	150–80	130	100
Cast-iron	150–80	130	100
Tar-coated cast-iron	145–80	130	100
Girth-riveted steel (projecting rivets in girth seams only)	—	130	100
Concrete	152–85	120	100
Full-riveted steel (projecting rivets in girth and horizontal seams)	—	115	100
Vitrified	—	110	100
Spiral-riveted steel (flow with lap)	—	110	100
Spiral-riveted steel (flow against lap)	—	100	90
Corrugated steel	—	60	60

Value of C	150	140	130	120	110	100	90	80	70	60
Multiplier to correct tables	.47	.54	.62	.71	.84	1.0	1.22	1.50	1.93	2.57

Friction Losses In Pipe; C = 100

[illegible]/8 Inch

FLOW US gal per min	STANDARD WT STEEL .[illegible]5" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	EXTRA STRONG STEEL .215" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
0.1	.55	.00	1.75	.884	.01	5.21
0.2	1.13	.02	6.31	1.77	.03	18.8
0.3	1.69	.04	13.4	2.65	.11	39.8
0.4	2.26	.08	22.8	3.54	.19	67.7
0.5	2.83	.12	34.4	4.42	.30	102
0.6	3.39	.18	48.2	5.32	.44	147
[illegible]	[illegible]	.24	64.1	6.29	.61	191
[illegible]	4.52	.32	82.0	7.08	.78	244
[illegible]	5.08	.40	102	7.96	.98	303
[illegible].0	5.65	.50	124	8.84	1.21	369

Friction Losses In Pipe; C = 100

1/4 Inch

FLOW US gal per min	STANDARD WT STEEL .364" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	EXTRA STRONG STEEL .302" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
0.4	1.23	.02	5.22	1.79	.05	13.0
0.6	1.85	.05	11.1	2.69	.11	27.4
0.8	2.47	09	18.8	3.59	.20	46.7
1.0	3.08	.15	28.5	4.48	.31	70.6
1.2	3.71	21	39.9	5.38	.45	98.9
1.4	4.33	.29	53.0	6.27	.61	132
1.6	4.94	.38	67.9	7.17	.80	168
1.8	5.55	.48	84.4	8.07	1.01	209
2.0	6.17	.59	103	8.96	1.25	254
2.5	7.71	.92	155	11.2	1.95	385

3/8 Inch

FLOW US gal per min	STANDARD WT STEEL .493" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	EXTRA STRONG STEEL .423" Inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
0.8	1.35	.03	4.30	1.83	.05	9.07
1.0	1.68	.04	6.50	2.28	.08	13.7
1.5	2.52	.10	13.8	3.43	.18	29.0
2.0	3.36	.18	23.4	4.57	.32	49.4
2.5	4.21	.28	35.4	5.71	.51	74.6
3.0	5.05	.40	49.6	6.85	.73	105
3.5	5.89	.54	66.0	8.00	.99	139
4.0	6.73	.70	84.5	9.14	1.30	178
5.0	8.41	1.10	134	11.4	2.0	269
6.0	10.1	1.58	179	13.7	2.9	377

1/2 Inch

FLOW US gal per min	Standard Wt Steel .622" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Extra Strong Steel .546" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Double Extra Strong Steel .252" inside dia: Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
0.5	.528	.00	.582	.686	.01	1.10	3.22	.16	47.2
1.0	1.06	.02	2.10	1.37	.03	3.96	6.44	.64	170
1.5	1.58	.04	4.44	2.06	.07	8.38	9.66	1.45	361
2.0	2.11	.07	7.57	2.74	.12	14.3	12.9	2.59	614
2.5	2.64	.11	11.4	3.43	.18	21.6	16.1	4.02	928
3.0	3.17	.16	16.0	4.11	.26	30.2			
3.5	3.70	.21	21.3	4.80	.36	40.2			
4.0	4.23	.28	27.3	5.48	.47	51.4			
4.5	4.75	.35	33.9	6.17	.59	64.0			
5.0	5.28	.43	41.2	6.86	.73	77.7			
5.5	5.81	.52	49.2	7.54	.88	92.7			
6.0	6.34	.62	57.8	8.23	1.05	109			
6.5	6.87	.73	67.0	8.91	1.23	126			
7.0	7.39	.85	76.8	9.60	1.43	145			
7.5	7.92	.97	87.3	10.3	1.6	165			
8.0	8.45	1.11	98.3	11.0	1.9	185			
8.5	8.98	1.25	110	11.6	2.1	207			
9.0	9.51	1.4	122	12.3	2.4	231			
9.5	10.0	1.6	135	13.0	2.6	255			
10	10.6	1.7	149	13.7	2.9	280			

0.433 psi/ft of water

÷ .433 = 2.31

TELLALOY
~~WELL~~ PUMP
also - influent pump line?

Need losses for HDPE pipe

Friction Losses In Pipe; ~~C=100~~ 6 Inch

FLOW US gal per min	Cast Iron 6.0" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Std Wt Steel 6.065" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Extra Strong Steel 5.761" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Double Extra Strong Steel 4.897" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
50	.57	.01	.047	.55	.00	.045	.62	.01	.058	.85	.01	.127
60	.68	.01	.066	.67	.01	.063	.74	.01	.081	1.02	.02	.178
70	.79	.01	.088	.78	.01	.084	.86	.01	.108	1.19	.02	.237
80	.91	.01	.113	.89	.01	.107	.98	.01	.138	1.36	.03	.304
90	1.02	.02	.141	1.00	.02	.133	1.11	.02	.171	1.53	.04	.378
100	1.13	.02	.171	1.11	.02	.162	1.23	.02	.208	1.70	.05	.459
120	1.36	.03	.239	1.33	.03	.227	1.48	.03	.292	2.04	.06	.643
140	1.59	.04	.318	1.56	.04	.302	1.72	.06	.388	2.38	.09	.855
160	1.82	.05	.408	1.78	.05	.387	1.97	.06	.497	2.72	.12	1.10
180	2.04	.06	.507	2.00	.06	.481	2.21	.08	.618	3.06	.15	1.36
200	2.27	.08	.616	2.22	.08	.584	2.46	.09	.751	3.40	.18	1.65
220	2.50	.10	.735	2.44	.09	.697	2.71	.11	.895	3.74	.22	1.97
240	2.72	.12	.863	2.67	.11	.819	2.96	.14	1.03	4.08	.26	2.32
260	2.95	.14	1.00	2.89	.13	.950	3.20	.16	1.22	4.42	.30	2.69
280	3.18	.16	1.15	3.11	.15	1.09	3.45	.19	1.40	4.77	.35	3.08
300	3.40	.18	1.30	3.33	.17	1.24	3.69	.21	1.59	5.11	.41	3.50
320	3.64	.21	1.47	3.56	.20	1.39	3.94	.24	1.79	5.45	.46	3.95
340	3.86	.23	1.64	3.78	.22	1.56	4.19	.27	2.00	5.79	.52	4.42
360	4.08	.26	1.83	4.00	.25	1.73	4.43	.31	2.23	6.13	.58	4.91
380	4.31	.29	2.02	4.22	.28	1.92	4.68	.34	2.46	6.47	.65	5.43
400	4.55	.32	2.22	4.44	.31	2.11	4.93	.38	2.71	6.81	.72	5.97
450	5.11	.41	2.76	5.00	.39	2.62	5.54	.48	3.36	7.66	.91	7.42
500	5.68	.50	3.36	5.56	.48	3.19	6.16	.59	4.09	8.51	1.13	9.02
550	6.25	.61	4.00	6.11	.58	3.80	6.77	.71	4.88	9.37	1.36	10.8
600	6.81	.72	4.70	6.67	.69	4.46	7.39	.85	5.73	10.2	1.6	12.6
650	7.38	.85	5.45	7.22	.81	5.17	8.00	.99	6.64	11.1	1.9	14.6
700	7.95	.98	6.25	7.78	.94	5.93	8.63	1.16	7.62	11.9	2.2	16.8
750	8.52	1.13	7.10	8.34	1.08	6.74	9.24	1.33	8.66	12.8	2.5	19.1
800	9.08	1.28	8.00	8.90	1.23	7.60	9.85	1.51	9.75	13.6	2.9	21.5
850	9.65	1.45	8.95	9.45	1.39	8.50	10.5	1.7	10.9	14.5	3.3	24.1
900	10.2	1.6	9.95	10.0	1.6	9.44	11.1	1.9	12.1	15.3	3.7	26.7
950	10.8	1.8	11.0	10.5	1.7	10.2	11.7	2.1	13.4	16.2	4.1	29.6
1000	11.4	2.0	12.1	11.1	1.9	11.5	12.3	2.4	14.7	17.0	4.5	32.5
1100	12.5	2.4	14.4	12.2	2.3	13.7	13.5	2.8	17.6	18.7	5.4	38.8
1200	13.6	2.9	16.9	13.3	2.7	16.1	14.8	3.4	20.7	20.4	4.5	45.5
1300	14.8	3.4	19.7	14.4	3.2	18.6	16.0	4.0	23.9	22.1	7.6	52.8
1400	15.9	3.9	22.5	15.6	3.8	21.4	17.2	4.6	27.5	23.8	8.8	60.6
1500	17.0	4.5	25.6	16.7	4.5	24.3	18.5	5.3	31.2	25.5	10.1	68.8
1600	18.2	5.1	28.9	17.8	4.9	27.4	19.7	6.0	35.2	27.2	11.5	77.6
1700	19.3	5.8	32.3	18.9	5.6	30.6	20.9	6.8	39.4	28.9	13.0	86.8
1800	20.4	6.5	35.9	20.0	6.2	34.0	22.2	7.7	43.7	30.6	14.6	96.4
1900	21.5	7.2	39.7	21.1	6.9	37.6	23.4	8.4	48.3	32.3	16.2	107
2000	22.7	8.0	43.6	22.2	7.7	41.4	24.6	9.4	53.1	34.0	18.0	117
2200	25.0	9.7	52.0	24.4	9.3	49.4	27.1	11.4	63.4	37.4	21.7	140
2400	27.2	11.5	61.1	26.7	11.1	58.0	29.6	13.6	74.5	40.8	25.9	164

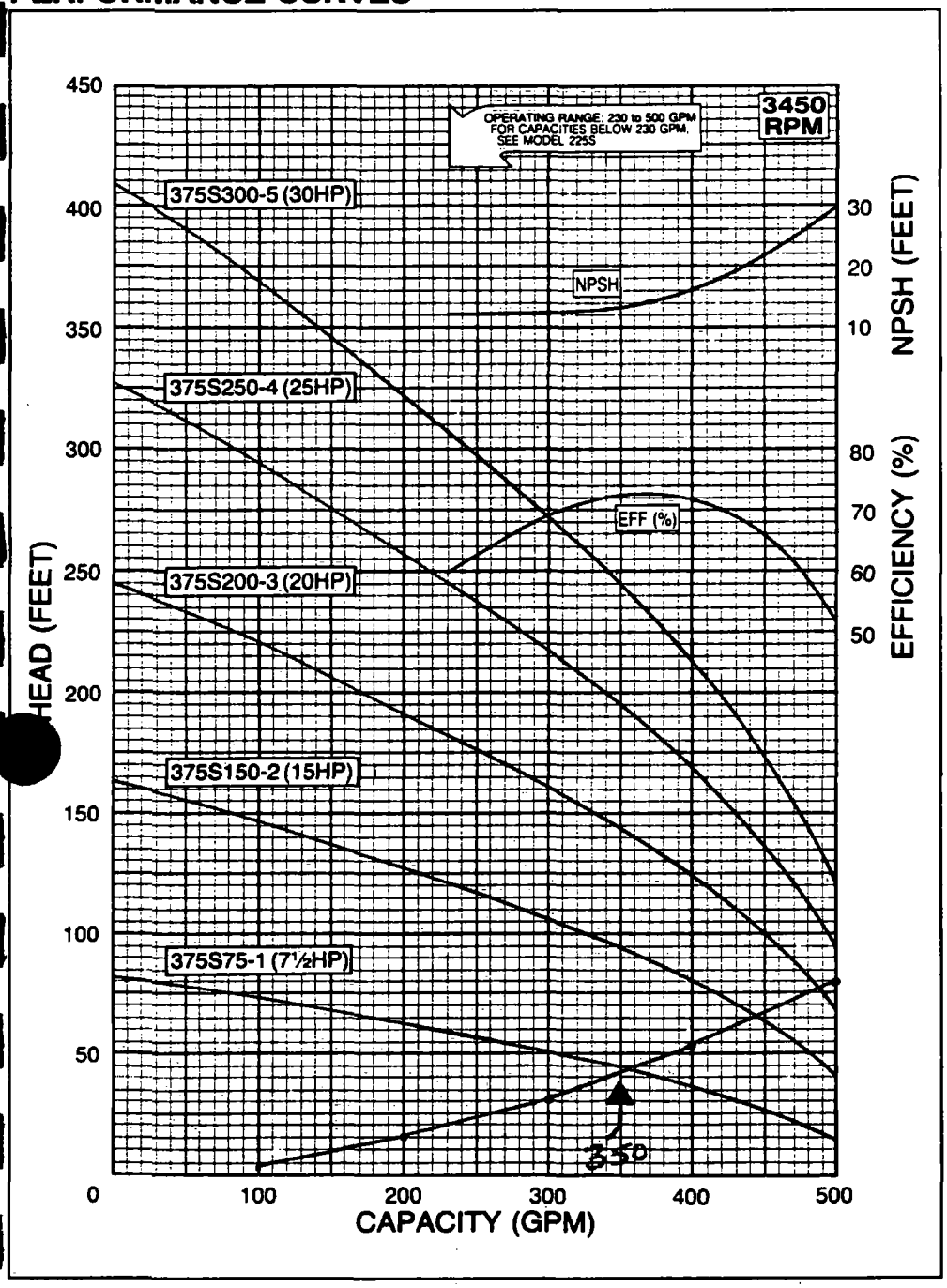
Friction Losses In Pipe; ~~C=100~~ 8 Inch

FLOW US gal per min	Cast Iron 8.0" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Std Wt Steel 7.981" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Extra Strong Steel 7.625" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Double Extra Strong Steel 6.875" inside dia Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
130	.83	.01	.069	.83	.01	.069	.91	.01	.087	1.12	.02	.143
140	.90	.01	.079	.90	.01	.079	.98	.01	.099	1.21	.02	.164
150	.96	.01	.089	.96	.01	.091	1.05	.02	.116	1.30	.03	.187
160	1.02	.02	.101	1.03	.02	.102	1.12	.02	.127	1.38	.03	.210
170	1.05	.02	.112	1.09	.02	.114	1.19	.02	.142	1.47	.03	.235
180	1.15	.02	.125	1.15	.02	.126	1.26	.02	.158	1.56	.04	.261
190	1.21	.02	.138	1.22	.02	.140	1.33	.03	.175	1.64	.04	.289
200	1.25	.03	.152	1.28	.03	.154	1.41	.03	.192	1.73	.05	.318
220	1.40	.03	.181	1.41	.03	.183	1.55	.04	.229	1.90	.06	.379
240	1.53	.04	.213	1.54	.04	.215	1.69	.04	.269	2.07	.07	.445
260	1.66	.04	.247	1.67	.04	.250	1.83	.05	.312	2.25	.08	.516
280	1.79	.05	.283	1.80	.05	.286	1.97	.06	.358	2.42	.09	.592
300	1.91	.06	.322	1.92	.06	.325	2.11	.07	.406	2.59	.10	.672
350	2.24	.08	.428	2.24	.08	.433	2.46	.09	.540	3.02	.14	.894
400	2.56	.10	.548	2.57	.10	.554	2.81	.12	.692	3.46	.19	1.14
450	2.87	.13	.681	2.88	.13	.689	3.16	.15	.860	3.89	.24	1.42
500	3.19	.16	.828	3.20	.16	.838	3.51	.19	1.05	4.32	.29	1.73
550	3.51	.19	.987	3.52	.19	.999	3.86	.23	1.25	4.75	.35	2.06
600	3.83	.23	1.16	3.85	.23	1.17	4.22	.28	1.46	5.19	.42	2.42
650	4.15	.27	1.34	4.17	.27	1.36	4.57	.32	1.70	5.62	.49	2.78
700	4.47	.31	1.54	4.49	.31	1.56	4.92	.38	1.95	6.05	.57	3.22
750	4.79	.36	1.75	4.81	.36	1.77	5.27	.43	2.21	6.49	.65	3.66
800	5.11	.41	1.97	5.13	.41	1.99	5.62	.49	2.49	6.91	.74	4.13
850	5.43	.46	2.21	5.45	.46	2.23	5.97	.55	2.79	7.35	.84	4.62
900	5.75	.51	2.46	5.77	.52	2.48	6.32	.62	3.10	7.78	.94	5.13
950	6.06	.57	2.71	6.09	.58	2.74	6.67	.69	3.43	8.21	1.05	5.67
1000	6.38	.63	2.98	6.41	.64	3.02	7.03	.77	3.77	8.64	1.16	6.24
1100	7.03	.77	3.56	7.05	.77	3.60	7.83	.95	4.49	9.50	1.40	7.44
1200	7.66	.91	4.18	7.69	.92	4.23	8.63	1.10	5.28	10.4	1.7	8.74
1300	8.30	1.07	4.85	8.33	1.08	4.90	9.13	1.30	6.12	11.2	2.0	10.4
1400	8.95	1.24	5.56	8.97	1.25	5.62	9.83	1.50	7.02	12.1	2.3	11.6
1500	9.58	1.43	6.32	9.61	1.44	6.39	10.5	1.7	7.93	13.0	2.6	13.2
1600	10.2	1.6	7.12	10.3	1.7	7.20	11.2	2.0	8.99	13.8	3.0	14.9
1800	11.5	2.1	8.85	11.5	2.1	8.95	12.6	2.5	11.2	15.6	3.8	18.5
2000	12.8	2.6	10.8	12.8	2.5	10.9	14.1	3.1	13.6	17.3	4.7	22.5
2200	14.1	3.1	12.8	14.1	3.1	13.0	15.5	3.7	16.6	19.0	5.6	26.8
2400	15.3	3.6	15.1	15.4	3.7	15.2	16.9	4.4	19.0	20.7	6.7	31.5
2600	16.6	4.3	17.5	16.7	4.3	17.7	18.3	5.2	22.1	22.5	7.9	36.5
2800	17.9	5.0	20.0	18.0	5.0	20.3	19.7	6.0	25.3	24.2	9.1	41.9
3000	19.1	5.7	22.8	19.2	5.7	23.0	21.1	6.9	28.8	25.9	10.4	47.6
3500	22.4	7.8	30.3	22.4	7.8	30.6	24.6	9.4	38.3	30.2	14.2	63.3
4000	25.6	10.2	38.8	25.6	10.2	39.2	28.1	12.2	49.0	34.6	18.6	81.0
4500	28.8	12.9	48.2	28.8	12.9	48.8	31.6	15.5	60.9	38.9	23.5	101
5000	32.0	15.9	58.6	32.0	15.9	59.3	35.1	19.1	74.0	43.2	29.0	122
5500	35.1	19.1	69.9	35.3	19.4	70.7	38.6	23.2	88.3	47.5	35.1	146

GRUNDFOS 375 GPM MODEL 375S

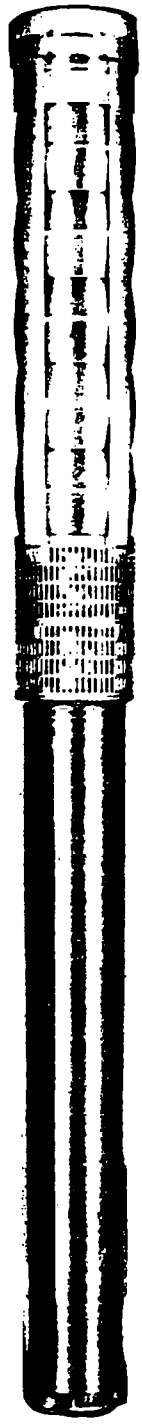
PERFORMANCE CURVES

TELHALLOY WELL



FLOW RANGE
230 to 500 GPM

PUMP OUTLET
4" NPT



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	MIN. WELL SIZE (INCHES)	LENGTH (INCHES)	MAX. WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
375S75-1	7½	8	44⅞	7⅛	153
375S150-2	15	8	53⅛	7⅛	181
375S200-3	20	8	60	7⅛	197
375S250-4	25	8	66⅞	7⅛	226
375S300-5	30	8	73¾	7⅛	245

NOTES:
Specifications are subject to change without notice.
See Deep Set models for higher head.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT TECHALLOY W.O. NO. ____

TASK DESCRIPTION WELL PUMP TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____

DEPT ____ DATE ____

SYSTEM CURVE ON PUMP CURVE DIAGRAM SHOWS A MINIMUM 7 1/2 HP. USE 15 HP

RFW 10-05-003/A-5/85
512-5643

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT TECH ALLOY W.O. NO. ____

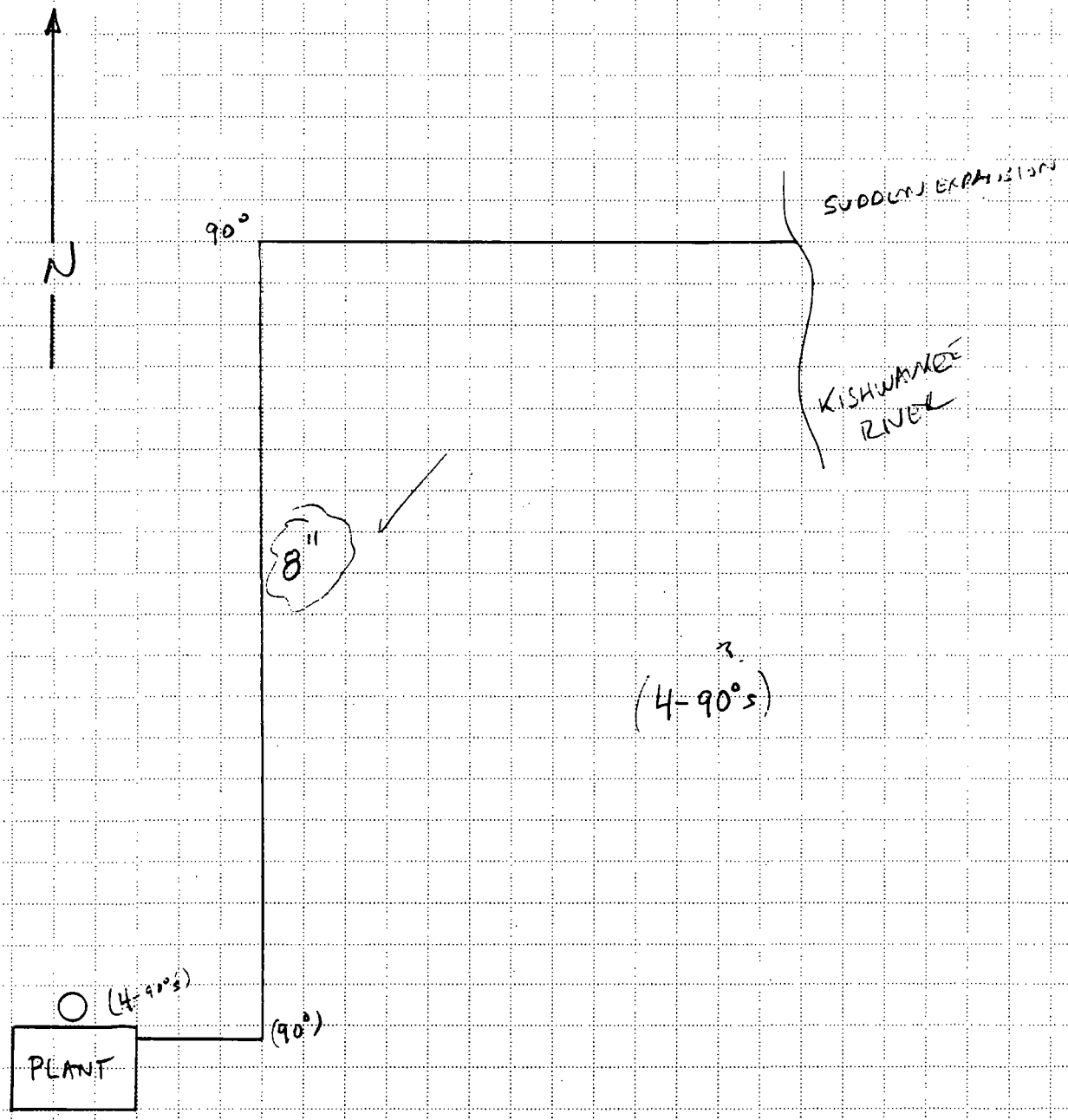
TASK DESCRIPTION EFFLUENT PUMP TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____



RFW 10-05-003/A-5/85
512-5643

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT TECHALLOY W.O. NO. ____

TASK DESCRIPTION EFFLUENT PUMP TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

	100	200	300	400	500
DISCHARGE 8"					
PIPE 4500'					
6-90°'s 120'					
GATE (3) 15'					
CHECK 50'					
TEE (3) 135'					
ENTRANCE 15'					
3x8 REDUCER 20'					
TOTAL PIPE 4855					
H_f PIPE	N/A	7	16	27	41
HDPE (corr)		.5	.5	.5	.5
H_f (PIPE) (corrected)		4	8	14	21
FILTER (10psi)	23	23	23	23	23
H_f	23	27	31	37	44
STATIC (H)	3	3	3	3	3
TOTAL H	26	30	34	40	47

RFW 10-05-003/A-5/85
512-5613

EFFLUENT PUMP

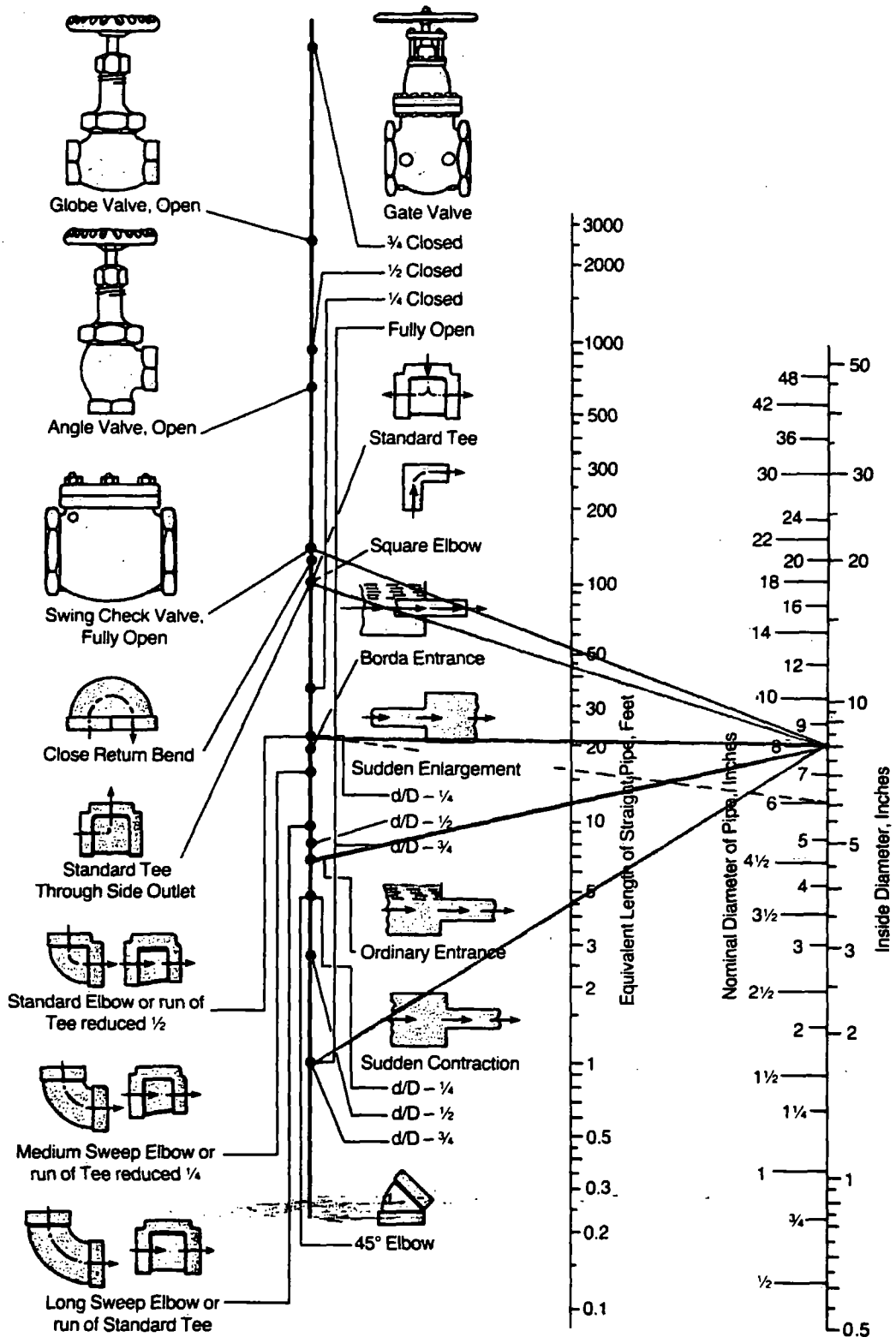
APPENDIX

Chart 35

Resistance of Valves and Fittings to Flow of Fluids

Example: The dashed line shows that the resistance of a 6-in. standard elbow is equivalent to approximately 16 ft of 6-in. standard pipe.

Note: For sudden enlargements or sudden contractions, use the smaller diameter, d on the pipe-size scale. Head loss through check valves varies with types manufactured. Consult with manufacturer for correct values.



Courtesy of Crane Co.

TEHALLOY ~~EFFLUENT~~ PUMP

Friction Losses In Pipe; C = 100
6 Inch

FLOW US gal per min	Cast Iron 6.0" inside dia			Std Wt Steel 6.065" inside dia			Extra Strong Steel 5.761" inside dia			Double Extra Strong Steel 4.897" inside dia		
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
50	.57	.01	.047	.55	.00	.045	.62	.01	.058	.85	.01	.127
60	.68	.01	.066	.67	.01	.063	.74	.01	.081	1.02	.02	.178
70	.79	.01	.088	.78	.01	.084	.86	.01	.108	1.19	.02	.237
80	.91	.01	.113	.89	.01	.107	.98	.01	.138	1.36	.03	.304
90	1.02	.02	.141	1.00	.02	.133	1.11	.02	.171	1.53	.04	.378
100	1.13	.02	.171	1.11	.02	.162	1.23	.02	.208	1.70	.05	.459
120	1.36	.03	.239	1.33	.03	.227	1.48	.03	.292	2.04	.06	.643
140	1.59	.04	.318	1.56	.04	.302	1.72	.05	.338	2.38	.09	.856
160	1.82	.05	.408	1.78	.05	.387	1.97	.06	.497	2.72	.12	1.10
180	2.04	.06	.607	2.00	.06	.481	2.21	.08	.618	3.06	.15	1.36
200	2.27	.08	.616	2.22	.08	.584	2.46	.09	.751	3.40	.18	1.65
220	2.50	.10	.735	2.44	.09	.697	2.71	.11	.895	3.74	.22	1.97
240	2.72	.12	.863	2.67	.11	.819	2.96	.14	1.03	4.08	.26	2.32
260	2.95	.14	1.00	2.89	.13	.950	3.20	.16	1.22	4.42	.30	2.69
280	3.18	.16	1.15	3.11	.15	1.09	3.45	.19	1.40	4.77	.35	3.08
300	3.40	.18	1.30	3.33	.17	1.24	3.69	.21	1.59	5.11	.41	3.50
320	3.64	.21	1.47	3.56	.20	1.39	3.94	.24	1.79	5.45	.46	3.95
340	3.86	.23	1.64	3.78	.22	1.56	4.19	.27	2.00	5.79	.52	4.42
360	4.08	.26	1.83	4.00	.25	1.73	4.43	.31	2.23	6.13	.58	4.91
380	4.31	.29	2.02	4.22	.25	1.92	4.68	.34	2.46	6.47	.65	5.43
400	4.55	.32	2.22	4.44	.31	2.11	4.93	.38	2.71	6.81	.72	5.97
450	5.11	.41	2.76	5.00	.39	2.62	5.54	.48	3.36	7.66	.91	7.42
500	5.68	.50	3.36	5.56	.48	3.19	6.16	.59	4.09	8.51	1.13	9.02
550	6.25	.61	4.00	6.11	.58	3.80	6.77	.71	4.88	9.37	1.36	10.8
600	6.81	.72	4.70	6.66	.69	4.46	7.39	.85	5.73	10.2	1.6	12.6
650	7.38	.85	5.45	7.22	.81	5.17	8.00	.99	6.64	11.1	1.9	14.6
700	7.95	.99	6.25	7.78	.94	5.93	8.63	1.16	7.62	11.9	2.2	16.8
750	8.52	1.13	7.10	8.34	1.08	6.74	9.24	1.33	8.66	12.8	2.5	19.1
800	9.08	1.28	8.00	8.90	1.23	7.60	9.85	1.51	9.75	13.6	2.9	21.5
850	9.65	1.45	8.95	9.45	1.39	8.50	10.5	1.7	10.9	14.5	3.3	24.1
900	10.2	1.6	9.95	10.0	1.6	9.44	11.1	1.9	12.1	15.3	3.7	26.7
950	10.8	1.8	11.0	10.5	1.7	10.2	11.7	2.1	13.4	16.2	4.1	29.6
1000	11.4	2.0	12.1	11.1	1.9	11.5	12.3	2.4	14.7	17.0	4.5	32.5
1100	12.5	2.4	14.4	12.2	2.3	13.7	13.5	2.8	17.6	18.7	5.4	38.8
1200	13.6	2.9	16.9	13.3	2.7	16.1	14.8	3.4	20.7	20.4	4.5	45.5
1300	14.8	3.4	19.7	14.4	3.2	18.6	16.0	4.0	23.9	22.1	7.6	52.8
1400	15.9	3.9	22.5	15.6	3.6	21.4	17.2	4.6	27.5	23.8	8.8	60.6
1500	17.0	4.5	25.6	16.7	4.3	24.3	18.5	5.3	31.2	25.5	10.1	68.8
1600	18.2	5.1	28.9	17.8	4.9	27.4	19.7	6.0	35.2	27.2	11.5	77.5
1700	19.3	5.8	32.3	18.9	5.6	30.6	20.9	6.8	39.4	28.9	13.0	86.8
1800	20.4	6.5	35.9	20.0	6.2	34.0	22.2	7.7	43.7	30.6	14.6	96.4
1900	21.5	7.2	39.7	21.1	6.9	37.6	23.4	8.4	48.3	32.3	16.2	107
2000	22.7	8.0	43.6	22.2	7.7	41.4	24.6	9.4	53.1	34.0	18.0	117
2200	25.0	9.7	52.0	24.4	9.3	49.4	27.1	11.4	63.4	37.4	21.7	140
2400	27.2	11.5	61.1	26.7	11.1	58.0	29.6	13.6	74.5	40.8	25.9	164

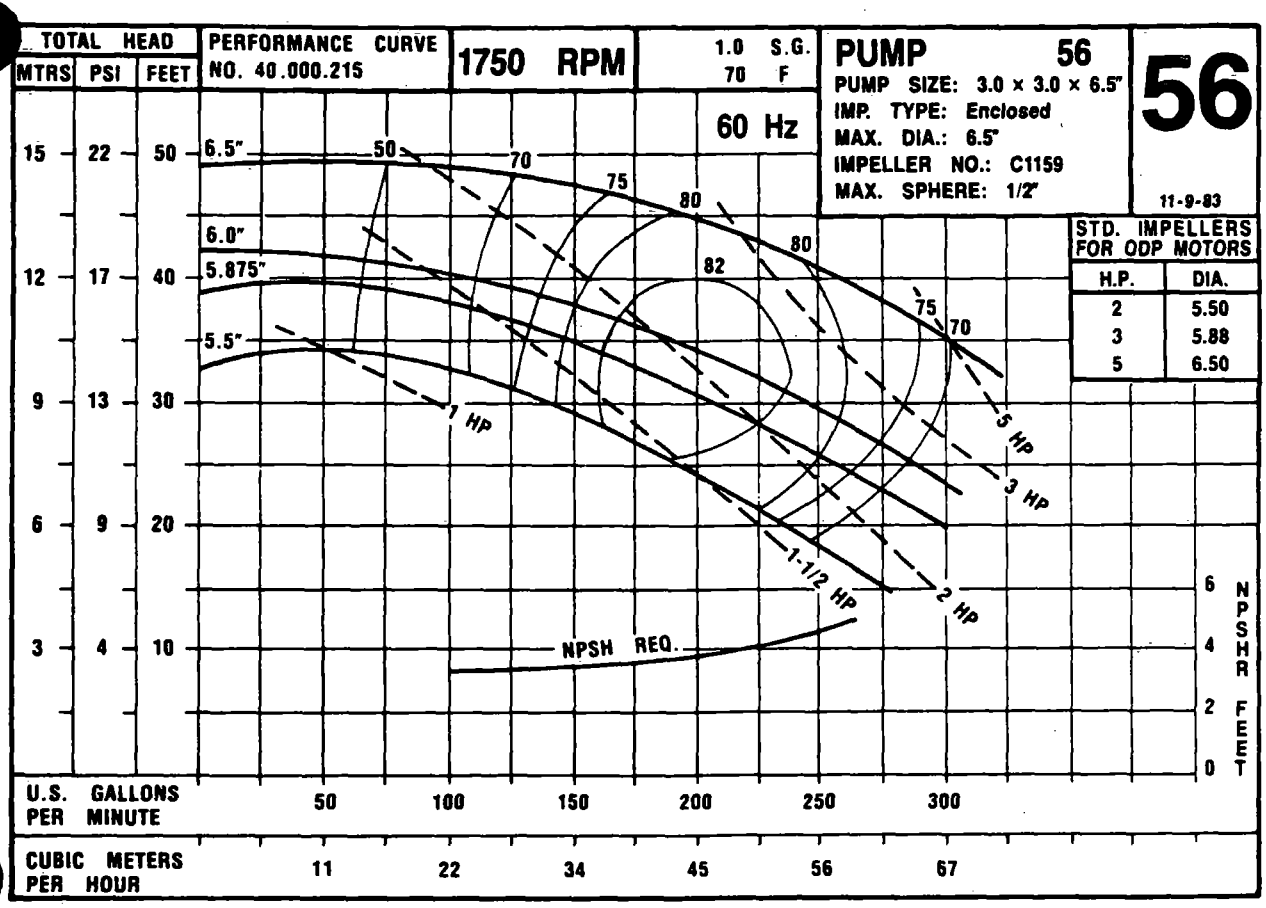
Friction Losses In Pipe; C = 100
8 Inch

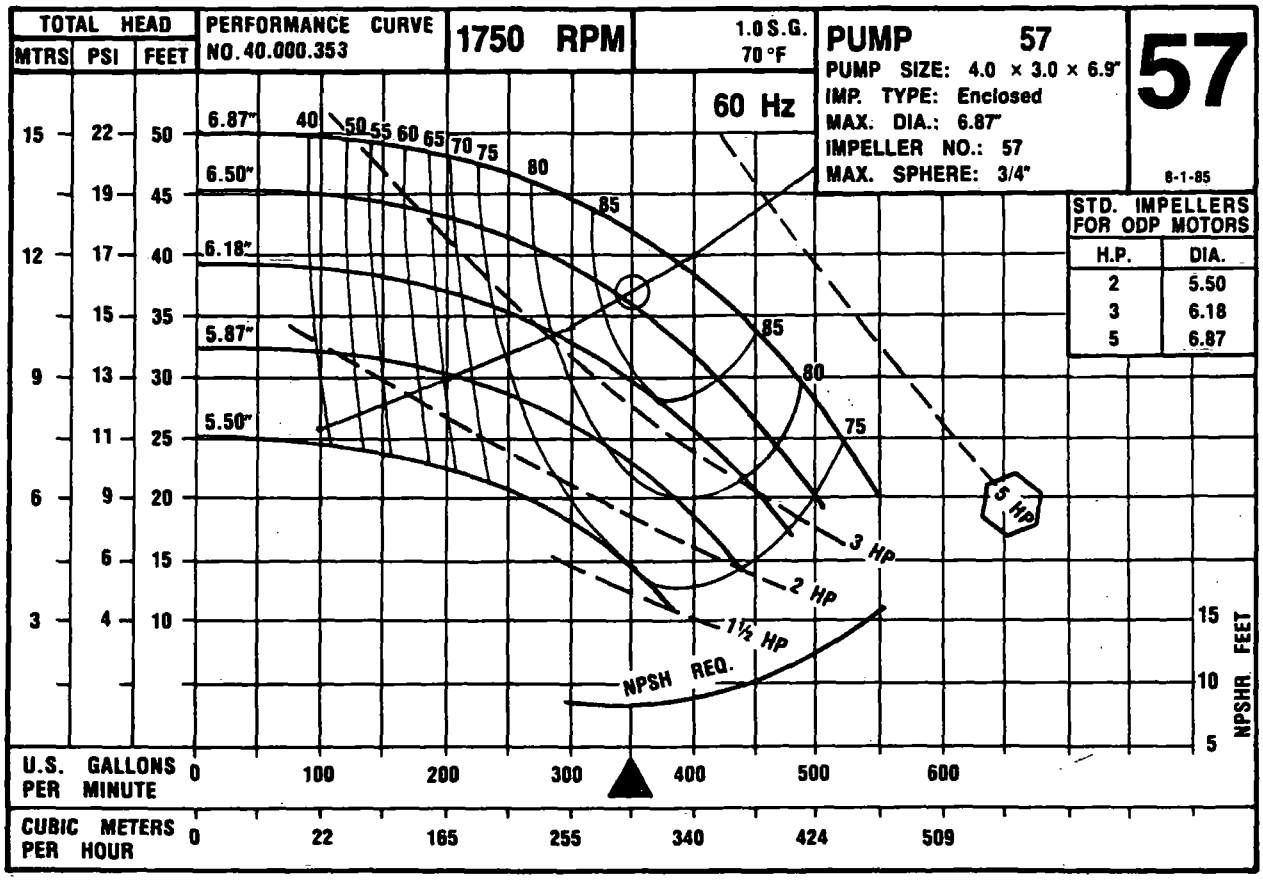
FLOW US gal per min	Cast Iron 8.0" inside dia			Std Wt Steel 7.981" inside dia			Extra Strong Steel 7.625" inside dia			Double Extra Strong Steel 6.875" inside dia		
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
130	.53	.01	.069	.83	.01	.069	.91	.01	.087	1.12	.02	.143
140	.90	.01	.079	.90	.01	.079	.98	.01	.099	1.21	.02	.164
150	.96	.01	.089	.96	.01	.091	1.05	.02	.116	1.30	.03	.187
160	1.02	.02	.101	1.03	.02	.102	1.12	.02	.127	1.38	.03	.210
170	1.05	.02	.112	1.09	.02	.114	1.19	.02	.142	1.47	.03	.235
180	1.15	.02	.125	1.15	.02	.126	1.26	.02	.158	1.56	.04	.261
190	1.21	.02	.138	1.22	.02	.140	1.33	.03	.175	1.64	.04	.289
200	1.25	.03	.152	1.28	.03	.154	1.41	.03	.192	1.73	.05	.318
220	1.40	.03	.181	1.41	.03	.183	1.55	.04	.229	1.90	.06	.379
240	1.53	.04	.213	1.54	.04	.215	1.69	.04	.269	2.07	.07	.445
260	1.66	.04	.247	1.67	.04	.250	1.83	.05	.312	2.25	.08	.516
280	1.79	.05	.283	1.80	.05	.286	1.97	.06	.358	2.42	.09	.592
300	1.91	.06	.322	1.92	.06	.325	2.11	.07	.406	2.59	.10	.672
350	2.24	.08	.428	2.24	.08	.433	2.46	.09	.540	3.02	.14	.894
400	2.56	.10	.548	2.57	.10	.554	2.81	.12	.692	3.46	.19	1.14
450	2.87	.13	.681	2.88	.13	.689	3.16	.15	.860	3.89	.24	1.42
500	3.19	.16	.828	3.20	.16	.838	3.51	.19	1.05	4.32	.29	1.73
550	3.51	.19	.987	3.52	.19	.999	3.86	.23	1.25	4.75	.35	2.06
600	3.83	.23	1.16	3.85	.23	1.17	4.22	.28	1.46	5.19	.42	2.42
650	4.15	.27	1.34	4.17	.27	1.36	4.57	.32	1.70	5.62	.49	2.78
700	4.47	.31	1.54	4.49	.31	1.56	4.92	.38	1.95	6.05	.57	3.22
750	4.79	.36	1.75	4.81	.36	1.77	5.27	.43	2.21	6.49	.65	3.66
800	5.11	.41	1.97	5.13	.41	1.99	5.62	.49	2.49	6.91	.74	4.13
850	5.43	.46	2.21	5.45	.46	2.23	5.97	.55	2.79	7.35	.84	4.62
900	5.75	.51	2.46	5.77	.52	2.48	6.32	.62	3.10	7.78	.94	5.13
950	6.06	.57	2.71	6.09	.58	2.74	6.67	.69	3.43	8.21	1.05	5.67
1000	6.38	.63	2.98	6.41	.64	3.02	7.03	.77	3.77	8.64	1.16	6.24
1100	7.03	.77	3.56	7.05	.77	3.60	7.83	.95	4.49	9.50	1.40	7.44
1200	7.66	.91	4.18	7.69	.92	4.23	8.43	1.10	5.28	10.4	1.7	8.74
1300	8.30	1.07	4.85	8.33	1.08	4.90	9.13	1.30	6.12	11.2	2.0	10.4
1400	8.95	1.24	5.56	8.97	1.25	5.62	9.83	1.50	7.02	12.1	2.3	11.6
1500	9.59	1.43	6.32	9.61	1.44	6.39	10.5	1.7	7.93	13.0	2.6	13.2
1600	10.2	1.6	7.12	10.3	1.7	7.20	11.2	2.0	8.99	13.9	3.0	14.9
1800	11.5	2.1	8.85	11.5	2.1	8.95	12.6	2.5	11.2	15.6	3.8	18.5
2000	12.8	2.6	10.8	12.8	2.5	10.9	14.1	3.1	13.6	17.3	4.7	22.5
2200	14.1	3.1	12.8	14.1	3.1	13.0	15.5	3.7	16.6	19.0	5.6	26.8
2400	15.4	3.6	15.1	15.4	3.7	15.2	16.9	4.4	19.0	20.7	6.7	31.5
2600	16.8	4.3	17.5	16.7	4.3	17.7	18.3	5.2	22.1	22.5	7.9	36.5
2800	17.9	5.0	20.0	18.0	5.0	20.3	19.7	6.0	25.3	24.2	9.1	41.9
3000	19.1	5.7	22.8	19.2	5.7	23.0	21.1	6.9	28.8	25.9	10.4	47.6
3500	22.4	7.8	30.3	22.4	7.8	30.6	24.6	9.4	38.3	30.2	14.2	63.3
4000	25.6	10.2	38.8	25.6	10.2	39.2	28.1	12.3	49.0	34.6	18.5	81.0
4500	28.8	12.8	48.2	28.8	12.9	48.8	31.6	15.5	60.9	38.9	23.5	101
5000	32.0	15.6	58.6	32.0	15.9	59.3	35.1	19.1	74.0	43.2	29.0	122
5500	35.2	19.1	69.9	35.3	19.4	70.7	38.6	23.2	88.3	47.5	35.1	146

307

TEXHALLOY
EFFLUENT PUMP

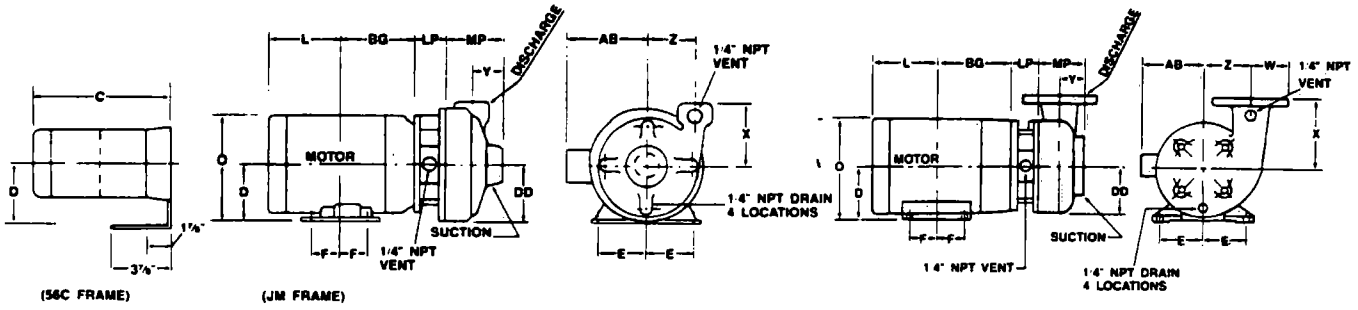
6.5″ 1750





Horsepower curves do not include motor service factor.

CLOSE COUPLED



NOTE: Suction Flange is machined on face of casing, blind tapped with 4 each 5/8"-11 holes to accept standard 125 lb. ANSI B16.1 flange

PUMP DIMENSIONS - NPT

MODEL	SUCTION × DISCHARGE (NPT)	LP	X	Y	Z	DD	MP
50	2 × 1½	2.50	5.00	2.50	3.75	4.25	4.56
52	2½ × 2	2.50	6.00	2.50	4.37	4.50	4.56
54	3 × 2½	2.50	6.25	3.87	4.62	4.62	5.87
55	3 × 3	2.50	6.25	4.00	4.62	4.62	6.00
56	3 × 3	2.50	6.25	4.00	4.62	4.62	6.00

PUMP DIMENSIONS - FLANGED

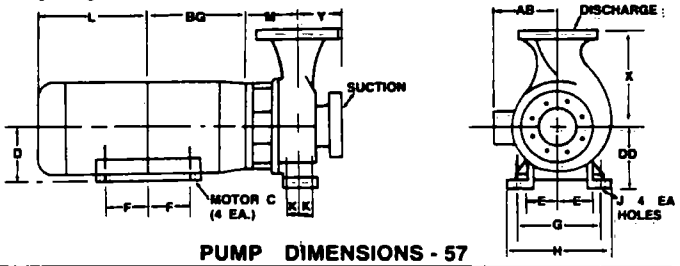
PUMP NO.	SUCTION × DISCHARGE	LP	X	Y	Z	DD	MP	W
54	2½ x 2½	2.50	6.75	2.50	4.62	4.62	4.50	3.50
55	3 x 3	2.50	7.00	2.50	4.62	4.62	4.50	3.75
56	3 x 3	2.50	7.00	2.50	4.62	4.62	4.50	3.75

Suction and Discharge connections are flanged and machined to ANSI B16.2
Mating Flanges, Gaskets & Hardware not included

MOTOR DIMENSIONS

H.P.	FRAME	D	E	F	O	AB	BG	L*	C
1/4, 1/3	56C	4.50	2.06	—	—	3.25	—	—	8.00
1/2	56C	4.50	2.06	—	—	3.25	—	—	8.25
3/4	56C	4.50	2.06	—	—	3.25	—	—	8.75
1	143JM	3.50	2.75	2.50	7.00	3.25	5.38	4.69	—
1½, 2	145JM	3.50	2.75	2.50	7.00	5.76	5.38	4.69	—
3	182JM	4.50	3.75	2.25	9.00	8.12	5.88	4.94	—
5	184JM	4.50	3.75	2.75	9.00	8.12	5.88	4.94	—
7½	213JM	5.25	4.25	2.75	9.56	8.12	7.25	6.25	—

* For TEFC Motors increase "L" by approx. 2".
L Dimension is not determined by NEMA specifications and therefore may vary slightly depending on motor manufacture.

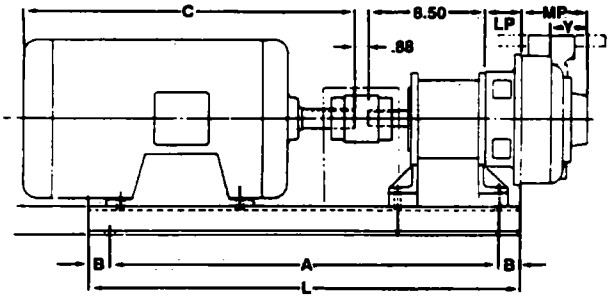


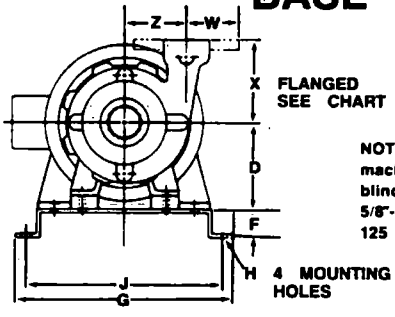
PUMP DIMENSIONS - 57

PUMP NO.	SUCTION × DISCHARGE	DD	G	H	J	K	M	X	Y
57	4 × 3	7.09	9.88	12.63	.56	1.88	4.72	8.75	4.88

Suction and Discharge connections are flanged and machined to ANSI B16.1.
Mating Flanges, Gaskets & Hardware not included.

BASE MOUNTED





NOTE: Suction Flange is machined on face of casing, blind tapped with 4 each 5/8"-11 holes to accept standard 125 lb. ANSI B16.1 flange

PUMP DIMENSIONS - NPT

PUMP NO.	SUCTION × DISCHARGE (NPT)	LP	X	Y	Z	MP
50	2 × 1½	2.50	5.00	2.50	3.75	4.56
52	2½ × 2	2.50	6.00	2.50	4.37	4.56
54	3 × 2½	2.50	6.25	3.87	4.62	5.87
55	3 × 3	2.50	6.25	4.00	4.62	6.00
56	3 × 3	2.50	6.25	4.00	4.62	6.00

PUMP DIMENSIONS - FLANGED

PUMP NO.	SUCTION × DISCHARGE	LP	X	Y	Z	MP	W
54	2½ x 2½	2.50	6.75	2.50	4.62	4.50	3.50
55	3 x 3	2.50	7.00	2.50	4.62	4.50	3.75
56	3 x 3	2.50	7.00	2.50	4.62	4.50	3.75

See Pump No. 57 dimensions above for base mounted pump dimensions.
Suction and Discharge connections are flanged and machined to ANSI B16.1.
Mating Flanges, Gaskets & Hardware not included.

MOTOR AND MOUNTING BASE DIMENSIONS

FRAME	3 PHASE-1750 RPM		A	B	C (MAX)		D	F	G	H	J	L
	ODP	TEFC			ODP	TEFC						
143T	1, 1½	1	28	1.00	12	12	5.13	2	13.50	.44	12.25	30
145T	2	1½, 2	28	1.00	13	14	5.13	2	13.50	.44	12.25	30
182T	3	3	28	1.00	15	16	5.13	2	13.50	.44	12.25	30
184T	5	5	28	1.00	15	17	5.13	2	13.50	.44	12.25	30
213T	7½	7½	28	1.00	17	18	5.25	2	13.50	.44	12.25	30

WESTON MANAGERS DESIGNERS/CONSULTANTS

SHEET 1 of ____

CLIENT/SUBJECT TECHALLOY W.O. NO. ____

TASK DESCRIPTION AIR STRIPPER PUMP TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

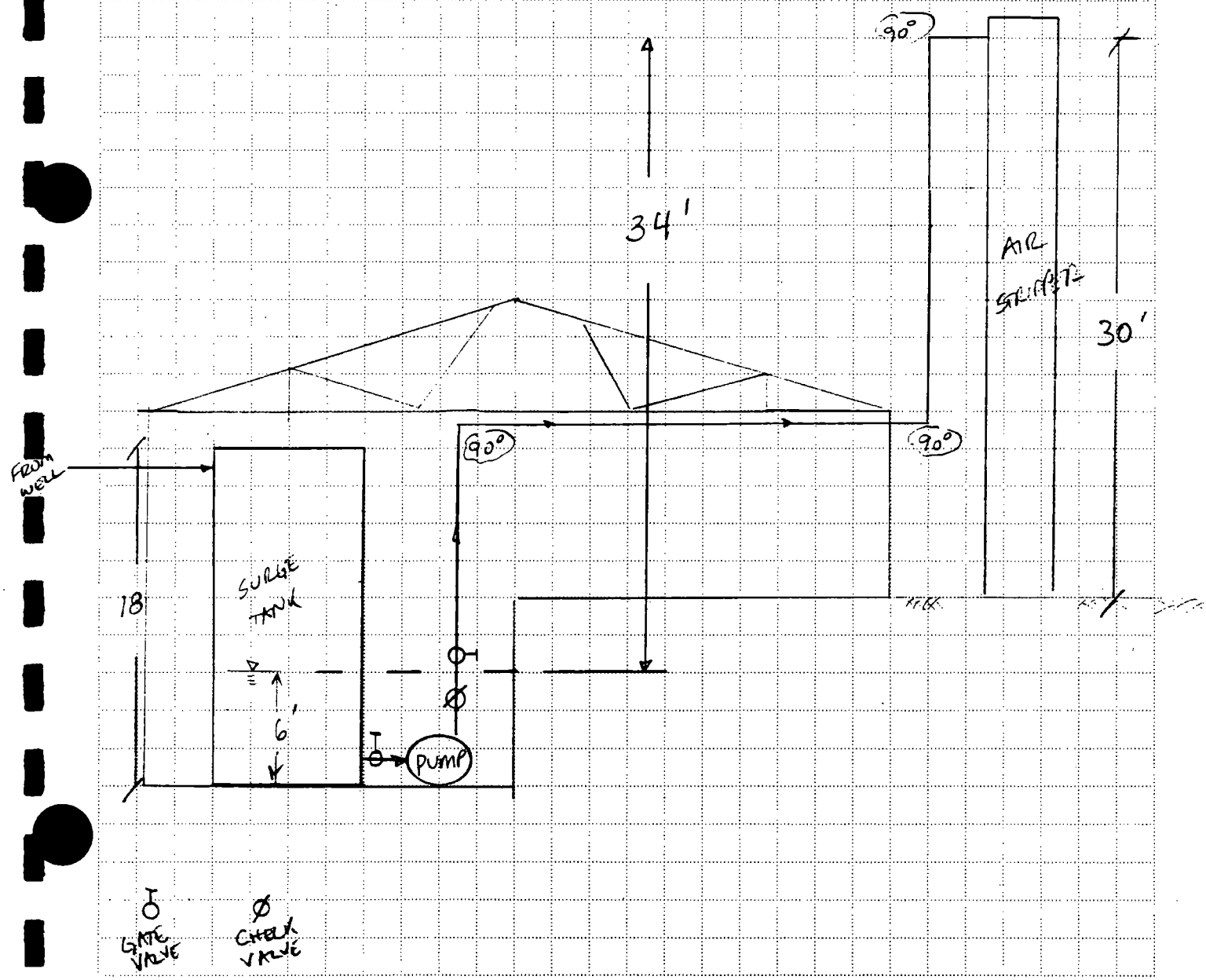
METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

SUCTION PIPE LENGTH ≈ 10 ft

DISCHARGE PIPE LENGTH ≈ 70 ft

ASSUME SUCTION PIPE = 8 inch
ASSUME DISCHARGE PIPE = 6 inch



RFW 10-05-003/A-5/85
512-5642

CLIENT/SUBJECT TERRALOY

TASK DESCRIPTION AIR STRIPPER PUMP

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY DEPT ____ DATE ____

W.O. NO. ____

TASK NO. ____

SHEET 2 of ____

	100 gpm	200 gpm	300 gpm	400 gpm	500 gpm
SUCTION (6")					
PIPE LENGTH 10'					
GATE VALE = 8' (15D)					
ENTRANCE = 9'					
≈ 30'	.05	0.18	0.39	0.67	1.01
* CORRECTION FACTOR	0.5	0.5	0.5	0.5	0.5
HEADLOSS (ft)	.03	.09	.20	.35	.50

* "C" IN TABLES = 100

"C" HDPE = 150

RFW 10-08-003/A-5/85

AIR STRIPPER

SUCTION SIDE

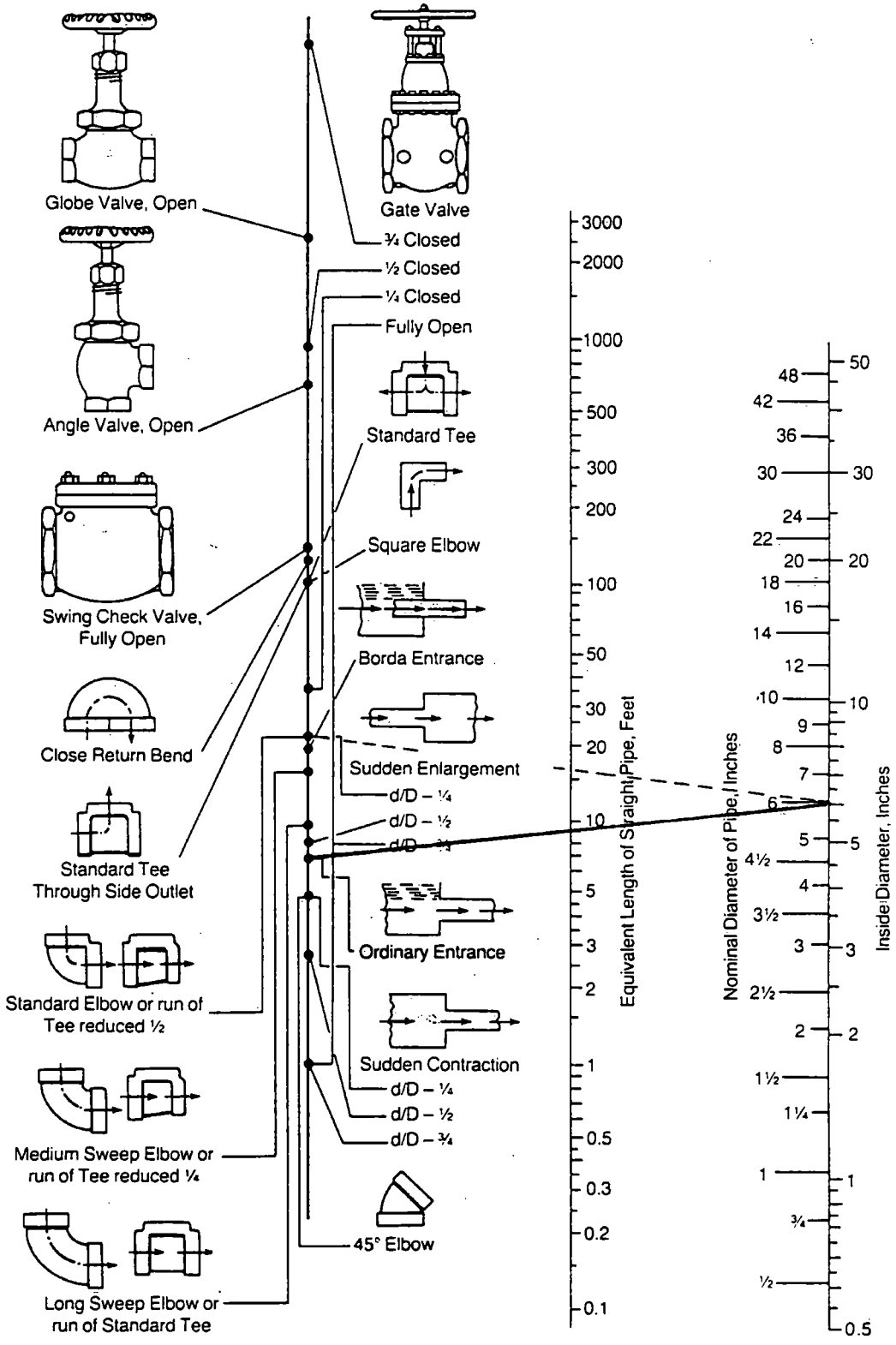
APPENDIX

Chart 35

Resistance of Valves and Fittings to Flow of Fluids

Example: The dashed line shows that the resistance of a 6-in. standard elbow is equivalent to approximately 16 ft of 6-in. standard pipe.

Note: For sudden enlargements or sudden contractions, use the smaller diameter, d on the pipe-size scale. Head loss through check valves varies with types manufactured. Consult with manufacturer for correct values.



Courtesy of Crane Co.

CLIENT/SUBJECT TELKALLOY

TASK DESCRIPTION AIR STRIPPER FEED PUMP

PREPARED BY _____ DEPT _____ DATE _____

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

WESTON MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

W.O. NO. _____

TASK NO. _____

APPROVED BY

DEPT _____ DATE _____

DISCHARGE (6")		100gpm	200gpm	300gpm	400gpm	500gpm
PIPE	70'					
4" x 6" REDUCER	4'					
CHECKVALVE	40'					
GATEVALVE	4'					
"TEE"	10'					
ELBOWS (3)	50'					
TOTAL PIPE	180					
H_f (PIPE)		0.3	1	2	4	6
AIR STRIPPER NOZZLE 3lbs @ 2.31 ft/lb		7	7	7	7	7
CYCLONE CLARIFIER (15psi)		35	35	35	35	35
FILTER (10psi)		23	23	23	23	23
H_f		65	66	67	69	71
STATIC (H)		34	34	34	34	34
TOTAL HL (ft)		99	100	101	103	105

RFW 10-05-003/A-5/85
512-5643

AIR STRIPPER PUMP
DISCHARGE SIDE 6"

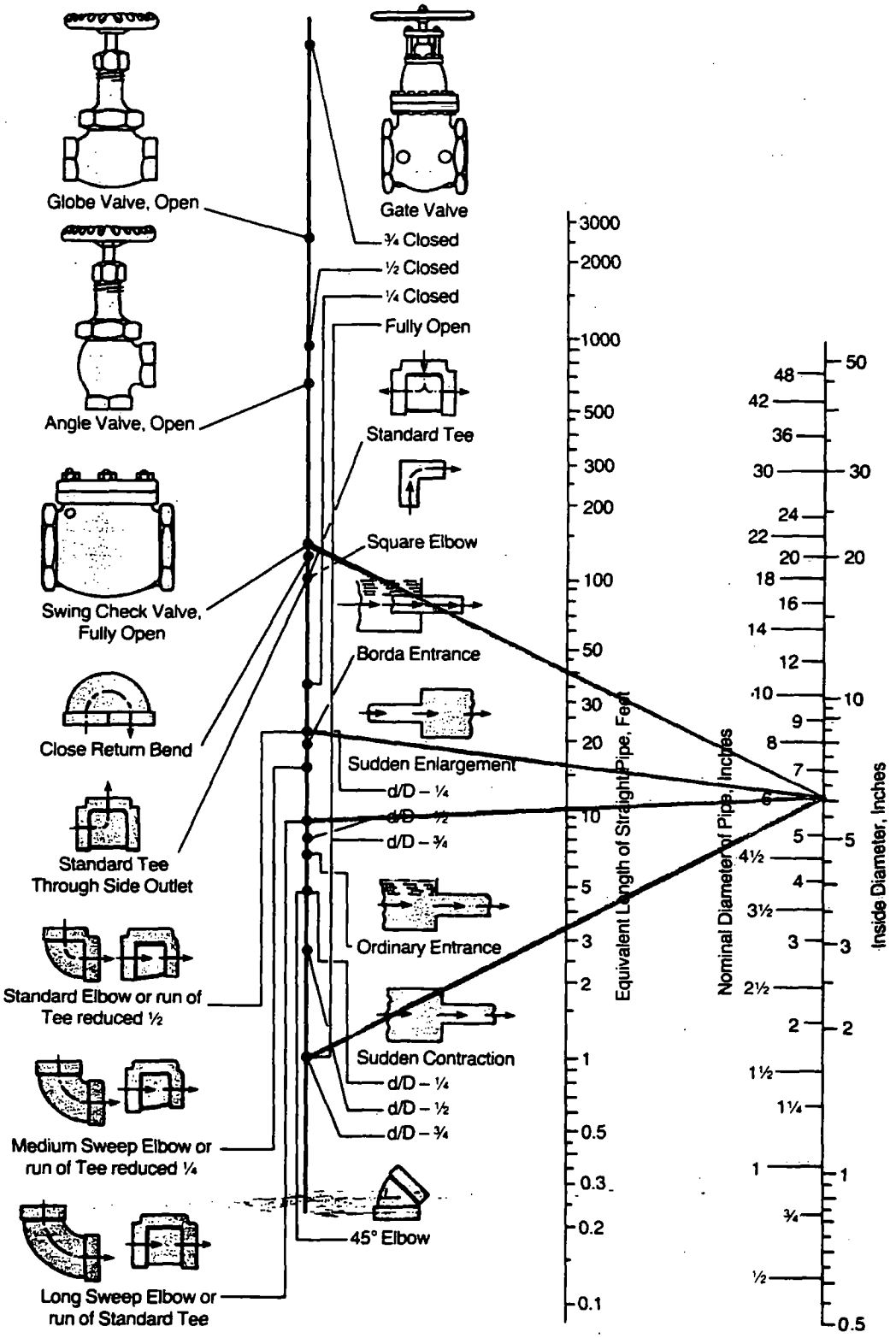
APPENDIX

Chart 35

Resistance of Valves and Fittings to Flow of Fluids

Example: The dashed line shows that the resistance of a 6-in. standard elbow is equivalent to approximately 16 ft of 6-in. standard pipe.

Note: For sudden enlargements or sudden contractions, use the smaller diameter, d on the pipe-size scale. Head loss through check valves varies with types manufactured. Consult with manufacturer for correct values.



Courtesy of Crane Co.

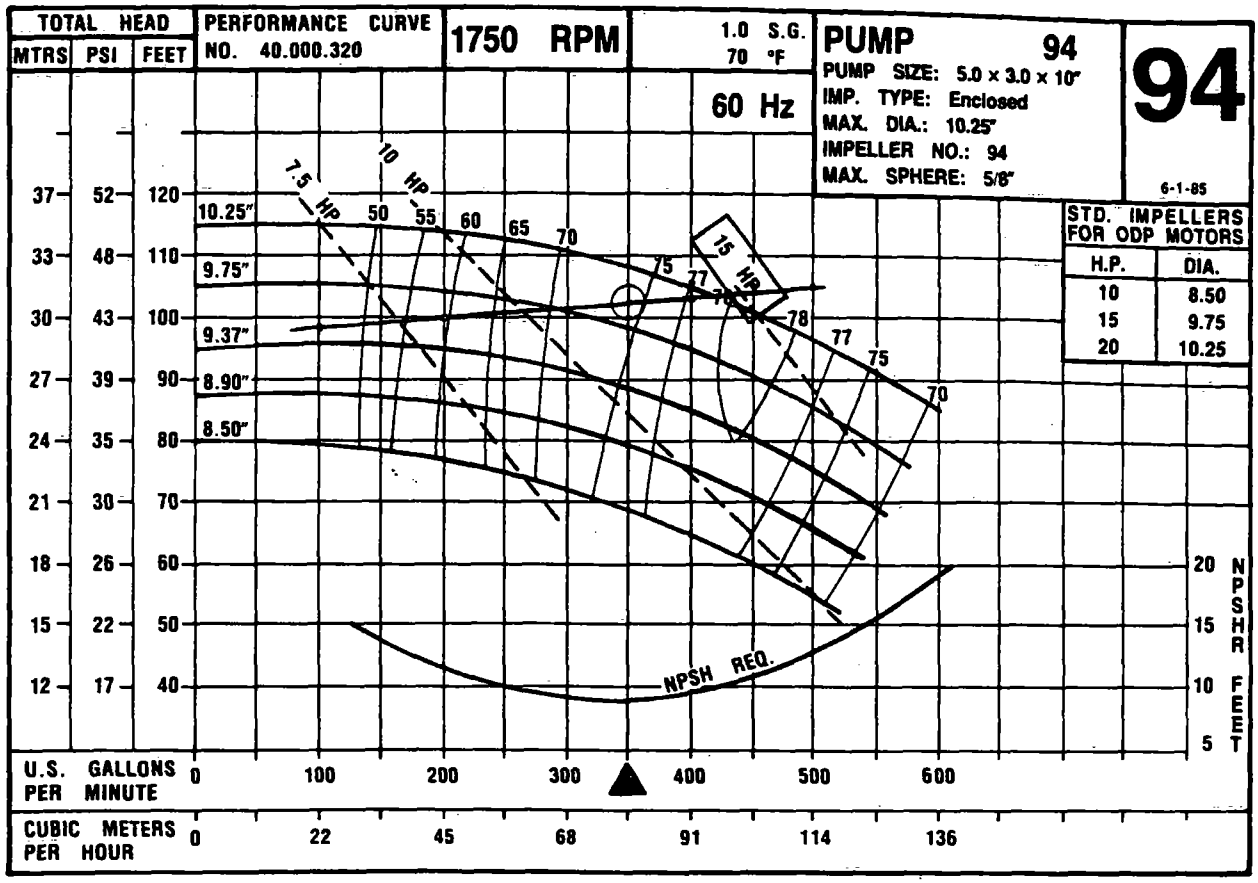
Friction Losses In Pipe; C = 100
6 Inch

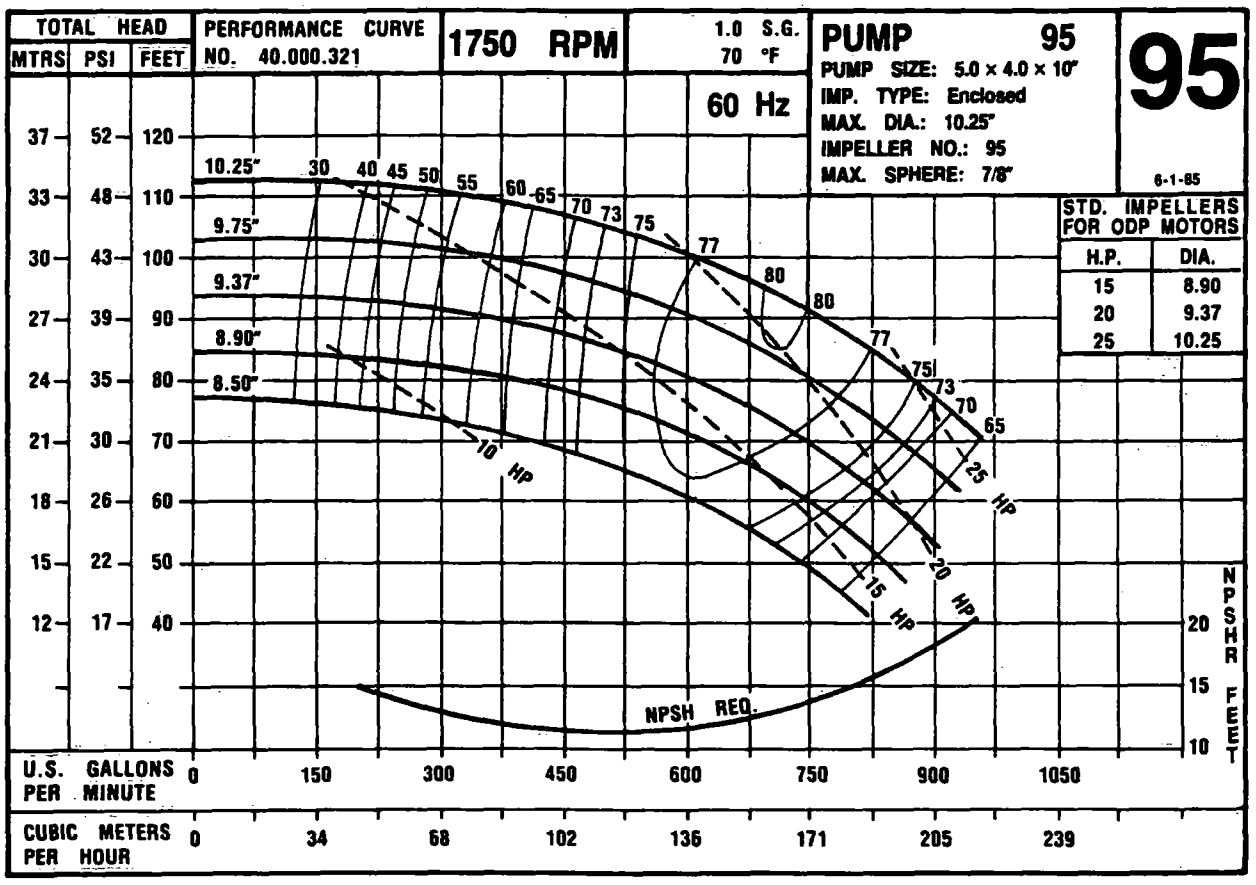
FLOW US gal per min	Cast Iron 6.0" inside dia			Std Wt Steel 6.065" inside dia			Extra Strong Steel 5.761" inside dia			Double Extra Strong Steel 4.897" inside dia		
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
50	.57	.01	.047	.56	.00	.045	.62	.01	.058	.85	.01	.127
60	.68	.01	.066	.67	.01	.063	.74	.01	.081	1.02	.02	.178
70	.79	.01	.088	.78	.01	.084	.86	.01	.108	1.19	.02	.237
80	.91	.01	.113	.89	.01	.107	.98	.01	.138	1.36	.03	.304
90	1.02	.02	.141	1.00	.02	.133	1.11	.02	.171	1.53	.04	.378
100	1.13	.02	.171	1.11	.02	.162	1.23	.02	.208	1.70	.05	.459
120	1.36	.03	.239	1.33	.03	.227	1.48	.03	.292	2.04	.06	.643
140	1.59	.04	.318	1.56	.04	.302	1.72	.06	.388	2.38	.09	.855
160	1.82	.05	.408	1.78	.05	.387	1.97	.06	.497	2.72	.12	1.10
180	2.04	.06	.507	2.00	.06	.481	2.21	.08	.618	3.06	.15	1.36
200	2.27	.08	.616	2.22	.08	.584	2.46	.09	.751	3.40	.18	1.65
220	2.50	.10	.735	2.44	.09	.697	2.71	.11	.895	3.74	.22	1.97
240	2.72	.12	.863	2.67	.11	.819	2.96	.14	1.03	4.08	.26	2.32
260	2.95	.14	1.00	2.89	.13	.950	3.20	.16	1.22	4.42	.30	2.69
280	3.18	.16	1.15	3.11	.15	1.09	3.45	.19	1.40	4.77	.35	3.08
300	3.40	.18	1.30	3.33	.17	1.24	3.69	.21	1.59	5.11	.41	3.50
320	3.64	.21	1.47	3.56	.20	1.39	3.94	.24	1.79	5.45	.46	3.95
340	3.86	.23	1.64	3.78	.22	1.56	4.19	.27	2.00	5.79	.52	4.42
360	4.08	.26	1.83	4.00	.25	1.73	4.43	.31	2.23	6.13	.58	4.91
380	4.31	.29	2.02	4.22	.28	1.92	4.68	.34	2.46	6.47	.65	5.43
400	4.55	.32	2.22	4.44	.31	2.11	4.93	.38	2.71	6.81	.72	5.97
450	5.11	.41	2.76	5.00	.39	2.62	5.54	.48	3.36	7.66	.91	7.42
500	5.68	.50	3.36	5.56	.48	3.19	6.16	.59	4.09	8.51	1.13	9.02
550	6.25	.61	4.00	6.11	.58	3.80	6.77	.71	4.88	9.37	1.36	10.8
600	6.81	.72	4.70	6.66	.69	4.46	7.39	.85	5.73	10.2	1.6	12.6
650	7.38	.85	5.45	7.22	.81	5.17	8.00	.99	6.64	11.1	1.9	14.6
700	7.95	.98	6.25	7.78	.94	5.93	8.63	1.16	7.62	11.9	2.2	16.8
750	8.52	1.13	7.10	8.34	1.08	6.74	9.24	1.33	8.66	12.8	2.5	19.1
800	9.08	1.28	8.00	8.90	1.23	7.60	9.85	1.51	9.75	13.6	2.9	21.5
850	9.65	1.45	8.95	9.45	1.39	8.50	10.5	1.7	10.9	14.5	3.3	24.1
900	10.2	1.6	9.95	10.0	1.5	9.44	11.1	1.9	12.1	15.3	3.7	26.7
950	10.8	1.8	11.0	10.5	1.7	10.2	11.7	2.1	13.4	16.2	4.1	29.6
1000	11.4	2.0	12.1	11.1	1.9	11.5	12.3	2.4	14.7	17.0	4.5	32.5
1100	12.5	2.4	14.4	12.2	2.3	13.7	13.5	2.8	17.6	18.7	5.4	38.9
1200	13.6	2.9	16.9	13.3	2.7	16.1	14.8	3.4	20.7	20.4	6.5	45.5
1300	14.8	3.4	19.7	14.4	3.2	18.6	16.0	4.0	23.9	22.1	7.6	52.8
1400	15.9	3.9	22.5	15.6	3.6	21.4	17.2	4.6	27.5	23.8	8.8	60.6
1500	17.0	4.5	25.6	16.7	4.3	24.3	18.5	5.3	31.2	25.5	10.1	68.8
1600	18.2	5.1	28.9	17.8	4.9	27.4	19.7	6.0	35.2	27.2	11.5	77.5
1700	19.3	5.8	32.5	18.9	5.6	30.6	20.9	6.8	39.4	28.9	13.0	86.8
1800	20.4	6.5	35.9	20.0	6.2	34.0	22.2	7.7	43.7	30.6	14.6	96.4
1900	21.5	7.2	39.7	21.1	6.9	37.6	23.4	8.4	48.3	32.3	16.2	107
2000	22.7	8.0	43.6	22.2	7.7	41.4	24.6	9.4	53.1	34.0	18.0	117
2200	25.0	9.7	52.0	24.4	9.3	49.4	27.1	11.4	63.4	37.4	21.7	140
2400	27.2	11.5	61.1	26.7	11.1	58.0	29.6	13.6	74.5	40.8	25.9	164

Friction Losses In Pipe; C = 100
8 Inch

FLOW US gal per min	Cast Iron 8.0" inside dia			Std Wt Steel 7.981" inside dia			Extra Strong Steel 7.625" inside dia			Double Extra Strong Steel 6.875" inside dia		
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
130	.83	.01	.069	.83	.01	.069	.91	.01	.087	1.12	.02	.143
140	.90	.01	.079	.90	.01	.079	.98	.01	.099	1.21	.02	.164
150	.96	.01	.089	.96	.01	.091	1.05	.02	.116	1.30	.03	.187
160	1.02	.02	.101	1.03	.02	.102	1.12	.02	.127	1.38	.03	.210
170	1.08	.02	.112	1.09	.02	.114	1.19	.02	.142	1.47	.03	.235
180	1.15	.02	.125	1.15	.02	.126	1.26	.02	.158	1.56	.04	.261
190	1.21	.02	.138	1.22	.02	.140	1.33	.03	.175	1.64	.04	.289
200	1.28	.03	.152	1.28	.03	.154	1.41	.03	.192	1.73	.05	.318
220	1.40	.03	.181	1.41	.03	.183	1.55	.04	.229	1.90	.06	.379
240	1.53	.04	.213	1.54	.06	.215	1.69	.04	.269	2.07	.07	.445
260	1.66	.04	.247	1.67	.04	.250	1.83	.06	.312	2.25	.08	.516
280	1.79	.05	.283	1.80	.05	.286	1.97	.06	.358	2.42	.09	.592
300	1.91	.06	.322	1.92	.06	.328	2.11	.07	.406	2.59	.10	.672
350	2.24	.08	.428	2.24	.08	.433	2.46	.09	.540	3.02	.14	.894
400	2.56	.10	.548	2.57	.10	.554	2.81	.12	.692	3.46	.19	1.14
450	2.87	.13	.681	2.88	.13	.689	3.16	.15	.860	3.89	.24	1.42
500	3.19	.16	.828	3.20	.16	.838	3.51	.19	1.05	4.32	.29	1.73
550	3.51	.19	.987	3.52	.19	.999	3.86	.23	1.25	4.75	.35	2.06
600	3.83	.23	1.16	3.55	.23	1.17	4.22	.28	1.46	5.19	.42	2.42
650	4.15	.27	1.34	4.17	.27	1.36	4.57	.32	1.70	5.62	.49	2.78
700	4.47	.31	1.54	4.49	.31	1.56	4.92	.38	1.95	6.05	.57	3.22
750	4.79	.36	1.76	4.81	.36	1.77	5.27	.43	2.21	6.49	.65	3.66
800	5.11	.41	1.97	5.13	.41	1.99	5.62	.49	2.49	6.91	.74	4.13
850	5.43	.46	2.21	5.45	.46	2.23	5.97	.55	2.79	7.35	.84	4.62
900	5.75	.51	2.46	5.77	.53	2.48	6.33	.62	3.10	7.78	.94	5.13
950	6.06	.57	2.71	6.09	.58	2.74	6.67	.69	3.43	8.21	1.05	5.67
1000	6.38	.63	2.98	6.41	.64	3.02	7.03	.77	3.77	8.64	1.16	6.24
1100	7.03	.77	3.56	7.05	.77	3.60	7.83	.95	4.49	9.50	1.40	7.44
1200	7.66	.91	4.18	7.69	.92	4.23	8.43	1.10	5.28	10.4	1.7	8.74
1300	8.30	1.07	4.85	8.33	1.08	4.90	9.13	1.30	6.12	11.2	2.0	10.4
1400	8.95	1.24	5.56	8.97	1.25	5.62	9.83	1.50	7.02	12.1	2.3	11.6
1500	9.59	1.43	6.32	9.61	1.44	6.39	10.5	1.7	7.98	13.0	2.6	13.2
1600	10.2	1.6	7.12	10.3	1.7	7.20	11.2	2.0	8.99	13.8	3.0	14.9
1800	11.5	2.1	8.85	11.5	2.1	8.95	12.6	2.5	11.2	15.6	3.8	18.5
2000	12.8	2.6	10.8	12.8	2.5	10.9	14.1	3.1	13.6	17.3	4.7	22.5
2200	14.1	3.1	12.8	14.1	3.1	13.0	15.5	3.7	16.6	19.0	5.6	26.8
2400	15.3	3.6	15.1	15.4	3.7	15.2	16.9	4.4	19.0	20.7	6.7	31.5
2600	16.6	4.3	17.5	16.7	4.3	17.7	18.3	5.2	22.1	22.5	7.9	36.5
2800	17.9	5.0	20.0	18.0	5.0	20.3	19.7	6.0	25.3	24.2	9.1	41.9
3000	19.1	5.7	22.8	19.2	5.7	23.0	21.1	6.9	28.8	25.9	10.4	47.6
3500	22.4	7.8	30.3	22.4	7.8	30.6	24.6	9.4	38.3	30.2	14.2	63.3
4000	25.6	10.2	38.8	25.6	10.2	39.2	28.1	12.3	49.0	34.6	18.6	81.0
4500	28.7	12.9	48.2	28.8	12.9	48.8	31.6	15.5	60.9	38.9	23.5	101
5000	31.9	15.8	58.6	32.0	15.9	59.3	35.1	19.1	74.0	43.2	29.0	122
5500	35.1	19.1	69.9	35.3	19.4	70.7	38.6	23.2	88.3	47.5	35.1	146

347

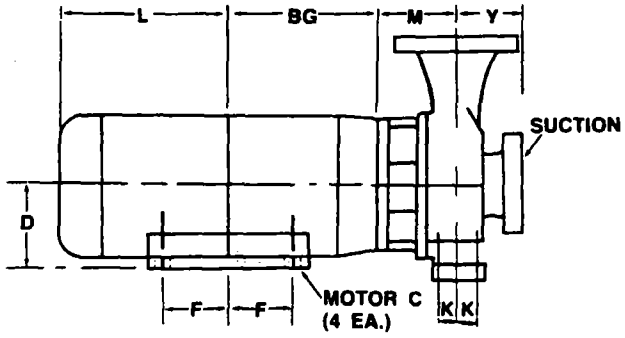


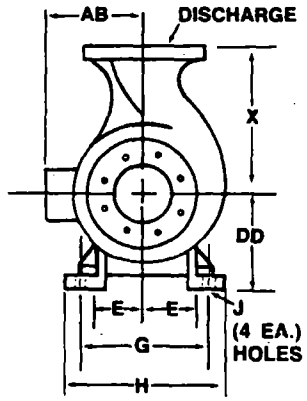


Horsepower curves do not include motor service factor

10″ 1750

CLOSE COUPLED





PUMP DIMENSIONS

PUMP NO.	SUCTION × DISCHARGE	DD	G	H	J	L	M	X	Y
91	2½ × 1½	7.09	9.88	12.63	.56	1.88	7.31	8.88	3.88
92	3 × 2	7.09	9.88	12.63	.56	1.88	7.31	8.88	4.88
93	4 × 2½	7.88	11.06	14.25	.75	2.38	7.81	9.88	4.88
94	5 × 3	8.86	12.43	15.75	.75	2.38	7.81	11.00	4.88
95	5 × 4	8.86	12.43	15.75	.75	2.38	8.00	11.00	5.50
96	6 × 5	9.84	12.43	15.75	.75	2.38	8.00	13.88	5.50

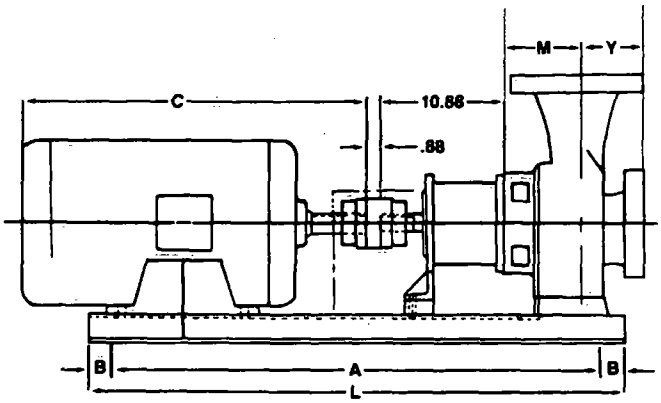
Suction and Discharge Connections are flanged and machined to ANSI B16.1
Mating Flanges, Gaskets and Hardware not included

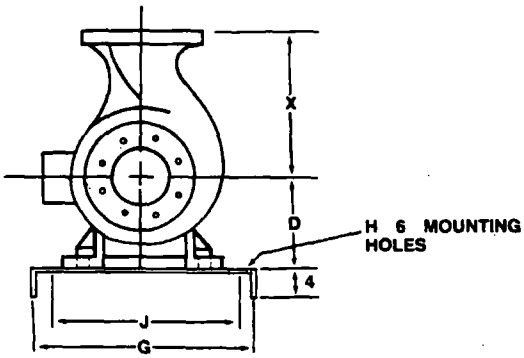
MOTOR DIMENSIONS

NO.	HP	FRAME	D	E	F	BG	C	L	AB
91	3	182TCZ	4.50	3.75	2.25	6.38	.41	4.94	8.12
92	5	184TCZ	4.50	3.75	2.75	6.38	.41	5.44	8.12
	7.5	213TCZ	5.25	4.25	2.75	7.25	.41	6.13	8.76
	10	215TCZ	5.25	4.25	3.50	8.00	.41	6.88	8.76
93	7.5	213JP	5.25	4.25	2.75	7.25	.41	6.13	8.76
94	10	215JP	5.25	4.25	3.50	8.00	.41	6.88	8.76
95	15	254JP	6.25	5.00	4.12	9.00	.53	8.13	10.69
96	20	256JP	6.25	5.00	5.00	10.00	.53	9.00	10.69
	25	284JP	7.00	5.50	4.75	9.75	.53	9.50	12.25
	30	286JP	7.00	5.50	5.50	10.50	.53	9.50	12.25

* For TEFC Motors increase "L" by approx. 2".
L Dimension is not determined by NEMA specifications and therefore may vary slightly depending on motor manufacture.
Motor rabbet changes from 8.5 to 12.5 AK on frame 284 JP and larger.

BASE MOUNTED





PUMP DIMENSIONS

PUMP NO.	SUCTION × DISCHARGE	D	M	X	Y
91	2½ × 1½	7.09	7.31	8.88	3.88
92	3 × 2	7.09	7.31	8.88	4.88
93	4 × 2½	7.88	7.81	9.88	4.88
94	5 × 3	8.86	7.81	11.00	4.88
95	5 × 4	8.86	8.00	11.00	5.50
96	6 × 5	9.84	8.00	13.88	5.50
97	8 × 6	9.84	8.00	14.75	6.25

Suction and Discharge Connections are flanged and machined to ANSI B16.1.
Mating Flanges, Gaskets & Hardware not included.

MOTOR AND MOUNTING BASE DIMENSIONS

FRAME	3 PHASE-1750 RPM ODP	3 PHASE-1750 RPM TEFC	A	B	C (MAX) ODP	C (MAX) TEFC	G	H	J	L
182 T	3	3	42	1.50	15	16	15.00	.75	13.00	45
184 T	5	5	42	1.50	15	17	15.00	.75	13.00	45
213 T	7½	7½	46	1.50	17	18	18.00	.75	16.00	49
215 T	10	10	46	1.50	17	20	18.00	.75	16.00	49
254 T	15	15	50	1.50	20	24	18.00	.75	16.00	53
256 T	20	20	50	1.50	22	24	18.00	.75	16.00	53
284 T	25	25	50	1.50	25	25	18.00	.75	16.00	53
286 T	30	30	50	1.50	26	27	18.00	.75	16.00	53
324 T	40	40	50	1.50	28	28	22.00	.75	19.00	53
326 T	50	50	50	1.50	29	30	22.00	.75	19.00	53

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 1 of 1

CLIENT/SUBJECT Techalloy W.O. NO.

TASK DESCRIPTION Air Emissions TASK NO.

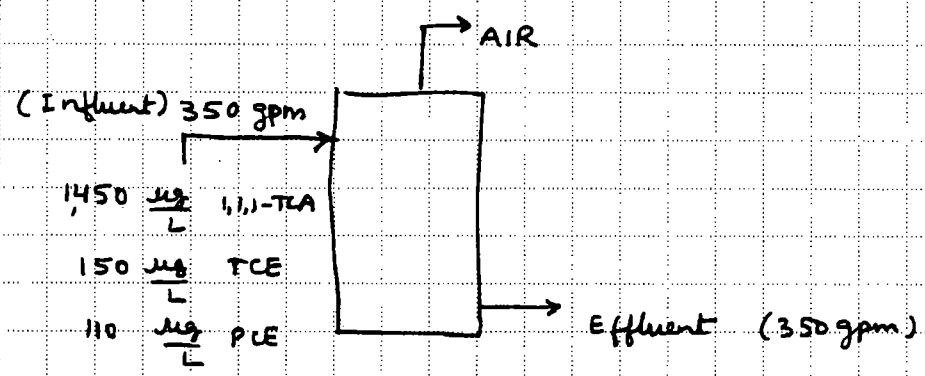
PREPARED BY Anup Kothari DEPT 710 DATE 8/18/93

MATH CHECK BY DEPT DATE

METHOD REV. BY DEPT DATE

APPROVED BY

DEPT DATE



Mass In (lbs/hr)

$$TCA \equiv 1,450 \frac{ug}{L} \times \frac{10^{-6}\ g/ug}{453.6\ g/lb} \times \frac{350\ gal}{min} \times \frac{3.79\ L/gal}{\frac{1\ hr}{60\ min}}$$

$$\equiv 1,450 \times 1.75 \times 10^{-4}\ lb/hr$$

$$\equiv 0.25\ lb/hr$$

$$TCE \equiv 150 \times 1.75 \times 10^{-4}\ lb/hr$$

$$\equiv 0.03\ lb/hr$$

$$PCE \equiv 110 \times 1.75 \times 10^{-4}\ lb/hr$$

$$\equiv 0.02\ lb/hr$$

Conservative estimate for air emissions,

Assuming all VOC in influent goes out as air emissions.

RFW 10-05-003/A-5/85
512-5643

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SHEET 1 of 1

CLIENT/SUBJECT Teckalloy W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY WEK DEPT DATE 8/16/93

MATH CHECK BY DEPT DATE

METHOD REV. BY DEPT DATE

APPROVED BY

DEPT DATE

DETERMINE AIR REQUIREMENTS FOR MIXING

BASED ON "WASTEWATER ENGINEERING" by METCALF & EDDY, INC
AIR MIXING 20-30 scfm/1000 cuft

VOLUME OF TANK 90" DIA X 214" HIGH
7.5 ft x 17.83'
OR 787 cuft

USE $\frac{25 \text{ scfm}}{1000 \text{ cuft}}$ x 787 cuft = 20 scfm

FOR INITIAL CALCULATIONS
ASSUME DISCHARGE PRESSURE =

DEPTH OF WATER OVER DIFFUSERS	17.83 - 1 = 16.83 ft
DIFFUSER LOSSES	2.3
AIR FILTER	0.17
SILENCER	0.5
CHECK VALVE	0.33
	20.13 ft

OR 8.7 PSI

RFW 10-05-003/A-5/85

WESTON
MANAGERS DESIGNERS/CONSULTANTS

CLIENT/SUBJECT Techalloy W.O. NO.

TASK DESCRIPTION Average Influent Concentrations TASK NO.

PREPARED BY Anup Kothari DEPT DATE

MATH CHECK BY DEPT DATE

METHOD REV. BY DEPT DATE

APPROVED BY

DEPT DATE

Objective : To estimate average influent concentrations in extracted groundwater.

Data

Plume Width = 1200 ft.

The proposed extraction well is near MW-HBR and TW-3 (See Figure 1-2 of the Interim Measures Design Report). Average concentrations were estimated by plotting 1,1,1-TCA, TCE and PCE concentrations along the plume width. The area under the curve divided by the plume width then gives the average concentration

i.e.

$$\text{Average concentration} = \frac{\text{Area under "Concentration v/s plume width" curve}}{\text{Total plume width}}$$

$$= \frac{\int c\,dx}{\int dx}$$

dx = increment of plume width

c = concentration

Concentration v/s plume width curves are attached and calculations are shown with the plots.

INFLUENT CONCENTRATIONS

Avg. TCA $= \frac{1,742,538}{1200}$

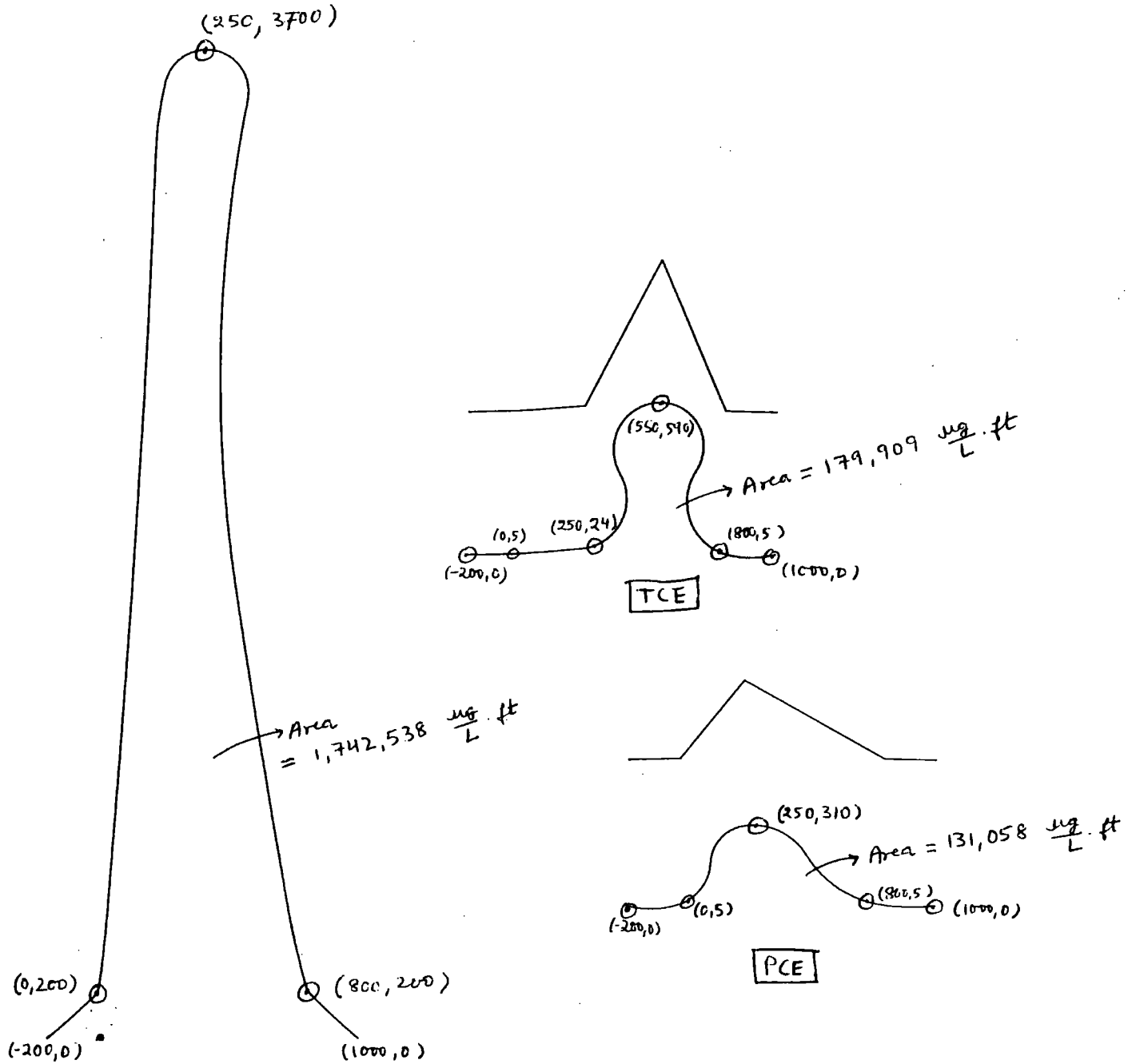
$\simeq 1450$ ug/L

Avg. TCE $= \frac{179,909}{1200}$

$\simeq 150$ ug/L

Avg. PCE $= \frac{131,058}{1200}$

$\simeq 110$ ug/L



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SHEET 1 of 4

CLIENT/SUBJECT Techalloy W.O. NO. 1989-012-002

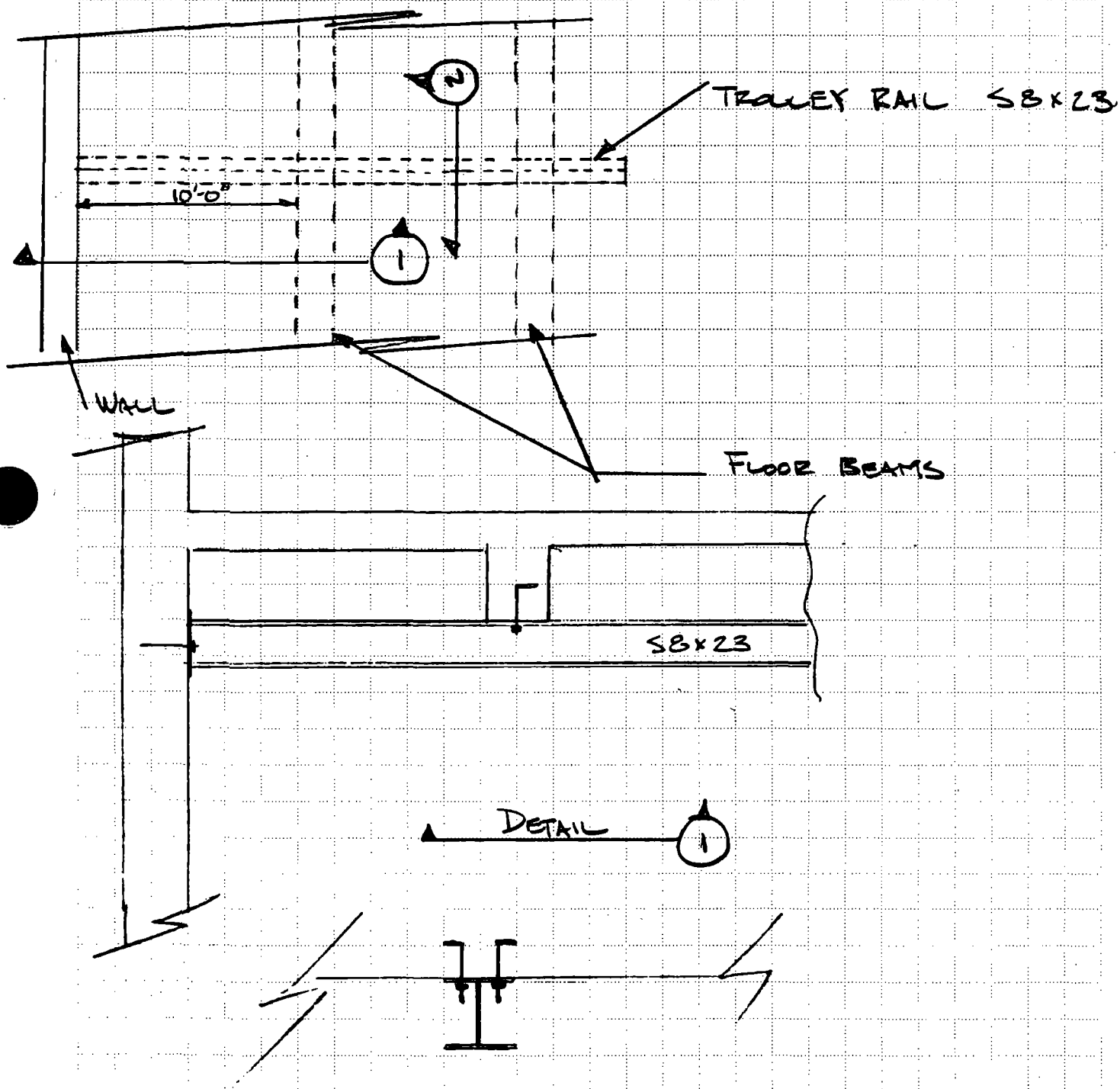
TASK DESCRIPTION LOWER BAY TROLLEY W/HOIST DESIGN TASK NO. 0200

PREPARED BY DAM DEPT 920 DATE 8/27/93

MATH CHECK BY CAW DEPT 920 DATE 27 AUG 93

METHOD REV. BY MAS DEPT 920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93



WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET 2 of 4

CLIENT/SUBJECT Techalloy — W.O. NO. 1989-010-003

TASK DESCRIPTION Trolley Design — TASK NO. 0200

PREPARED BY DAH — DEPT 920 — DATE 8/27/93

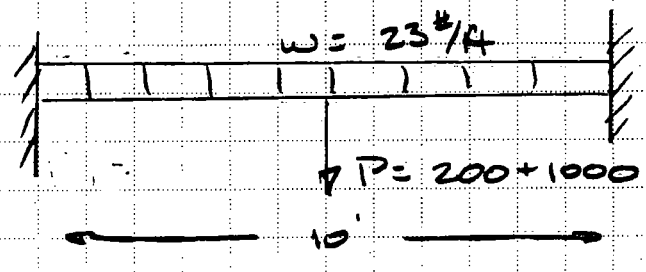
MATH CHECK BY CAW — DEPT 920 — DATE 27 Aug 93

METHOD REV. BY MAS — DEPT 0920 — DATE 8/27/93

APPROVED BY M. Allenspach — DEPT 0920 — DATE 8/27/93

1) CHECK TROLLEY RAIL SIZE

- ASSUME FIXED - FIXED CONNECTIONS
- Live Loads: Hoist - 200 lb
  Load - 1000 lb
- Dead Load - wt of beam: 23 lb/ft
- Length: 10'-0"



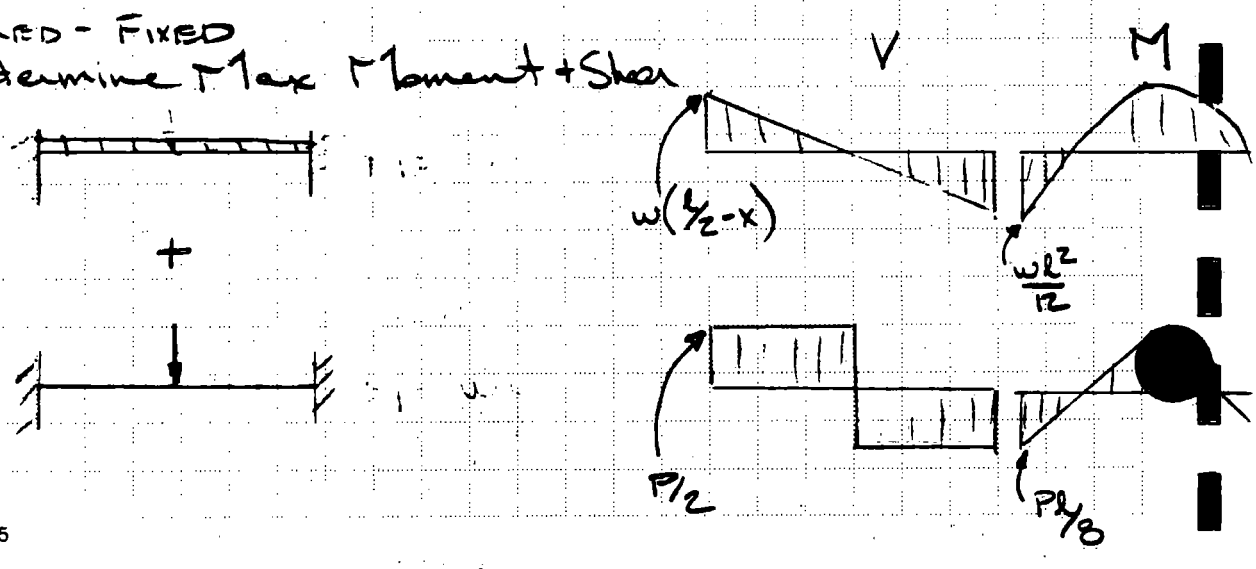
Factored Loads

LRFD 6-25

$P_u = 1.2D + 1.6L = 1.2(0) + 1.6(1200) = 1.92^k$

$w_u = 1.2(23\#/ft) = 0.0276\ k\text{-}ft$

2) Determine Max Moment + Shear (FIXED - FIXED)



WESTON

SHEET 3 of 4

CLIENT/SUBJECT Techalloy W.O. NO. 1989-010-002

TASK DESCRIPTION Trolley Design TASK NO. 0200

PREPARED BY DAM DEPT 920 DATE 8/27/93 APPROVED BY M. Allenspach

MATH CHECK BY CRS DEPT 920 DATE 27 AUG 93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93 DEPT 0920 DATE 8/27/93

a). Max. Shear $0.0276\left(\frac{19}{2}\right) + \frac{1.92}{2} = 1.1^{k}$

b) Max Moment $\frac{0.0276(10^2)}{12} + \frac{1.92(10)}{8} = 2.63$ k-ft.

FLEXURE 3-22

- $\phi M_n \geq M_u$ $\phi = 0.9$

$M_n = \frac{M_u}{\phi} = \frac{2.63 \text{ k-ft}}{0.9} = 2.92$ k-ft

$= 35.07$ k-in

$Z_{required} = \frac{M_n}{F_y} = \frac{35.07}{36} = 0.97 \text{ in}^3$

S8x23 $Z_x = 19.3 \text{ in}^3 >> 0.97 \text{ in}^3$

Section OK

SHEAR 6-45

- $\phi V_n \geq V_u$ $V_u = 1.1^{k}$ LRFD-F2

$\phi V_n = \phi_v (0.6 F_y) A_w$

A_w = Web area = twd $(.491)(8) = 3.53 \text{ in}^2$

F_y = yield stress 36 ksi.

$\phi V_n = 0.9(0.6(36))(3.53 \text{ in}^2)$

$= 69$ kips $>>> 1.1$

Section OK

RFW 10-05-003/A-5/85
512-5643

CLIENT/SUBJECT Techalloy W.O. NO. 01989-010-

TASK DESCRIPTION Trolley Design TASK NO. 0200

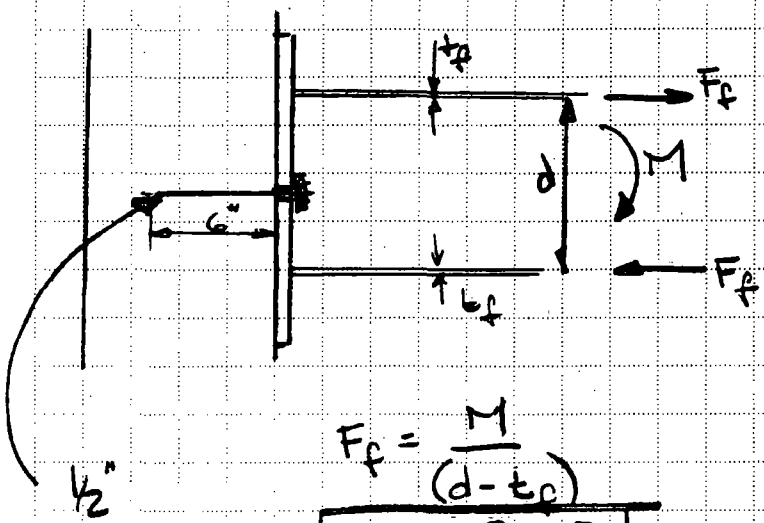
PREPARED BY DAT DEPT 920 DATE 8/27/93

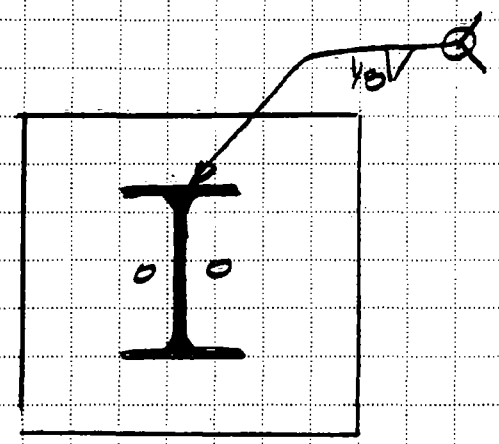
MATH CHECK BY CRW DEPT 920 DATE 27 AUG 93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

2) END PLATE CONNECTION





$$F_f = \frac{M}{(d - t_f)}$$

LRFD 5-143

t_f = tension flange thickness (in)
d = depth of beam (in)
M = factored beam end moment
F_f = nominal flange force

$$F_f = \frac{2.63\text{k-ft} \times (12)\text{in/ft}}{(8 - .426)} = 4.17 \text{ ksi}$$

Nominal area per bolt

$A_b = F_f / 2n\phi F_t$ p. 5-3

$$= \frac{4.17}{2(2)33.0} = 0.03 \text{ in}^2 \text{ req'd}$$

A_b of 1/2" threaded bolt

$$= \frac{\pi(.5)^2}{4} = 0.196 \text{ in}^2$$

$0.196 \text{ in}^2 > 0.03 \text{ in}^2$ OK

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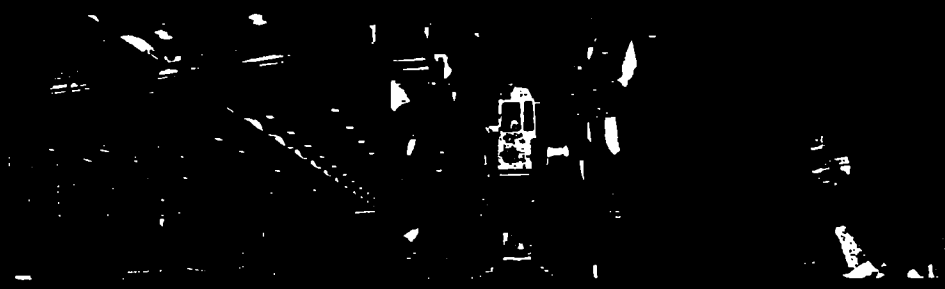
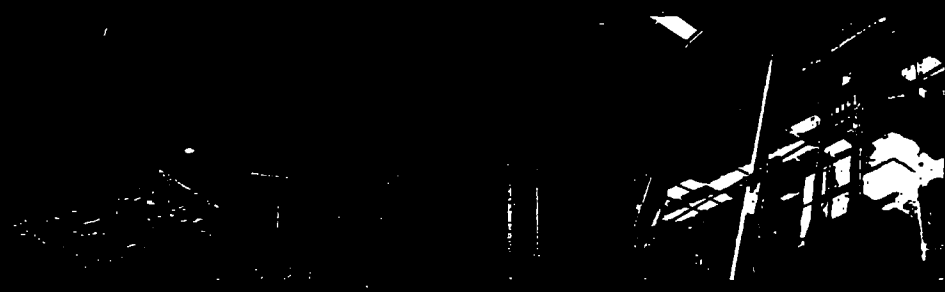


mansaver®
GRABS



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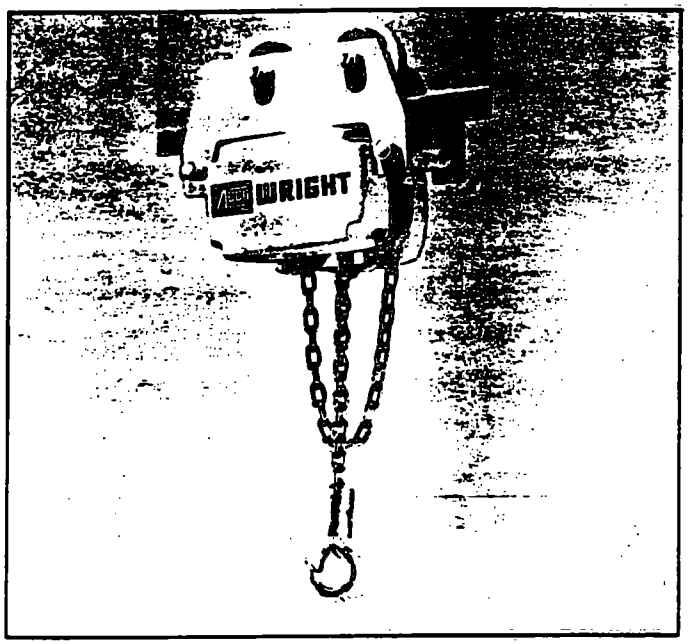
Aluminum Army Type Trolley Hoists

Wright Trolley Hoists—Plain and Geared



The load bar of a *Wright* aluminum army type hoist attaches the frame of a portable hand hoist directly to a trolley. This integral trolley design facilitates low headroom applications on monorails and bridge cranes.

Construction Features

Trolley

Ball bearings support all wheels. Models up to 2 ton capacity use dual tread through hardened cast iron wheels. Models over 2 tons have forged steel wheels with hardened tapered or flat treads.

A short wheel base allows the trolley to operate on curved beams. Steel side plates adjust to fit a wide range of beams and extend past the wheels as bumpers.

Frame

The lightweight, rugged, one piece frame is a cast, ductile, shock resistant, aluminum alloy.

Covers

Easily removed *Lexan* resin covers protect the gearing and brake, but do not support bearings.

Overload Limit Device

Installed at the factory for the capacity of the hoist, this limiting device provides added protection to load, hoist and operator.

Gear Train

Alloy steel heat-treated planetary spur gears, with shock resistant ductile cores, operate in a lubricated grease-tight chamber. Mounted on heavy duty permanently lubricated bearings, gears and pinions meet AGMA standards.

Load Brake

Weston type multiple disc brake controls load smoothly with no wear adjustment, holding full capacity loads in any position.

Load Sheave

The nodular iron load sheave is reversible for double life, since it is spline fitted to an alloy load shaft supported by prelubricated bearings. A one piece steel guide minimizes chain jams between the sheave and housing.

Load Chain

The zinc-plated, heat-treated alloy load chain is precisely calibrated to seat in the deep sheave pockets.

Hook

The hook is drop forged, heat treated, ductile, alloy steel, and equipped with spring latches. The hook is supported on a lifetime prelubricated thrust bearing which permits the hook to rotate 360° under capacity load.

Handwheel and Chain

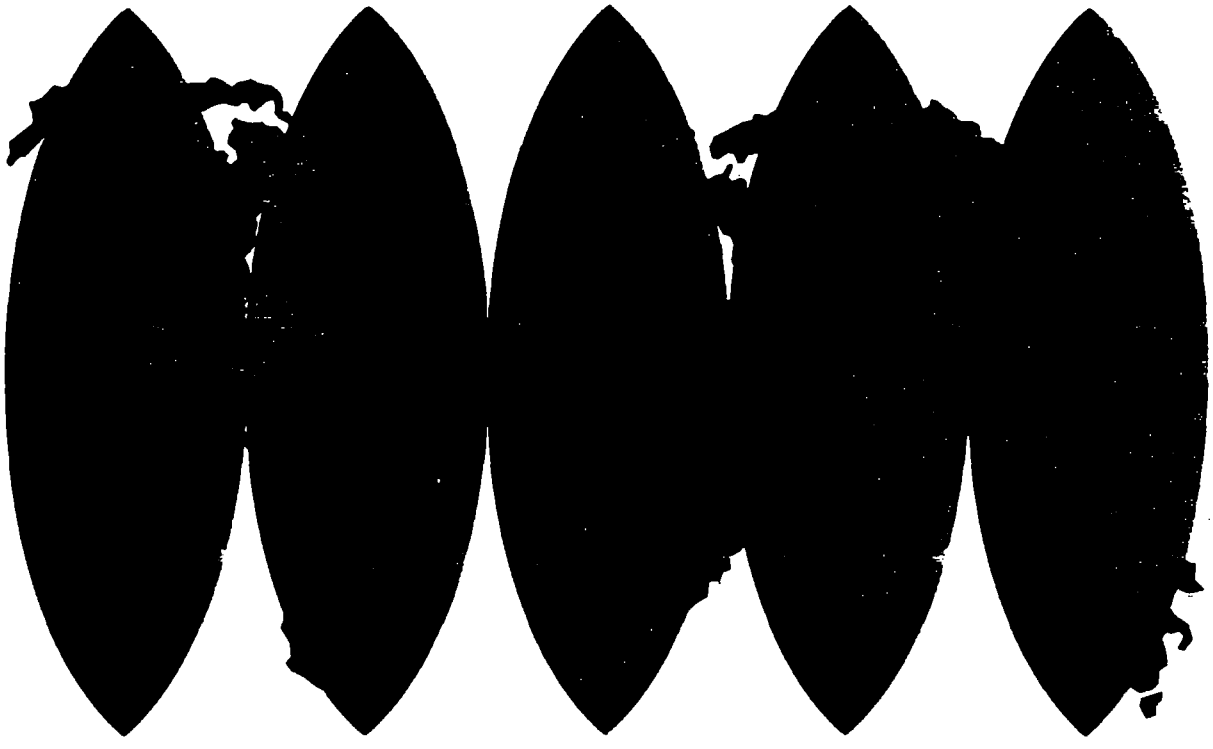
The pockets of the cast aluminum alloy handwheel precisely fit the zinc-plated, welded coil chain. The resilient *Lexan* cover protects the wheel and provides non-fouling chain guides.

Specifications

Capacity (tons)	Standard Lift[a] (ft.)	Type of Trolley[a]	Product Number	Pull to Travel (lbs.)	Minimum Radius Curve[e] (in.)	Chain Overhaul to lift load one foot (ft.)	Parts of Load Chain	Beam Range Flange Width[e] (in.) Minimum	Beam Range Flange Width[e] (in.) Maximum	Net Weight (lbs.)
½	8	Plain	1510050	15	60	46	1	3	5	84
		Geared	1510090	5[d]	60	46	1	3	5	99
1	8	Plain	1510060	30	60	46	1	3	5	86
		Geared	1510100	10[d]	60	46	1	3	5	101
2	8	Plain	1510080	60	66	53	1	3¼	5½	136
		Geared	1510120	20[d]	66	53	1	3¼	5½	157
3	8	Plain	1510130	90	96	106	2	4	6¼	236
		Geared	1510170	17[d]	96	106	2	4	6¼	273
4	8	Plain	1510140	120	96	106	2	4	6¼	236
		Geared	1510180	23[d]	96	106	2	4	6¼	273
5	8	Plain	1510150	150	96	159	3	4⅝	7	314
		Geared	1510190	28[d]	96	159	3	4⅝	7	350
6	8	Plain	1510160	180	96	159	3	4⅝	7	314
		Geared	1510200	35[d]	96	159	3	4⅝	7	350

[a] All references to beam flange width are for clearances only and do not imply that lower flange of the beam will support the hoist with load.
[b] Level of hand chain drop is 24" above lower limit hook.
[c] Up to 2 tons wheels are dual tread design. Over 2 tons wheels operate on either standard or wide flange beams (specify type beam).
[d] Amount of hand chain pull for geared trolley to travel. The hand chain overhaul per foot of travel is 3½ ft. for up to 2 ton capacities and 5 ft. for 3 to 6 tons.
[e] ½ through 4 tons minimum radius is based on 4" flange width and 5 and 6 tons is based on 4⅝" flange width. Flanges of larger width will increase minimum radius. Contact factory.

Moving A World of Materials



There is a Thern dealer near you.

For the name of a Thern dealer or distributor near you, call the factory toll free, 1-800-THERN-IT (800-843-7648).

Important!

It is the owner's or operator's responsibility to determine the suitability of the equipment to its intended use. Study all applicable codes, manuals, and regulations. Be sure to read the Owner's Manual supplied with the equipment before operating it.

Thern products are not for lifting people, or things over people.

Thern Inc
5712 Industrial Park Road • Winona, MN 55987
1-800-THERN-IT • FAX 507-454-5282

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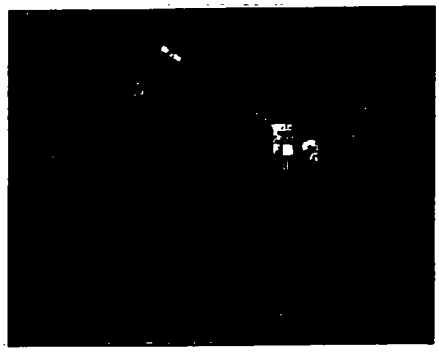
Therm Davit Cranes



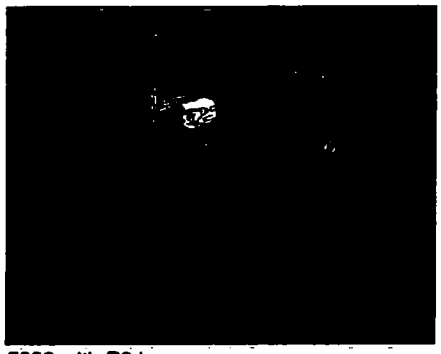
5121B

Econo Crane Series

Models 5121B • 5131B

Built for small jobs, these lightweight, portable cranes provide reliable service at an economical price. The 5121B can be shipped UPS.

- OPERATION – loads are lifted with an M4021B hand winch, mounted for left or right hand operation; winch includes a disc brake for load control.
- BASE – two types of bases available:
  - Model 511 (for 5121B) – mounts upright to dock floor, or can be recessed in a truck bed.
  - Model 514 (for 5131B) – four-point support for stability, with steel wheels in front, caster wheels in back for maneuverability.
- ROTATION – Model 5121B rotates 360° for horizontal load movement.
- BOOM – boom angle adjusts to 2 positions for operation; folds for storage or transport.
- OPTIONS – additional bases available separately; optional cable assemblies available.



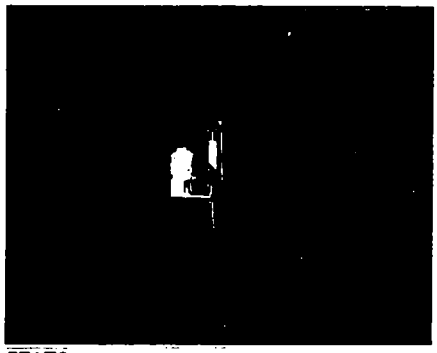
5332 with P2 base

Portacrane Series

Models 5332 • 5332E1 • 5332E2

Designed to be moved from base to base to serve more than one job site.

- OPERATION – loads are lifted with a winch attached to the boom.
  - Model 5332 – M4311B hand winch, with a disc brake for load control.
  - Model 5332E1 – 12 volt DC electric winch, with push button control.
  - Model 5332E2 – 115 volt AC electric winch, with push button control.
- BASE – two types of bases available:
  - Model T2 – Truck Base, for recessed installation in floors or truck beds.
  - Model P2 – Pedestal Base, for upright mounting direct to dock floor.
- ROTATION – boom rotates 270°, for horizontal load movement.
- BOOM – boom angle adjusts 45°; boom telescopes to 3 lengths for optimum positioning over the load.
- OPTIONS – additional bases available separately; optional cable assemblies available.



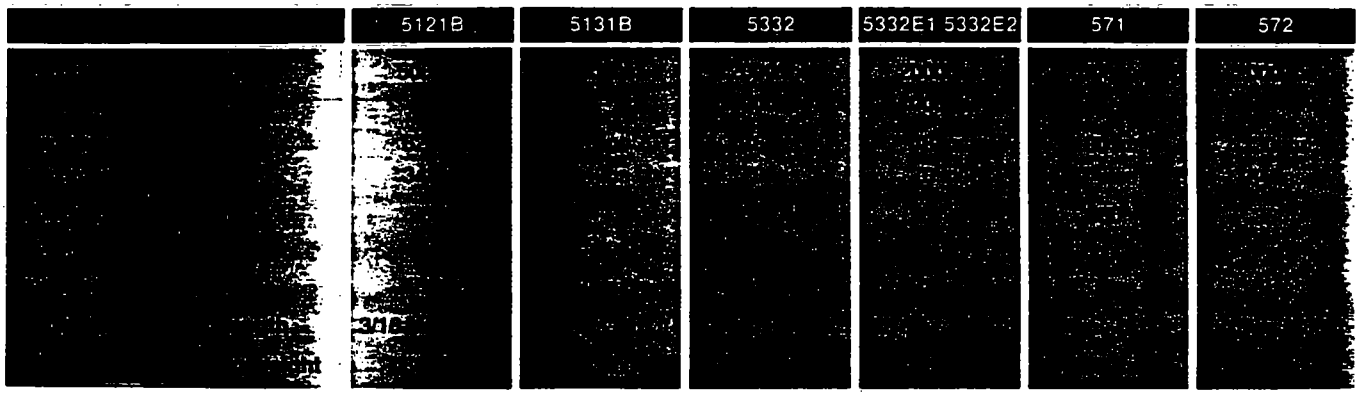
571E3

Fre Rol Crane Series

Series 571 • 572

Fre Rol cranes are designed to provide smooth, controlled movement of loads.

- OPERATION – loads are lifted with a winch attached to the mast.
  - Models 571/572 – M4311B hand winch, with a disc brake for load control.
  - Model 571E1 – 473A3/4B electric winch, for indoor use.
  - Model 571E2 – 473A3/4BW electric winch, for outdoor use.
  - Model 572E1 – 483A1B electric winch, for indoor use.
  - Model 572E2 – 483A1BW electric winch, for outdoor use.
  - Models 571E3/572E3 – 4771 Dura-Hoist, with 6 foot pendant control.
- BASE – heavy-duty gusseted steel, designed for permanent installation.
- ROTATION – boom and mast rotate 360° on tapered roller bearings for smooth horizontal load movement; mast locks in one of four positions.
- OPTIONS – optional cable assemblies available.



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MANAGERS DESIGNERS/CONSULTANTS

CLIENT/SUBJECT Techalloy W.O. NO. 01989-010-002

TASK DESCRIPTION Air Stripper Foundation Design TASK NO. 0200

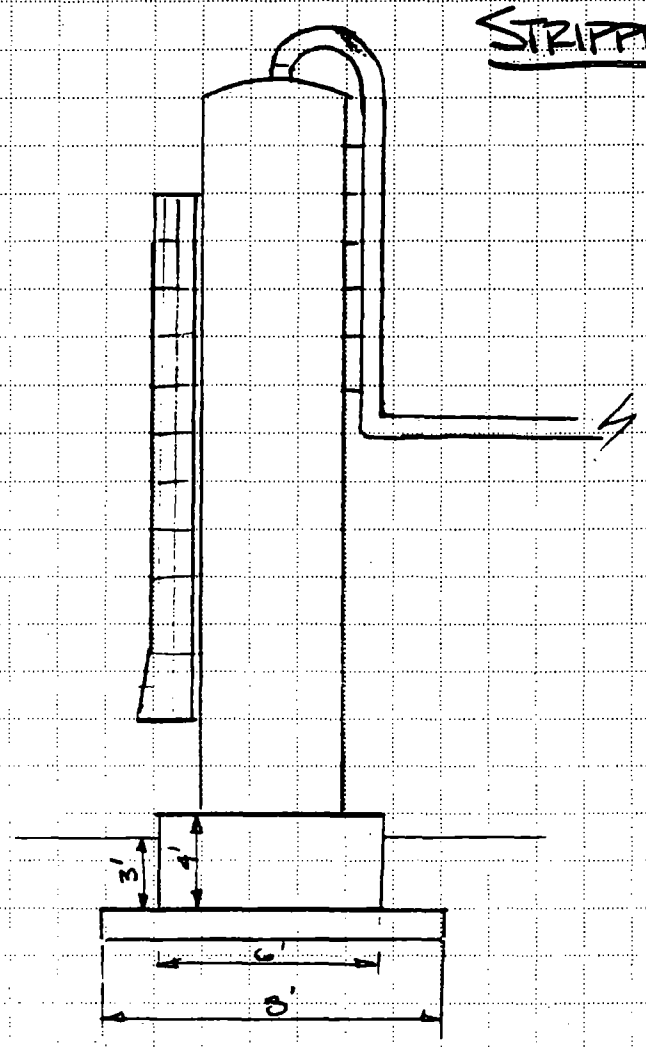
PREPARED BY DMT DEPT 920 DATE 8/26/93

MATH CHECK BY CDW DEPT 920 DATE 27 AUG 93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

Stripper Foundation Design



Design Conditions:

Size: 4'-0" Dia.
" 30'-0" Height

Weight: 6000# operating
24,000# worst case flooded

Assumptions:

- No lateral support provided
- Use Octagon pedestal/Footing Foundation
- Bearing Pressure gross 2500 psf.
- Wind Load Applied to Entire Height of Stripper
- Since conservative wind load are used seismic loading was not analyzed (By Inspection)

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CLIENT/SUBJECT Technalloy W.O. NO. 01989-010-00

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METHOD REV. BY MAD DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pack DEPT 0920 DATE 8/27/93

Pedestal Sizing - 1st Trial/revise if necessary following calcs.

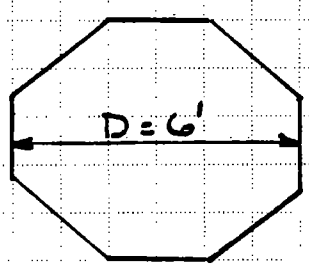
a) Since Tank ≥ 4'ϕ. Use Octagon shape

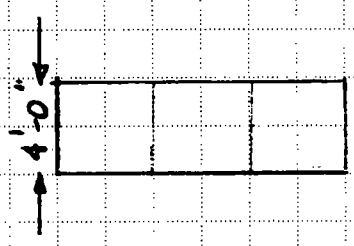
b) Assume Bolt Circle 10" larger than Tank ϕ

c) PROVIDE EXTRA 12"

SIZE = 4'-0" + 10" + 12" = 5'-10"

Use 6'-0"





d) USE DEPTH OF 4'-0" (To accomodate Anchor bolts and keep B.O. Ftg below frost line)

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APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

Footing Sizing - 1st Trial revise if necessary following calcs.

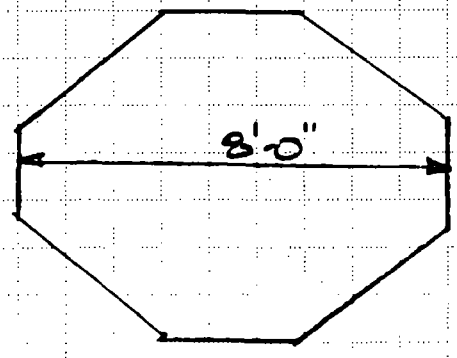
USE FORMULA:

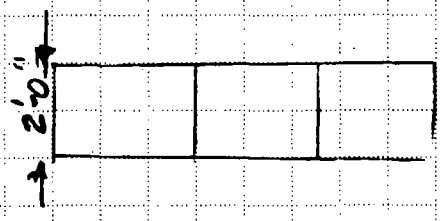
$$\text{DIA.} = 2.6 \times \sqrt[3]{\frac{M}{SB}}$$

$$= 2.6 \times \sqrt[3]{\frac{55.44}{2.5}}$$

DIA ≈ 7.3 use 8'-0"

Assume Depth of 2'-0"





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SHEET 4 of 17

CLIENT/SUBJECT Techalloy W.O. NO. 01989-010

TASK DESCRIPTION AIR STRIPPER FOUNDATION DESIGN TASK NO. 0200

PREPARED BY DAM DEPT 920 DATE 8/26/93

MATH CHECK BY CRW DEPT 920 DATE 27 AUG 93

METHOD REV. BY MAD DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

1) Determine Wind Load

UBC Sec 2311 (formula and tables attached)

- Use Basic Wind Speed = 80mph

1) Design Wind Pressure

$$p = C_e C_g q_s I$$

C_e = Exposure = 1.3 (assumed)

C_g = 4. Solid Tank Round = 0.8 [use 1.0 because of ladder + misc. piping] Conservative

q_s = 17psf.

I = 1.0

$$p = 1.3(1.0)17(1.0) = 22. \text{ psf.}$$

$$\underline{\underline{p = 22 \text{ psf}}}$$

RFW 10-05-003/A-5/85
512-5643

CLIENT/SUBJECT Techalloy W.O. NO. 01989-010-002

TASK DESCRIPTION AIR STRIPPER FOUNDATION DESIGN TASK NO. 0200

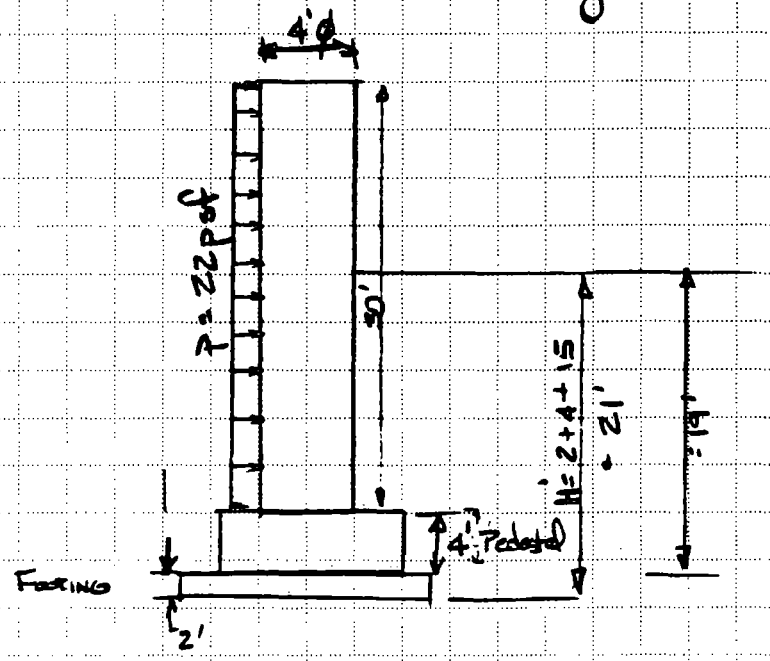
PREPARED BY DAM DEPT 920 DATE 8/26/93

MATH CHECK BY CAW DEPT 920 DATE 27 AUG 93

METHOD REV. BY MSD DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

2) Determine Overturning Moments @ Footing + Pedestal



OTM @ FOOTING

AREA =	WIND PRESS	LOAD	H	Moment
4' x 30'	0.022 ksf	2.64k	21'	55.44k

OTM @ PEDESTAL

AREA	WIND PRESS.	LOAD	H	Moment
4' x 30'	0.022 ksf	2.64k	19'	50.16k

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SHEET 6 of 17

CLIENT/SUBJECT Techalloy W.O. NO. 01989-010-002

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PREPARED BY DAM DEPT 920 DATE 8/26/93

MATH CHECK BY CDW DEPT 920 DATE 27 AUG 93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

2a) DETERMINE FOUNDATION + STRIPPER LOADS

a) PEDESTAL WT.

Area of pedestal × Ht. of Pedestal × 150#/cf (u.w. of Concrete)

$= 0.828(6)^2 \times 4' \times 150^{\#}/cf$

Ped. wt. = 17.9^k

b) FOOTING WT (including 1' of soil above footing)

Area of footing × Ht. of footing × 150#/cf

+ 1' soil × u.w. soil × (Area of footing - Area of pedestal)

$(0.828(8)^2 \times 2' \times 150^{\#}/cf) + 1' \times 100pcf \times (53.1 - 29.1)$
(53.1)

Ftg wt. = 18.2^k

c) Total wt. of Foundation = $17.9^k + 18.2^k = 36.1^k$

d) Weights used for Design

a. Worst Case - Operating (overfilled) + Found. wt.

$= 24^k + 36.1^k = 60.1^k$

b. Normal Case - Operating + Found wt.

$= 6^k + 36.1^k = 42.1^k$

RFW 10-05-003/A-5/85
512-5643

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CLIENT/SUBJECT Techalloy W.O. NO.

TASK DESCRIPTION Air Stripper Foundation Design TASK NO.

PREPARED BY DAM DEPT 920 DATE 8/26/93

MATH CHECK BY CRW DEPT 920 DATE 27 Aug 93

METHOD REV. BY MDS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

3) Determine Soil Bearing Pressures + Stability Ratios

- 2 cases - a) Normal Operation + Wind

b) Worst Case Operation + Wind

	Case a	Case b
P	60.1^k	42.1^k
M	55.4^k-ft	55.4 k-ft
e = M/P	0.92'	1.32'
Stability Ratio (D/2e)	4.35 > 2.0 ok	3.03 > 2.0 ok
Soil Bearing is L/D < 0.123?	yes (entire footing in compression use equations provided)	no (entire footing not in compression use charts provided
Soil Bearing Diagonal	$P/A\left(1 \pm \frac{8.19e}{D}\right)$ = 2.2 ksf < 2.5 ok	SB = LP/A (L from charts) = 1.9 ksf < 2.5
Soil Bearing Flat	$P/A\left(1 \pm \frac{7.57(e)}{D}\right)$ = 2.1 ksf < 2.5 ok	SB = LP/A = 1.8 ksf < 2.5

CLIENT/SUBJECT Techalloy W.O. NO. 01989-010-002

TASK DESCRIPTION Air Stripper Foundation Design TASK NO. 0200

PREPARED BY DAM DEPT 920 DATE 8/26/93

MATH CHECK BY CAW DEPT 920 DATE 27 Aug 93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

4) PEDESTAL REINFORCING

Compute max. tension @ pedestal perimeter due to OTM

$$F_u = 1.3 \times \frac{4M}{N \times BC} - 0.9\left(\frac{W}{N}\right)$$

M - OTM @ Base of pedestal

N = # of bars assumed (use 16)

BC - Bolt circle ϕ = say 5'-0"

W - Empty weight of vessel + pedestal

$$= 1.3\left(\frac{4(55.4^{k\cdot ft})}{16(5')}\right) - 0.9\left(\frac{6^k}{16}\right)$$

$$= 3.6 - 0.34$$

$$= 3.26^k$$

$$\text{Area Reqd} = \frac{3.26^k}{0.9(60\text{ ksi})} = \underline{0.06\text{ in}^2}$$

Conservatively use:

32 - #4 vertical with #4 ties @ 12" max.

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CLIENT/SUBJECT Techalloy W.O. NO. 01939-010-002

TASK DESCRIPTION Air Stripper Foundation Design TASK NO. 0200

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MATH CHECK BY CMS DEPT 920 DATE 27 AUG 93

METHOD REV. BY MSA DEPT 0920 DATE 8/27/93

APPROVED BY M. Albuspach DEPT 0920 DATE 8/27/93

5) FOOTING REINFORCING

BY INSPECTION: BOTTOM FOOTING REINFORCING SHALL BE #6 @ 12" c/c.

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CLIENT/SUBJECT Techalloy W.O. NO. 01989-010-00

TASK DESCRIPTION Air Stripper Foundation Design TASK NO. 0200

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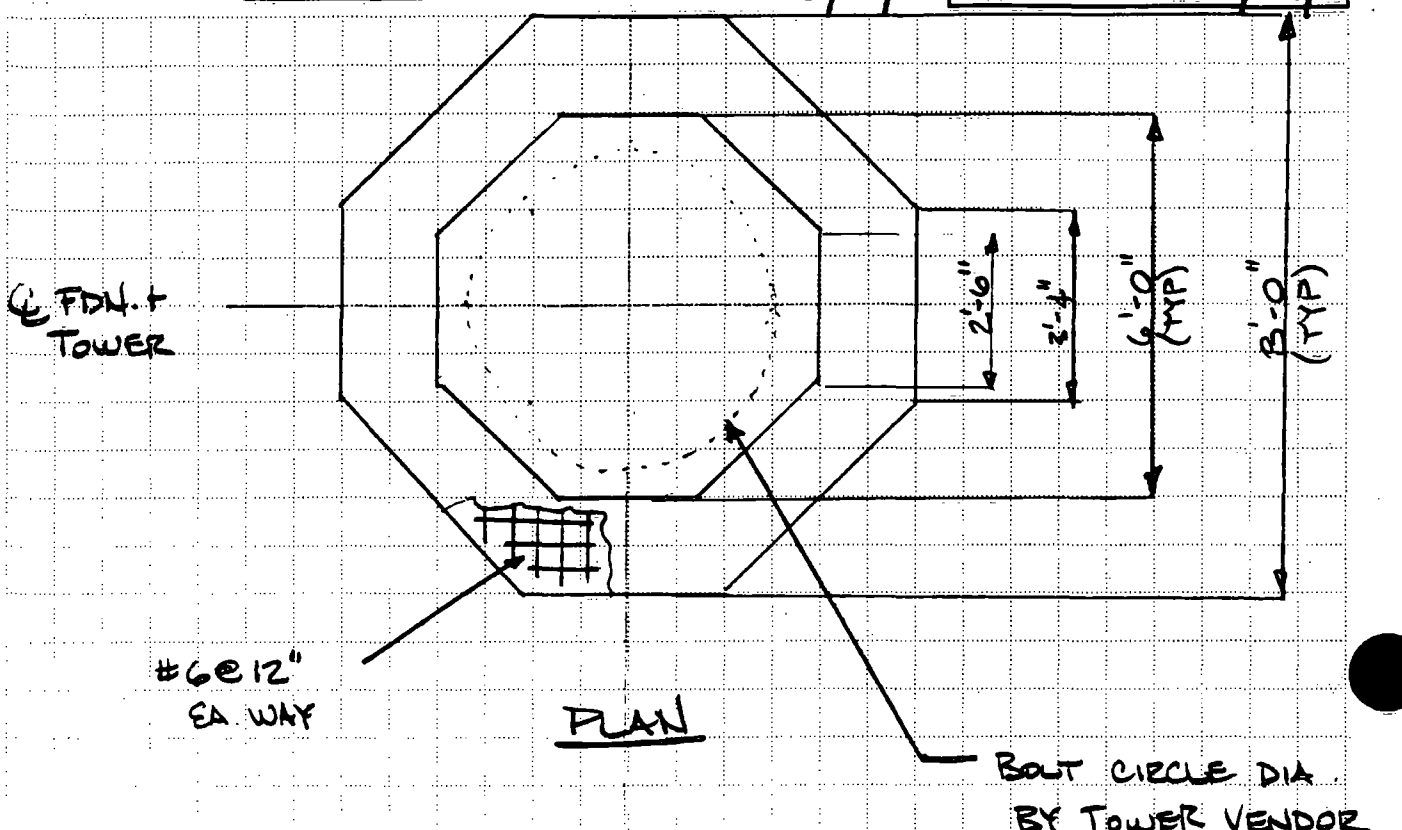
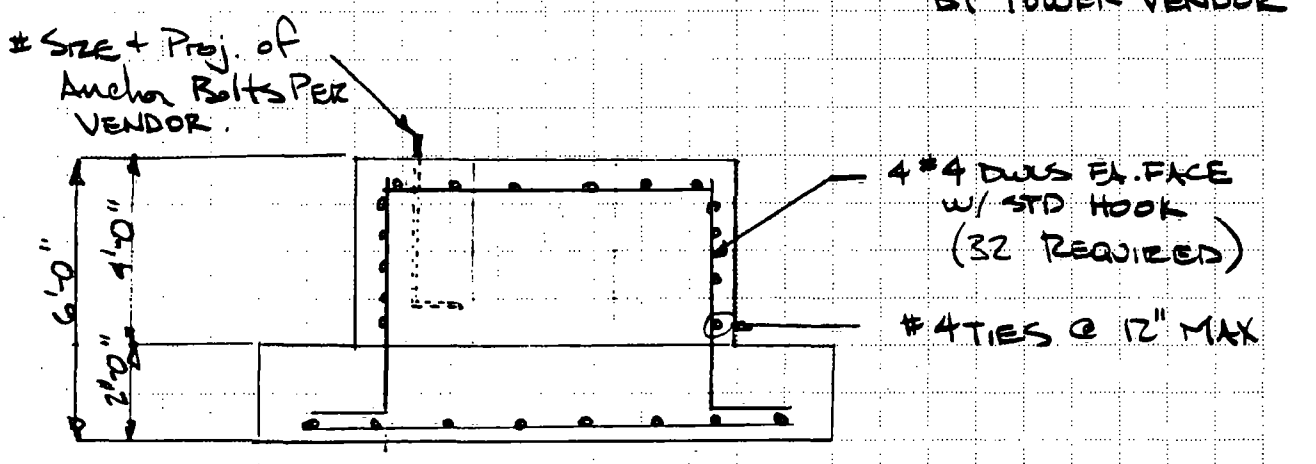


PLAN



SECTION

(c) **Heliport and Helistop Landing Areas.** In addition to other design requirements of this chapter, heliport and helistop landing or touchdown areas shall be designed for the maximum stress induced by the following:

1. Dead load plus actual weight of the helicopter.
2. Dead load plus a single concentrated impact load covering 1 square foot of 0.75 times the fully loaded weight of the helicopter if it is equipped with hydraulic-type shock absorbers, or 1.5 times the fully loaded weight of the helicopter if it is equipped with a rigid or skid-type landing gear.
3. The dead load plus a uniform live load of 100 pounds per square foot. The required live load may be reduced in accordance with the formula in Section 2306.

(d) **Hydrostatic Uplift.** All foundations, slabs and other footings subject to water pressure shall be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure.

Walls and Structural Framing

Sec. 2309. (a) General. Walls and structural framing shall be erected true and plumb in accordance with the design.

(b) **Interior Walls.** Interior walls, permanent partitions and temporary partitions which exceed 6 feet in height shall be designed to resist all loads to which they are subjected but not less than a force of 5 pounds per square foot applied perpendicular to the walls. The deflection of such walls under a load of 5 pounds per square foot shall not exceed 1/240 of the span for walls with brittle finishes and 1/120 of the span for walls with flexible finishes. See Table No. 23-P for earthquake design requirements where such requirements are more restrictive.

> EXCEPTION: Flexible, folding or portable partitions are not required to meet the load and deflection criteria but must be anchored to the supporting structure to meet the provisions of this code.

Anchorage of Concrete or Masonry Walls

Sec. 2310. Concrete or masonry walls shall be anchored to all floors and roofs which provide lateral support for the wall. Such anchorage shall provide a positive direct connection capable of resisting the horizontal forces specified in this chapter or a minimum force of 200 pounds per lineal foot of wall, whichever is greater. Walls shall be designed to resist bending between anchors where the anchor spacing exceeds 4 feet. Required anchors in masonry walls of hollow units or cavity walls shall be embedded in a reinforced grouted structural element of the wall. See Sections 2312 (g), 2312 (h) 2 H and 2312 (h) 2 I.

Wind Design

Sec. 2311. (a) General. Every building or structure and every portion thereof shall be designed and constructed to resist the wind effects determined in accordance with the requirements of this section. Wind shall be assumed to come from

any horizontal direction. No reduction in wind pressure shall be taken for the shielding effect of adjacent structures.

Structures sensitive to dynamic effects, such as buildings with a height-width ratio greater than five, structures sensitive to wind-excited oscillations, such as vortex shedding or icing, and buildings over 400 feet in height, shall be, and any structure may be, designed in accordance with approved national standards.

(b) Basic Wind Speed. The minimum basic wind speed for determining design wind pressure shall be taken from Figure No. 1. Where terrain features and local records indicate that 50-year wind speeds at standard height are higher than those shown in Figure No. 1, these higher values shall be the minimum basic wind speeds.

(c) Exposure. An exposure shall be assigned at each site for which a building or structure is to be designed. Exposure C represents the most severe exposure and has terrain which is flat and generally open, extending one-half mile or more from the site in any full quadrant. Exposure B has terrain which has buildings, forest or surface irregularities 20 feet or more in height covering at least 20 percent of the area extending one mile or more from the site.

(d) Design Wind Pressures. Design wind pressures for structures or elements of structures shall be determined for any height in accordance with the following formula:

$$p = C_e C_q q_s I \quad \text{.....(11-1)}$$

WHERE:

p = Design wind pressure.

C_e = Combined height, exposure and gust factor coefficient as given in Table No. 23-G.

C_q = Pressure coefficient for the structure or portion of structure under consideration as given in Table No. 23-H.

q_s = Wind stagnation pressure at the standard height of 30 feet as set forth in Table No. 23-F.

I = Importance factor as set forth in Section 2311 (i).

(e) Primary Frames and Systems. The primary frames or load-resisting system of every structure shall be designed for the pressures calculated using Formula (11-1) and the pressure coefficients, C_q, of either Method 1 or Method 2. In addition, design of the overall structure and its primary load-resisting system shall conform to Section 2303.

The base overturning moment for the entire structure, or for any one of its individual primary lateral resisting elements, shall not exceed two thirds of the dead-load-resisting moment. For an entire structure with a height-to-width ratio of 0.5 or less in the wind direction and a maximum height of 60 feet, the combination of the effects of uplift and overturning may be reduced by one-third. The weight of earth superimposed over footings may be used to calculate the dead-load-resisting moment.

1. **Method 1 (Normal Force Method).** Method 1 shall be used for the design of gabled rigid frames and may be used for any structure. In the Normal Force Method, the wind pressures shall be assumed to act simultaneously normal to all exterior surfaces. For pressures on roofs and leeward walls, C_e shall be evaluated at the mean roof height.

2. **Method 2 (Projected Area Method).** Method 2 may be used for any structure less than 200 feet in height except those using gabled rigid frames. This method may be used in stability determinations for any structure less than 200 feet high. In the Projected Area Method, horizontal pressures shall be assumed to act upon the full vertical projected area of the structure, and the vertical pressures shall be assumed to act simultaneously upon the full horizontal projected area.

(f) Elements and Components of Structures. Design wind pressures for each element or component of a structure shall be determined from Formula (11-1) and C_q values from Table No. 23-H, and shall be applied perpendicular to the surface. For outward acting forces the value of C_e shall be obtained from Table No. 23-G based on the mean roof height and applied for the entire height of the structure. Each element or component shall be designed for the more severe of the following loadings:

1. The pressures determined using C_q values for elements and components acting over the entire tributary area of the element.

2. The pressures determined using C_q values for local areas at discontinuities such as corners, ridges and eaves. These local pressures shall be applied over a distance from a discontinuity of 10 feet or 0.1 times the least width of the structure, whichever is less.

The wind pressures from Subsections (e) and (f) need not be combined.

(g) Open-frame Towers. Radio towers and other towers of trussed construction shall be designed and constructed to withstand wind pressures specified in this section, multiplied by the shape factors set forth in Table No. 23-H.

(h) Miscellaneous Structures. Greenhouses, lath houses, agricultural buildings or fences 12 feet or less in height shall be designed in accordance with Section 2311. However, three fourths of q_z, but not less than 10 pounds per square foot, may be substituted for q_z in Formula (11-1). Pressures on local areas at discontinuities need not be considered.

(i) Importance Factor. A factor of 1.15 shall be used for essential facilities which must be safe and usable for emergency purposes after a windstorm in order to preserve the health and safety of the general public. Such facilities shall include:

1. Hospitals and other medical facilities having surgery or emergency treatment areas.
2. Fire and police stations.
3. Municipal government disaster operation and communication centers deemed to be vital in emergencies.
4. Buildings where the primary occupancy is for assembly use for more than 300 people.

A factor of 1.0 shall be used for all other buildings.

TABLE NO. 23-D—MAXIMUM ALLOWABLE DEFLECTION FOR STRUCTURAL MEMBERS[1]

TYPE OF MEMBER	MEMBER LOADED WITH LIVE LOAD ONLY (L.L.)	MEMBER LOADED WITH LIVE LOAD PLUS DEAD LOAD (L.L. + K.D.L.)
Roof Member Supporting Plaster or Floor Member	$L/360$	$L/240$

[1]Sufficient slope or camber shall be povided for flat roofs in accordance with Section 2305 (f).

L.L. = Live load

D.L. = Dead load

K = Factor as determined by Table No. 23-E

L = Length of member in same units as deflection

TABLE NO. 23-E—VALUE OF "K"

WOOD		REINFORCED CONCRETE[2]	STEEL
Unseasoned	Seasoned[1]		
1.0	0.5	$[2 - 1.2\,(A'_s/A_s)] \geq 0.6$	0

[1]Seasoned lumber is lumber having a moisture content of less than 16 percent at time of installation and used under dry conditions of use such as in covered structures.

[2]See also Section 2609.

A'_s = Area of compression reinforcement.

A_s = Area of nonprestressed tension reinforcement.

TABLE NO. 23-F—WIND STAGNATION PRESSURE (q_s) AT STANDARD HEIGHT OF 30 FEET

Basic wind speed (mph)[1]	70	80	90	100	110	120	130
Pressure q_s (psf)	13	17	21	26	31	37	44

[1]Wind speed from Section 2311 (b).

TABLE NO. 23-G—COMBINED HEIGHT, EXPOSURE AND GUST FACTOR COEFFICIENT (C_e)

HEIGHT ABOVE AVERAGE LEVEL OF ADJOINING GROUND, IN FEET	EXPOSURE C	EXPOSURE B
0- 20	1.2	0.7
20- 40	1.3	0.8
40- 60	1.5	1.0
60-100	1.6	1.1
100-150	1.8	1.3
150-200	1.9	1.4
200-300	2.1	1.6
300-400	2.2	1.8

TABLE NO. 23-H—PRESSURE COEFFICIENTS (C_p)

STRUCTURE OR PART THEREOF	DESCRIPTION	C_p FACTOR
1. Primary frames and systems	Method 1 (Normal force method)	
	Walls:	
	Windward wall	0.8 inward
	Leeward wall	0.5 outward
	Roofs[1]:	
	Wind perpendicular to ridge	
	Leeward roof or flat roof	0.7 outward
	Windward roof	
	less than 2:12	0.7 outward
	Slope 2:12 to less than 9:12	0.9 outward or 0.3 inward
	Slope 9:12 to 12:12	0.4 inward
	Slope > 12:12	0.7 inward
	Wind parallel to ridge and flat roofs	0.7 outward
	Method 2 (Projected area method)	
	On vertical projected area	
	Structures 40 feet or less in height	1.3 horizontal any direction
	Structures over 40 feet in height	1.4 horizontal any direction
	On horizontal projected area[1]	0.7 upward
2. Elements and components	Wall elements	
	All structures	1.2 inward
	Enclosed structures	1.1 outward
	Open structures	1.6 outward
	Parapets	1.3 inward or outward
	Roof elements	
	Enclosed structures	
	Slope<9:12	1.1 outward
	Slope 9:12 to 12:12	1.1 outward or 0.8 inward
	Slope>12:12	1.1 outward or inward
	Open structures	
	Slope<9:12	1.6 outward
	Slope 9:12 to 12:12	1.6 outward or 0.8 inward
	Slope>12:12	1.6 outward or 1.1 inward

(Continued)

STRUCTURE OR PART THEREOF	DESCRIPTION	C_e FACTOR
3. Local areas at discontinuities[2]	Wall corners	2.0 outward
	Canopies or overhangs at eaves or rakes	2.8 upward
	Roof ridges at ends of buildings or eaves and roof edges at building corners	3.0 upward
	Eaves or rakes without overhangs away from building corners and ridges away from ends of building	2.0 upward
	Cladding connections Add 0.5 to outward or upward C_e for appropriate location	
4. Chimneys, tanks and solid towers	Square or rectangular	1.4 any direction
	Hexagonal or octagonal	1.1 any direction
	Round or elliptical	0.8 any direction
5. Open-frame towers[3,4]	Square and rectangular	
	Diagonal	4.0
	Normal	3.6
	Triangular	3.2
6. Tower Accessories (such as ladders, conduit, lights and elevators)	Cylindrical members	
	2 inches or less in diameter	1.0
	Over 2 inches in diameter	0.8
	Flat or angular members	1.3
7. Signs, flagpoles, lightpoles, minor structures[4]		1.4 any direction

[1]For one story or the top story of multistory open structures an additional outward C_e factor of 0.5 shall be used. The most critical combination shall be used for design. For definition of open structure see Section 2311 (j).

[2]Local pressures shall apply over a distance from the discontinuity of 10 feet or 0.1 times the least width of the structure, whichever is smaller.

[3]Wind pressures shall be applied to the total normal projected area of all the elements of one face. The forces shall be assumed to act parallel to wind direction.

[4]Factors for cylindrical elements are two thirds of those for flat or angular elements.

Not used

TABLE NO. 23-I
SEISMIC ZONE FACTOR Z

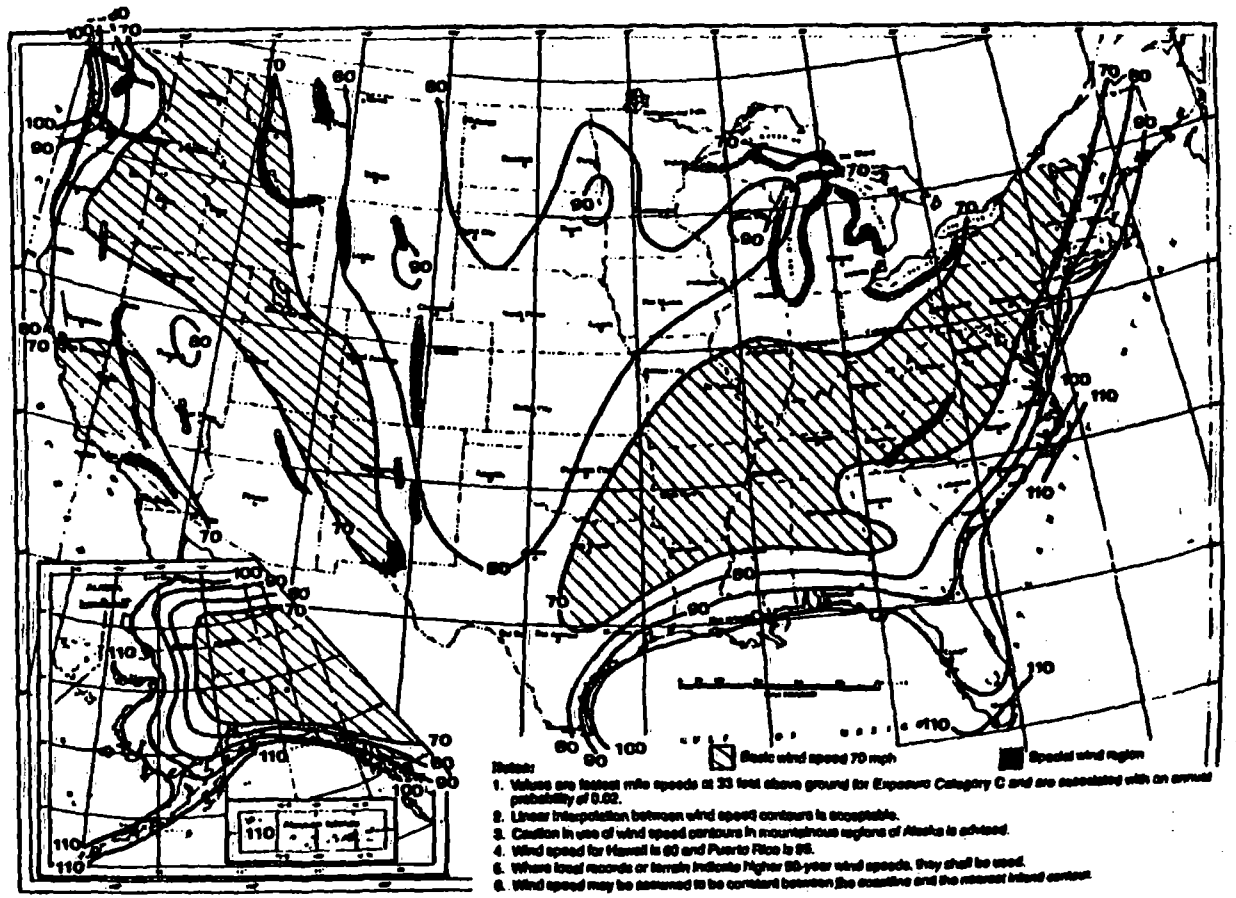
ZONE	1	2A	2B	3	4
Z	0.075	0.15	0.20	0.30	0.40

The zone shall be determined from the seismic zone map in Figure No. 2.

TABLE NO. 23-J
SITE COEFFICIENTS[1]

TYPE	DESCRIPTION	S FACTOR
S_1	A soil profile with either: (a) A rock-like material characterized by a shear-wave velocity greater than 2,500 feet per second or by other suitable means of classification, or (b) Stiff or dense soil condition where the soil depth is less than 200 feet.	1.0
S_2	A soil profile with dense or stiff soil conditions, where the soil depth exceeds 200 feet.	1.2
S_3	A soil profile 40 feet or more in depth and containing more than 20 feet of soft to medium stiff clay but not more than 40 feet of soft clay.	1.5
S_4	A soil profile containing more than 40 feet of soft clay.	2.0

[1]The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type soil profile S_3 shall be used. Soil profile S_4 need not be assumed unless the building official determines that soil profile S_4 may be present at the site, or in the event that soil profile S_4 is established by geotechnical data.



Notes:

1. Values are fastest mile speeds at 33 feet above ground for Exposure Category C and are associated with an annual probability of 0.02.
2. Linear interpolation between wind speed contours is acceptable.
3. Caution in use of wind speed contours in mountainous regions of Alaska is advised.
4. Wind speed for Hawaii is 80 and Puerto Rico is 95.
5. Where local records or terrain indicate higher 50-year wind speeds, they shall be used.
6. Wind speed may be assumed to be constant between the coastline and the nearest inland contour.

FIGURE NO. 1—BASIC WIND SPEEDS IN MILES PER HOUR

WESTON

SHEET 1 of 36

CLIENT/SUBJECT TECHALLOY CO. W.O. NO. 01989-010-002

TASK DESCRIPTION PRELIMINARY DESIGN CALCULATIONS TASK NO. 0200

PREPARED BY CDW DEPT 000920 DATE 23 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/23/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pack DEPT 0920 DATE 8/27/93

DESIGN CONDITIONS

SOIL: ASSUME ALLOWABLE SOIL BEARING (q_{all}) = 2.5 k/ft²

" ANGLE OF INTERNAL FRICTION (ϕ) = 30°

SOIL WT. = 121.3 lb/ft³

ASSUME WATER TABLE IS AT EXISTING GRADE ELEV.

REINFORCING STEEL: f_y = 60,000 lb/in²

CONCRETE: f'_c = 4000 lb/in²

ASSUME UNIT WT. = 150 lb/ft³

BUOYANCY CHECK

DIMENSIONAL ASSUMPTIONS:

SLAB IS 16" THICK — BLDG. IS 28'-0" WIDE

WALLS ARE 12" THICK — " " 32'-0" LONG

FINISHED FLOOR IS 8" THICK

WT. OF STRUCTURE COMPONENTS:

① SLAB = (32')(28')(1.33')(.15 k/ft³) = 179 k

② WALLS = {2[(10')(26')(1')] + 2[(10')(32')(1')]} (.15 k/ft³) = 174 k

③ F. FLOOR = (32')(28')(.67')(.15 k/ft³) = 90 k

WESTON

SHEET 2 of 36

CLIENT/SUBJECT Techalloy Co W.O. NO. 01989-010-02

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

(4) ASSUME FABRICATED BLDG. LOADING IS DISTRIBUTED TO CORNER COLUMNS W/ VALUE OF 3^k, AND TO OTHER WALL COLUMNS W/ VALUE OF 5^k

ASSUME 2 BAYS IN THE BLDG. ⇒ 4 CORNERS & 2 WALL Co

$\Rightarrow 4(3^k) + 2(5^k) = 22^k$

WT. OF EQUIPMENT (EMPTY FOR WORST CASE):

(1) 3 FILTERS @ 320 lb/EA. = $.96^k$

(2) 3 FEED PUMPS @ 500 lb/EA. = 1.5^k

(3) SURGE TANK (EMPTY WEIGHT) = 1.5^k

$PAD = \left(\frac{\pi}{4}\right)(12')^2(1.5')(.15^k/ft^3) = 25^k$

(4) MISC. ITEMS (STAIRS, HANDRAILING, CRANE, ETC.)

ESTIMATE = 10^k

TOTAL WT. OF STRUCTURE & EQUIPMENT = 504^k

BUOYANT FORCE = $(32')(28')(11.33')(.0624^k/ft^3) = 634^k$

F.S. (UPLIFT) = $\frac{504^k}{634^k} = 0.79 < 1.0$ ∴ NO GOOD!!

⇒ ALLOWABLE WATER TABLE FOR F.S. = 1.2

$F_{BUOY} = \frac{504^k}{1.2} = 420^k$

RFW 10-05-003/A-5/85

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 09989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CAN DEPT 920 DATE 27 AUG 93

MATH CHECK BY DMT DEPT 920 DATE 8/27/93

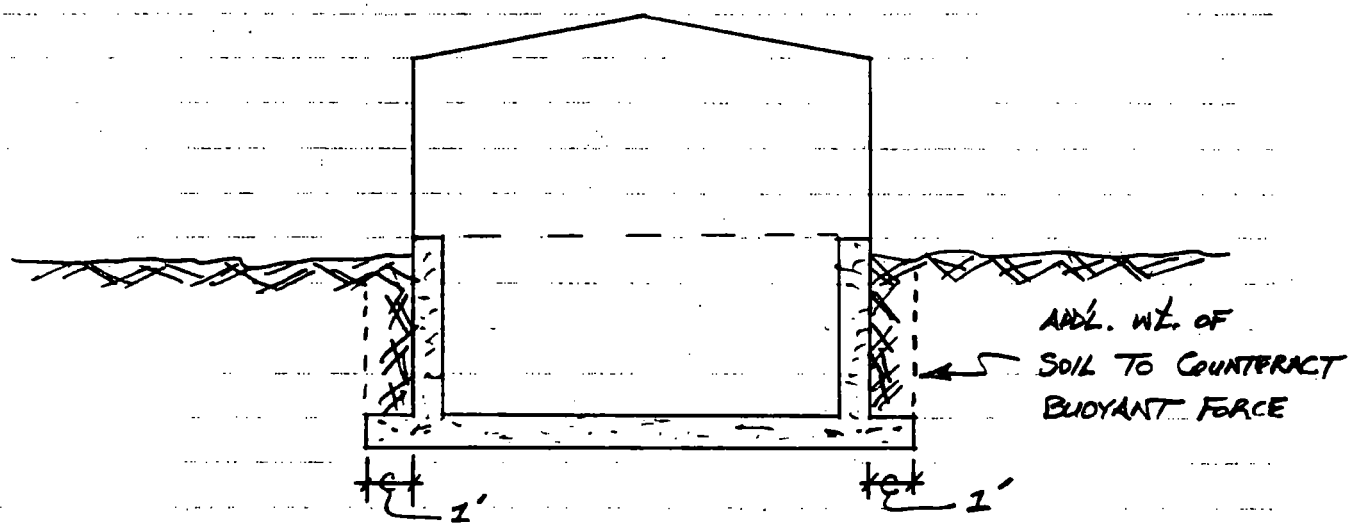
METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

$$h_{max} = \frac{420^k}{(32')(26')(.0624^k/ft^3)} = 7.51'$$

$\Rightarrow$ ALLOWABLE G.W.T. ELEVATION $= 11.33' - 7.51' = 3.82$ ft BELOW GRADE

ASSUME A ONE FOOT WIDE TOE SLAB IS PROVIDED FOR THE STRUCTURE AROUND THE SLAB PERIMETER.



WT. OF SOIL "BLOCK" AROUND PERIMETER OF TOE SLAB:

$$\left\{ 2\left[(10')(32')(1')\right] + 2\left[(10')(26')(1')\right] \right\}(.121\ ^k/ft^3) = 140^k$$

$$F.S.(\text{UPLIFT}) = \frac{504^k + 140^k}{634^k} = 1.02 \leq 1.2 \Rightarrow \text{TRY } 1.5' \text{ WIDE TOE}$$

$$\Rightarrow \left\{ 2\left[(10')(32')(1.5')\right] + 2\left[(10')(26')(1.5')\right] \right\}(.121\ ^k/ft^3) = 211^k$$

$$F.S.(\text{UPLIFT}) = \frac{504^k + 211^k}{634^k} = 1.13 \leq 1.2 \Rightarrow \text{CONTINUE DEVELOPING}$$

F.S. ≥ 1.2

RFW 10-05-003/A-5/85

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MANAGERS DESIGNERS/CONSULTANTS

SHEET 4 of 36

CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-01-0[illegible]2

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CAW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Arch DEPT 0920 DATE 8/27/93

TRY TOE SLAB @ 3' WIDE ⇒

$$\left\{2\left[(10')(32')(3')\right]+2\left[(10')(26')(3')\right]\right\}(.121^{k}/ft^{3}) = 421^{k}$$

$$F.S.(\text{UPLIFT}) = \frac{504^{k}+421^{k}}{634^{k}} = 1.46 \geq 1.2 \Rightarrow \text{TRY } 2.5' \text{ WIDE TOE} \Rightarrow$$

$$\left\{2\left[(10')(32')(2.5')\right]+2\left[(10')(26')(2.5')\right]\right\}(.121^{k}/ft^{3}) = 351^{k}$$

$$F.S.(\text{UPLIFT}) = \frac{504^{k}+351^{k}}{634^{k}} = 1.35 \geq 1.2 \Rightarrow \text{OK!}$$

HOWEVER, THIS WIDTH SEEMS EXCESSIVE AND WILL REQUIRE MUCH ADDITIONAL EXCAVATION TO ALLOW FOR CONSTRUCTION.

A MORE REASONABLE TOE WIDTH OF 1.5' CAN BE PROVIDED EASIER AND CHEAPER WHILE STILL MAINTAINING A F.S. OF 1.0 OR GREATER

JUSTIFICATION FOR USING A F.S. = 1.0 INSTEAD OF 1.2 IS FOUND IN THE VERY CONSERVATIVE APPROACH TAKEN DURING THIS ANALYSIS. ACTUAL CONDITIONS THAT WILL CONTRIBUTE TO THE RESISTANCE OF BUOYANT FORCES BUT WERE NOT INCLUDED IN THE CALCULATIONS INCLUDE ADHESIVE FORCES BETWEEN THE SOIL AND THE WALLS BELOW GRADE, AND THE LOWER PHREATIC SURFACE RESULTING FROM AN UNDERDRAIN SYSTEM INSTALLED DURING CONSTRUCTION OF THE STRUCTURE.

CONCLUSION

A TOE SLAB 1.5' WIDE WILL BE INSTALLED AROUND THE PERIMETER OF THE STRUCTURE TO RESIST BUOYANT FORCES IN THE SOIL.

RFW 10-05-003/A-5/85

WESTON

SHEET 5 of 36

CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

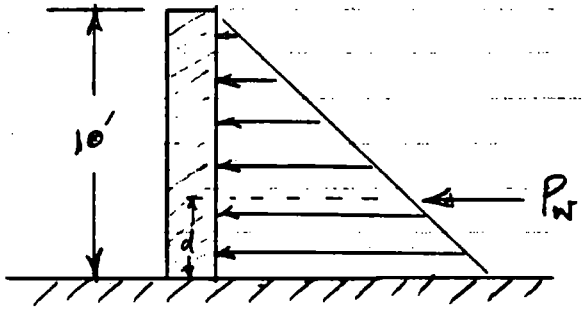
METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

SIDE WALL DESIGN

SIDE WALLS ARE TO BE DESIGNED AS VERTICAL CANTILEVER BEAMS BECAUSE OF THE LARGE LENGTH TO HEIGHT RATIO ($32'/10' = 32 \geq 3:1$).

TEST CASE I – CONTAINMENT STRUCTURE FULL OF WATER (1'-0" WIDE STRIP)



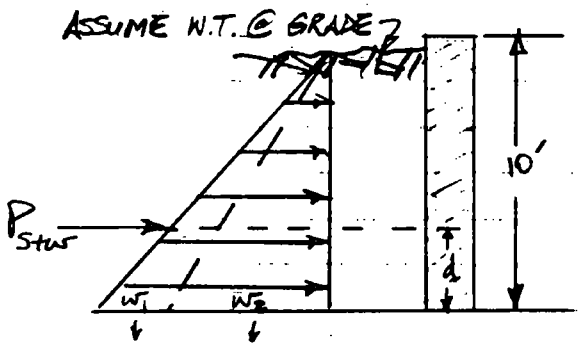
$P_w = \frac{1}{2}\gamma_w h^2$ $\gamma_w = .0624\ ^k/ft^3$

$P_w = (\frac{1}{2})(.0624\ ^k/ft^3)(10ft)^2 = 3.12\ ^k/ft$

$M = P_w d$ $d = (\frac{1}{3})(10') = 3.33'$

$M = (3.12\ ^k/ft)(3.33ft) = 10.4\ ^{ft\text{-}k}/ft$

TEST CASE II – ACTIVE EARTH PRESSURE ON EMPTY STRUCTURE



$K_a = \tan^2(45° - \frac{\phi}{2}) \Rightarrow \tan^2(45° - \frac{30°}{2}) = 0.33$

$w_T = w_1 + w_2 = K_a \gamma_s h + \gamma_w h$

$w_T = (.33)(.1213\ ^k/ft^3)(10ft) + (.0624\ ^k/ft^3)(10ft) = 1.02$

$P_{stw} = \frac{1}{2} w_T h = (\frac{1}{2})(1.02\ ^k/ft^2)(10ft) = 5.12\ ^k/ft$

$M = P_{stw} d \Rightarrow (5.12\ ^k/ft)(3.33ft) = 17.05\ ^{ft\text{-}k}/ft$

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MANAGERS DESIGNERS/CONSULTANTS

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 01939-010-0

TASK DESCRIPTION TASK NO. 0200

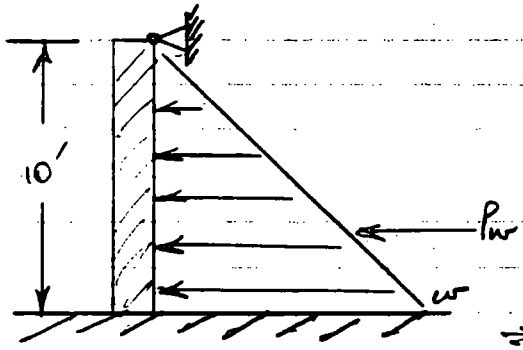
PREPARED BY CAW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAD DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

TEST CASE III – STRUCTURE FULL OF WATER WITH FLOOR OF BLDG. ACTING AS DIAPHRAGM SUPPORT @ TOP OF WALL



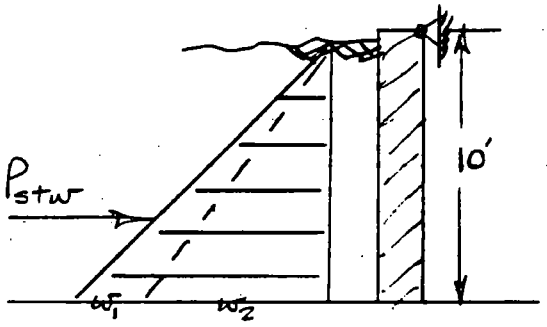
FROM FIXED END MOMENT DIAGRAM,

$$M = \frac{wL^2}{15} \Rightarrow w = \gamma_w h$$

$$\Rightarrow (.0624\ k/ft^3)(10\ ft)(1\ ft\ wide) = .624\ k/ft$$

$$\Rightarrow M = \frac{(.624\ k/ft)(10\ ft)^2}{15} = 4.16\ ft\text{-}k/ft$$

TEST CASE IV – ACTIVE EARTH PRESS. ON EMPTY STRUCTURE WITH TOP OF WALL PINNED AS IN CASE III



$$w_T = w_1 + w_2 = 1.02\ k/ft$$

$$M = \frac{wL^2}{15} = \frac{(1.02\ k/ft)(10\ ft)^2}{15} = 6.8\ ft\text{-}k/ft$$

WESTON

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

CONCLUSION: TEST CASE II CONTROLS REINFORCEMENT DESIGN

WALL REINFORCEMENT DESIGN

FOR STRUCTURES NOT AFFECTED BY WIND OR EARTHQUAKE FORCES, THE FACTORED LOADS ARE COMPUTED FROM $U = 1.4D + 1.7L$ WHERE D AND L ARE THE SPECIFIED DEAD AND LIVE LOADS.

SINCE CASE II CONTROLS, LIVE LOADING IS NOT A FACTOR IN THE DESIGN AND THE FORMULA BECOMES $U = 1.4D$.

THUS, FOR SHEAR FORCES, $V_u = (1.4)(5.12^k/ft) = 7.17^k/ft$

AND FOR BENDING MOMENTS, $M_u = (1.4)(17.05^{ft\text{-}k}/ft) = 23.87^{ft\text{-}k}/ft$

TRIAL DESIGN #1

① ASSUME 12" THICK WALL $\Rightarrow$ $d = \underset{\text{WALL}}{12''} - \underset{\text{COVER}}{2''} - \underset{\text{REBAR}}{.5''} = 9.5''$

② CHECK MIN. SHEAR STRENGTH $\Rightarrow$ $v_u = \frac{V_u}{.85\,bd} \leq 2\sqrt{f_c'}$

$\Rightarrow \frac{7.17^k/ft}{(.85)(12'')(9.5'')} = .074^{ksi}/ft \qquad 2\sqrt{4000\,psi} = .126\ ksi$

$\Rightarrow .074 \leq .126 \Rightarrow$ OK! SHEAR STRENGTH OF CONCRETE

③ DETERMINE FLEXURAL CAPACITY OF SECTION (K_u)

$$F = \frac{M_u}{K_u} = \left(\frac{bd^2}{12{,}000}\right) \Rightarrow \frac{(12'')(9.5'')^2}{12{,}000} = .090$$

WESTON

SHEET 8 of 3[illegible]

CLIENT/SUBJECT Techalloy Co. W.O. NO. 01999-010-[illegible]

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/28/93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pickel DEPT 0920 DATE 8/27/93

$$\Rightarrow K_u = \frac{M_u}{F} = \frac{23.87}{.09} = 264.5$$

$\Rightarrow$ FROM TABLE (FLEXURE 1.2), $a_u = 4.31$

④ DETERMINE AREA OF STEEL REQ'D. FOR M_u

$$\Rightarrow A_s = \frac{M_u}{a_u d} \Rightarrow \frac{23.87}{(4.31)(9.5)} = 0.58 \text{ in}^2/\text{ft WIDTH}$$

⑤ DETERMINE MIN. AREA OF STEEL REQ'D.

$$\Rightarrow A_{s(MIN)} = \frac{200bd}{F_y} = \frac{200(12)(9.5)}{60{,}000} = 0.38 \text{ in}^2/\text{ft}$$

$$\Rightarrow A_{s(REQ)} \geq A_{s(MIN)} \Rightarrow \underline{\underline{OK!}}$$

IN THIS CASE, THE MIN. STEEL IS JUST MORE THAN HALF OF THE REQ. STEEL. THUS, A THICKER WALL CAN BE CONSIDERED FOR ANALYSIS.

TRIAL DESIGN #2

① ASSUME 18" THICK WALL $\Rightarrow d = 15.5''$

② MIN. SHEAR $\Rightarrow \frac{7.17}{(.85)(12)(15.5)} = .045 \text{ ksi/ft} \leq .126 \text{ ksi/ft} \Rightarrow \underline{\underline{OK!}}$

③ FLEX. CAPACITY $\Rightarrow F = \frac{(12)(15.5)^2}{12{,}000} = .24$

$$\Rightarrow K_u = \frac{23.87}{.24} = 99.5 \Rightarrow a_u = 4.45$$

④ $A_{s(REQ)} = \frac{23.87}{(4.45)(15.5)} = .346 \text{ in}^2/\text{ft}$

⑤ $A_{s(MIN)} = \frac{200(12)(15.5)}{60{,}000} = .62 \text{ in}^2/\text{ft} \Rightarrow A_{s(REQ)} < A_{s(MIN)} \Rightarrow$ GOOD

WESTON
MANAGERS DESIGNERS/CONSULTANTS

CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-010-002
TASK DESCRIPTION TASK NO. 0200
PREPARED BY CRW DEPT 920 DATE 27 AUG 93
MATH CHECK BY DAM DEPT 920 DATE 8/27/93
METHOD REV. BY MAA DEPT 0920 DATE 8/27/93
APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

TRIAL DESIGN #3

① ASSUME 15" THICK WALL ⇒ $d = 12.5"$

② MIN. SHEAR ⇒ $\frac{7.17}{(.85)(12)(12.5)} = .056 \leq .126$ ⇒ OK!

③ FLEX. CAPACITY ⇒ $F = \frac{(12)(12.5)^2}{12{,}000} = .156$

⇒ $k_u = \frac{23.87}{.156} = 153$ ⇒ $a_u = 4.39$

④ $As_{(REQ)} = \frac{23.87}{(4.39)(12.5)} = .43 \ in^2/ft$

⑤ $As_{(MIN)} = \frac{200(12)(12.5)}{60{,}000} = .5 \ in^2/ft$

HERE, $As_{(REQ)} < As_{(MIN)}$ WHICH MEANS THAT IF THE 15" THICK WALL IS USED, THE MIN. AMOUNT OF STEEL WHICH IS ACCEPTABLE IS $0.5 \ in^2$ PER ft OF WALL WIDTH.

AS A RULE OF THUMB IN DESIGN, THE MINIMUM HORIZ. & VERT. STEEL = .3% OF THE CROSS SECTIONAL AREA

⇒ $(.003)(12")(15") = .54 \ in^2/2 = .27 \ in^2$ IN EACH FACE OF THE WALL

REVIEWING THE TRIAL RESULTS INDICATES THAT THE 12" THICK WALL WILL PROVIDE SHEAR RESISTANCE AND REQUIRES AN AMOUNT OF STEEL GREATER THAN THE MINIMUM INDICATED

∴ FROM TABLE A-7, USE #5 BARS @ 6" o/c VERTICALLY IN EACH FACE OF THE WALL

WESTON

SHEET 10 of 36

CLIENT/SUBJECT Techalloy Co

W.O. NO. 01989-010-[illegible]2

TASK DESCRIPTION

TASK NO. 0200

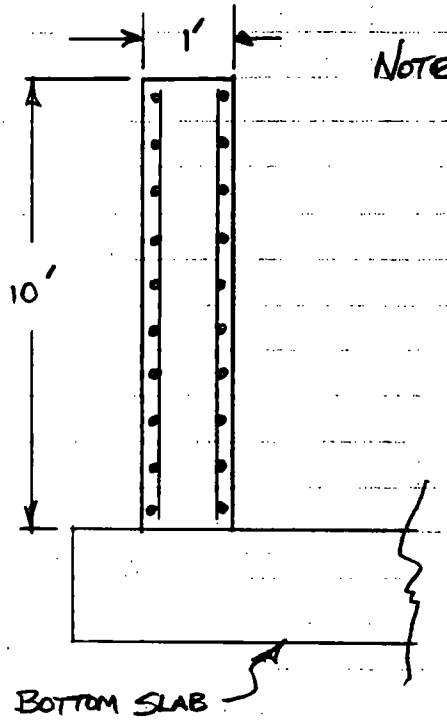
PREPARED BY [illegible] DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAD DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

HORIZONTAL REINFORCEMENT IN WALLS



NOTE: THE VERTICAL REINFORCEMENT SIZE AND SPACING WAS DETERMINED BY USING THE FLEXURAL DESIGN PROVISIONS CONTAINED IN ACI 318-89

GROSS AREA OF WALL SECTION

$\Rightarrow (10\,ft)(1\,ft) = 10\,ft^2$

MIN. RATIO OF HORIZ. REINFORCEMENT TO GROSS AREA = .002

$\Rightarrow$ AREA OF STEEL $= (10\,ft^2)(144\,in^2/ft^2)(.002) = 2.88$

$\Rightarrow$ PER ft OF HT. $= \frac{2.88}{10} = .288\,in^2$

FOR TWO LAYERS, $\frac{.288\,in^2}{2} = .144\,in^2$ PER LAYER

$\Rightarrow$ USE #4 BARS @ 12" o/c HORIZONTALLY IN EACH FACE

WESTON

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CAW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAT DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pack DEPT 0920 DATE 8/27/93

SLAB DESIGN

ASSUMPTIONS:
- SLAB THICKNESS IS 16"
- EDGES OF SLAB ARE FIXED
- SLAB IS CONSIDERED "ONE-WAY" FOR DESIGN PURPOSES
- MOMENTS TRANSFERRED FROM WALL TO SLAB ARE NOT INCLUDED
- UPLIFT FORCE (q_o) = (FULL HYDROSTATIC PRESS.) − (DL SLAB)

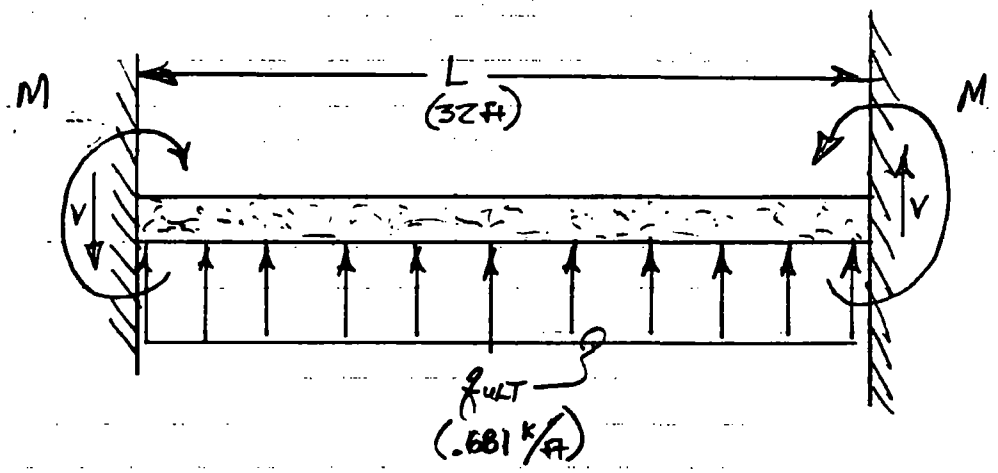
① DETERMINE FACTORED LOADS:

$$\text{SLAB wt.} = \frac{(16\text{ in})(150\text{ lb/ft}^3)(1\text{ ft wide})}{12\text{ in/ft}}(1.4) = .28\text{ k/ft}$$

$$\text{UPLIFT FORCE} = (11\text{ ft})(.0624\text{ k/ft}^3)(1\text{ ft wide})(1.4) = .961\text{ k/ft}$$

$$q_{ULT} = q_o(1.4) \Rightarrow .961\text{ k/ft} - .28\text{ k/ft} = .681\text{ k/ft}$$

② DEVELOP SHEAR & MOMENT DIAGRAMS:



WESTON MANAGERS DESIGNERS/CONSULTANTS

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CLIENT/SUBJECT TECHALLOY W.O. NO. 01999-010-09

TASK DESCRIPTION STRUCT. DESIGN TASK NO. 0200

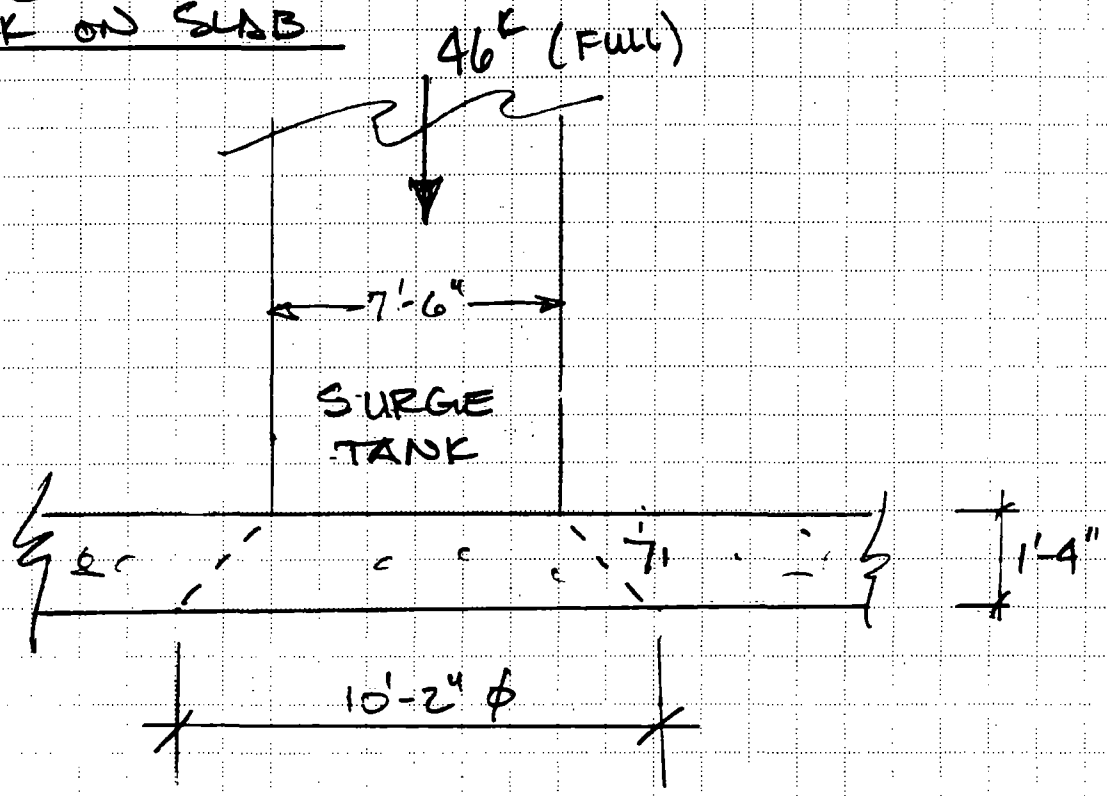
PREPARED BY MAA DEPT 0920 DATE 8-25-93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

SURGE TANK ON SLAB



7'-6
2-8
10'-2'

$A = (5.08')^2 \pi = 81 \text{ ft}^2$

$S.B. = 46^K / 81 \text{ ft}^2 = 0.57^{KSF}$

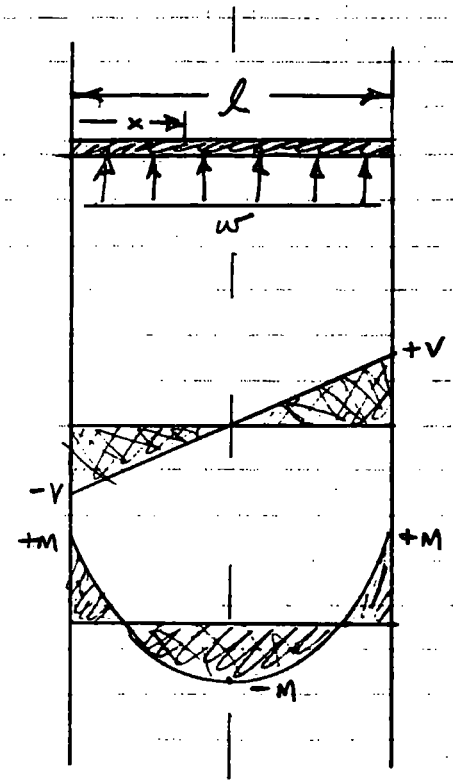
SOIL BEARING OK BY INSP.

CONCR SLAB IS ADEQUATE FOR ADD'L LOADING BENEATH TANK

RFW 10-05-003/A-5/85
512-5643

CLIENT/SUBJECT Techalloy Co. W.O. NO. 01939-010-002
TASK DESCRIPTION TASK NO. 0200
PREPARED BY CSW DEPT 920 DATE 27 AUG 93
MATH CHECK BY DAM DEPT 920 DATE 8/27/93
METHOD REV. BY MAS DEPT 0920 DATE 8/27/93
APPROVED BY M. Allen Spach DEPT 0920 DATE 8/27/93

FOR SIMPLIFICATION, ANALYZE THE BEAM WITH ONLY THE DISTRIBUTED LOAD WITHOUT CONSIDERING THE MOMENT INDUCED BY THE WALLS.



MOMENT DEVELOPED IN THE SLAB WILL BE DISTRIBUTED THROUGH THE SHORTER SPAN LENGTH IN THE DESIGN STRIP

CHECK FOR MAX. SHEAR:

$$V_x = w\left(\frac{l}{2} - x\right) \Rightarrow \left(.681^k/ft\right)\left(\frac{28\,ft}{2} - 0\,ft\right)$$

$$\Rightarrow V_{max} = 19.53^k$$

CHECK FOR MAX. MOMENT:

$$M_{max} = \frac{wl^2}{12} \Rightarrow \frac{(.681^k/ft)(28\,ft)^2}{12} = 44.5^{ft\text{-}k}$$

CHECK FOR MOMENT @ CENTER:

$$M_{CENTER} = \frac{wl^2}{24} \Rightarrow \frac{(.681^k/ft)(28\,ft)^2}{24} = 22.2^{ft\text{-}k}$$

③ CHECK SLAB THICKNESS REQ'D. FOR MOMENT:

$$K_u = \phi f_c' \omega (1 - .59\omega) \Rightarrow \omega = \frac{\rho f_y}{f_c'} \quad \text{WHERE } \rho \le 0.01 \text{ (ASSUMED)}$$

$$\Rightarrow \omega = \frac{(.01)(60{,}000)}{4000} = .15$$

$$\Rightarrow K_u = (.9)(4000)(.15)(1 - (.59)(.15)) = 492.21$$

$$\frac{M_u}{K_u} = \frac{bd^2}{12{,}000} \rightarrow bd^2 = \frac{(12{,}000)(44.5^{ft\text{-}k})}{492.} = 1085\,in^3$$

WESTON

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-212-

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CAW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Spach DEPT 0920 DATE 8/27/93

$\Rightarrow$ DESIGN STRIP IS 1 ft WIDE $\Rightarrow b = 12''$

$\Rightarrow d_{MIN} = \sqrt{\frac{1085}{12}} = 9.51 in$ TO KEEP $\rho \leq 0.01$

$\Rightarrow d_{ASSUMED} = 16'' - \underset{COVER}{3''} = 13.00 in \Rightarrow$ SLAB IS OK FOR FLEXURE

④ CHECK SLAB THICKNESS REQ'D. FOR SHEAR $(\phi V_c \geq V_u)$:

$\Rightarrow \phi V_c = .85(2\sqrt{f_c'}\, b_w d)$

$\Rightarrow (.85)(2)(\sqrt{4000})(12)(13) = 16.8^k \geq 10.02^k \Rightarrow$

SLAB IS OK FOR SHEAR

⑤ DESIGN THE REINFORCEMENT:

$\Rightarrow A_s = \frac{M_u}{a_u d} \Rightarrow a_u = \frac{\phi f_y (1 - .59\omega)}{12{,}000}$

$\Rightarrow \frac{(.9)(60{,}000)(1-(.59)(.15))}{12{,}000} = 4.10$

$\Rightarrow A_s = \frac{44.5}{(4.1)(13)} = 0.83 in^2$

$\Rightarrow$ FROM TABLE A-7, #6 REBAR @ 6" o/c EACH WAY ON BOTTOM MAT WILL SATISFY THE STEEL REQUIREMENT IN A 16" THICK BOTTOM SLAB

RFW 10-05-003/A-5/85

WESTON

SHEET 15 of 36

CLIENT/SUBJECT Technology Co. W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 Aug 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen DEPT 0920 DATE 8/27/93

FOR TOP MAT STEEL, M_{CENTER} CONTROLS →

$$A_s = \frac{22.2}{(4.1)(13)} = .42 \text{ in}^2$$

∴ FROM TABLE A-7, #6 BARS @ 12" O/C EACH WAY ON TOP MAT WILL SATISFY THE STEEL REQUIREMENT IN A 16" THICK BOTTOM SLAB

WESTON
MANAGERS DESIGNERS/CONSULTANTS

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-012-0

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CAW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

FLOOR DESIGN

ASSUMPTIONS: A) SLAB THICKNESS IS 8" ⇒ d = 6"
B) EDGES OF SLAB ARE PINNED
C) SLAB IS ANALYZED AS "ONE WAY"

NOTE: THE SLAB WILL BE CONSIDERED AS SEPARATE FROM THE FLOOR BEAMS TO ALLOW FOR A MORE SIMPLIFIED ANALYSIS AND DESIGN OF THE STRUCTURE.

FOR THE SLAB, TWO AREAS MUST BE CONSIDERED TO DETERMINE THE MOST RESTRICTIVE LOADING CONDITION.

AREA #1 — ONE FOOT STRIP RUNNING NORTH → SOUTH APPROX. 5 ft WEST OF COL. LINE B1-B2-B3.

① DETERMINE FACTORED LOADS:

$$\text{SLAB wt.} = \frac{(8\,in)(150\,lb/ft^3)(1\,ft\ wide)}{12\,in/ft}(1.4) = .14^k/ft \text{ DIST. LOAD}$$

FILTER wt. = (4000 lb OPER. wt.)(1.4) = 5600 lb

ASSUME ONE OF THE PEDESTAL LEGS RESTS ON STRIP ⇒ $\frac{5600}{3} = 1.87^k$

ASSUME AREA OF INFLUENCE = $4\,ft^2$ ⇒ $\frac{1.87^k}{4} = .47^k$ POINT LOAD

FROM TABLE 2, ASSUME LIVE LOAD = 60 psf

⇒ LL = $(.06\,k/ft^2)(1\,ft\ wide)(1.7) = .102\,k/ft$ DIST. LOAD

IT IS ASSUMED THAT THE LOADING EFFECTS RESULTING FROM OPERATION OF THE JIB CRANE AND THE TROLLEY HOIST CAN BE INCLUDED IN THE VALUE PROVIDED BY TABLE 2. SINCE THE LOADS ARE RELATIVELY SMALL IN MAGNITUDE AND ACT ON THE STRUCTURE FOR SHORT DURATIONS OF TIME.

WESTON

MANAGERS DESIGNERS/CONSULTANTS

SHEET 17 of 36

CLIENT/SUBJECT Technalloy Co. W.O. NO. 0939-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY Chris DEPT 920 DATE 27 Aug 93

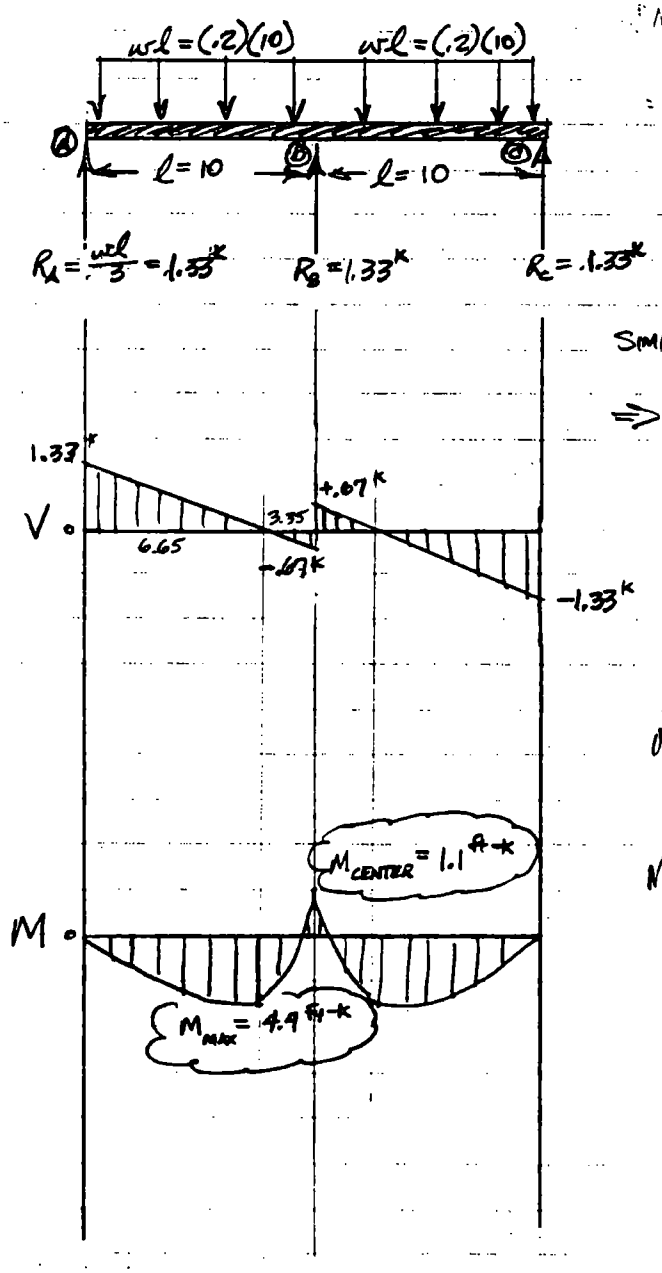
MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Jack DEPT 0920 DATE 8/27/93

② DEVELOP SHEAR & MOMENT DIAGRAMS :

FOR ANALYSIS, ASSUME TWO EQUAL SPANS SIMPLY SUPPORTED WITH ONLY DISTRIBUTED LOAD APPLIED



SIMILAR TRIANGLES : $\frac{1.33}{10-x} = \frac{.67}{x}$

$\Rightarrow 1.985 = \frac{10-x}{x} \Rightarrow x = \frac{10}{2.985} = 3.35$

$M_{MAX} = (\frac{1}{2})(1.33^k)(6.65ft) = 4.4^{ft-k}$

$M_{CENTER} = (\frac{1}{2})(.67^k)(3.35ft) = 1.1^{ft-k}$

WESTON

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CLIENT/SUBJECT Techalloy Co. W.O. NO. 01989-210-2

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CWS DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

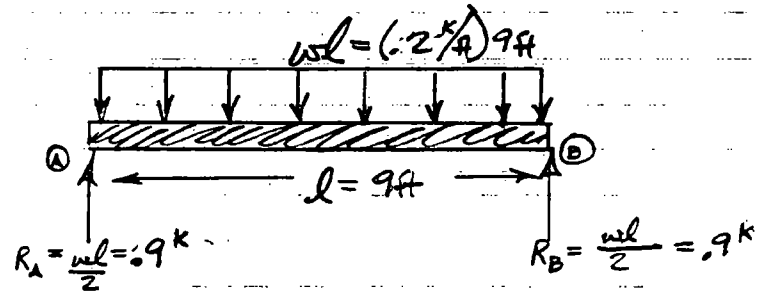
APPROVED BY M. Allen DEPT 0920 DATE 8/27/93

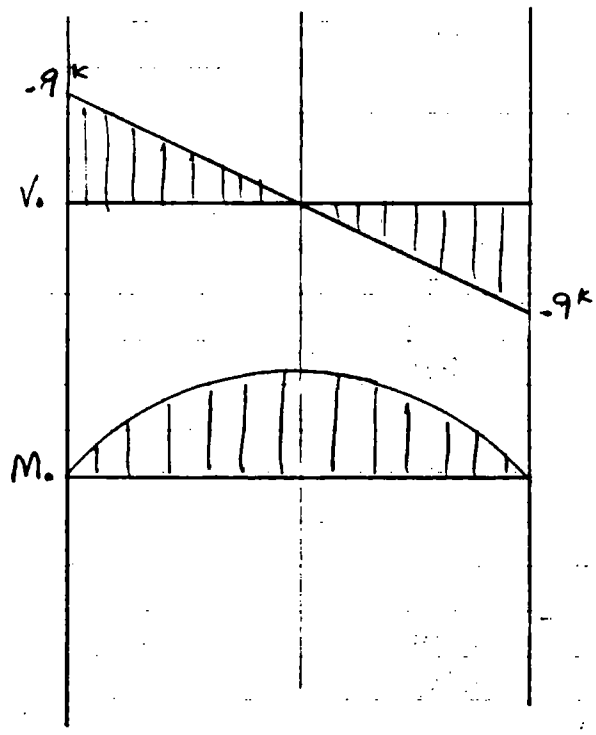
AREA #2 – ONE FOOT STRIP RUNNING NORTH → SOUTH AT APPROX. MIDPOINT OF THE FLOOR OPENINGS

① FACTORED LOADS: $(.1^k/ft)$ + $(.102^k/ft)$ = $.2^k/ft$
SLAB LIVE LOAD

② SHEAR & MOMENT DIAGRAMS:

FOR ANALYSIS, ASSUME ONE SPAN SIMPLY SUPPORTED





$V_o = R_A = R_B$

$M_{MAX} = \frac{wl^2}{8} \Rightarrow \frac{(.2)(9)^2}{8} = 2$ ft-k

RFW 10-05-003/A-5/85

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MANAGERS DESIGNERS/CONSULTANTS

CLIENT/SUBJECT Techalloy Co. W.O. NO. 0989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CAW DEPT 920 DATE 27 AUG 93

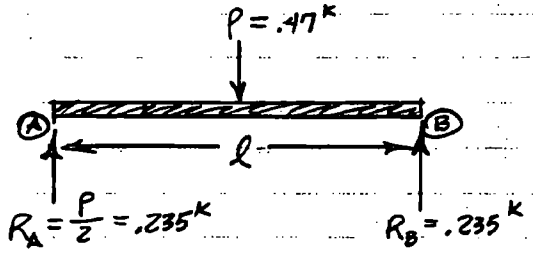
MATH CHECK BY DAM DEPT 920 DATE 8/27/93

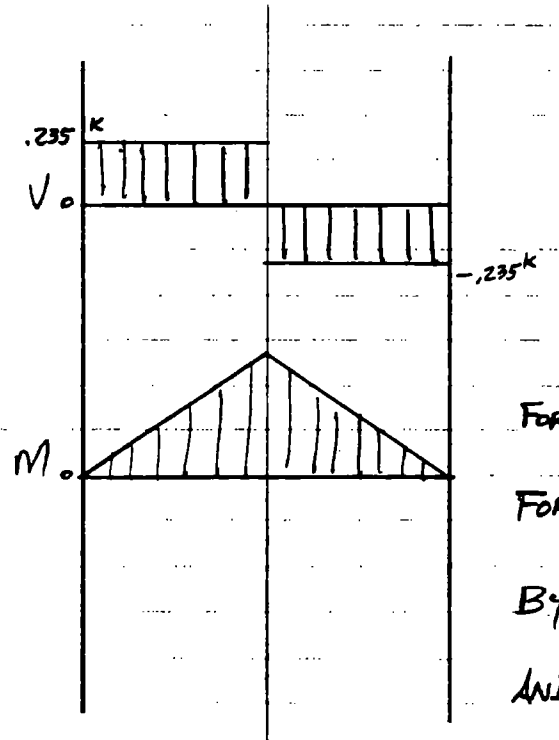
METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

THE POINT LOAD RESULTING FROM PLACEMENT OF THE FILTER WILL PRODUCE ADDITIONAL SHEAR AND MOMENT IN THE BEAMS USED FOR ANALYSIS. THE VALUES PRODUCED BY CALCULATION CAN BE SUPERIMPOSED UPON THOSE SHOWN PREVIOUSLY TO DETERMINE THE MOST RESTRICTIVE LOADING CONFIGURATION.

FOR A SIMPLY SUPPORTED, SINGLE SPAN BEAM:





$V = R = \frac{P}{2} = .235^k$

$M = \frac{Pl}{4}$

FOR AREA #1 — $M = \frac{(.47)(10)}{4} = 1.18^{ft\text{-}k}$

FOR AREA #2 — $M = \frac{(.47)(9)}{4} = 1.06^{ft\text{-}k}$

BY INSPECTION, MAX SHEAR = 1.57^k

AND MAX MOMENT = $5.6^{ft\text{-}k}$ IN AREA #1

CONCLUSION: AREA #1 IS THE MOST RESTRICTIVE FOR LOAD ANALYSIS AND WILL CONTROL IN DESIGN.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

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CLIENT/SUBJECT Technology 6 W.O. NO. D1939-012-

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CSW DEPT 920 DATE 27 Aug 93 APPROVED BY M. Allenspach

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93 DEPT 0920 DATE 8/27/93

③ CHECK SLAB THICKNESS REQ'D. FOR MOMENT:

$K_u = \phi f_c' \omega (1 - .59\omega) \Rightarrow \omega = \frac{\rho f_y}{f_c'}$ WHERE $\rho \le 0.01$ (ASSUMED)

$\Rightarrow \omega = \frac{(.01)(60{,}000)}{4000} = .15$

$\Rightarrow K_u = (.9)(4000)(.15)(1-(.59)(.15)) = 492$

$\Rightarrow \frac{M_u}{K_u} = \frac{bd^2}{12{,}000} \Rightarrow bd^2 = \frac{(12{,}000)(5.6)}{492} = 136.6\ in^3$

$\Rightarrow$ DESIGN STRIP IS 1 ft WIDE $\Rightarrow b = 12''$

$\Rightarrow d_{MIN} = \sqrt{\frac{136.6}{12}} = 11.4$ in TO KEEP $\rho \le 0.01$

$\Rightarrow d_{ASSUMED} = 6'' \Rightarrow$ SLAB IS NOT OK FOR FLEXURE w/ $\rho \le 0.01$

④ CHECK SLAB THICKNESS REQ'D. FOR SHEAR ($\phi V_c \ge V_u$):

$\Rightarrow \phi V_c = .85(2\sqrt{f_c'}\, b_w d)$

$\Rightarrow (.85)(2)(\sqrt{4000})(12)(6) = 7.74^k \ge 1.57^k$

$\Rightarrow$ SLAB IS OK FOR SHEAR w/ $\rho \le 0.01$

⑤ DESIGN THE REINFORCEMENT:

$\Rightarrow F = \frac{bd^2}{12000} \Rightarrow \frac{(12)(6)^2}{12000} = .036$

$\Rightarrow K_u = \frac{M_u}{F} \Rightarrow \frac{5.6}{.036} = 155.6 \Rightarrow a_u = 4.39$

$\Rightarrow A_s = \frac{M_u}{a_u d} \Rightarrow \frac{5.6}{(4.39)(6)} = .212\ in^2$

$\Rightarrow$ WITH CONSERVATIVE ANALYSIS, IT IS RECOMMENDED THAT #4 BARS @ 12" o/c EACH WAY TOP & BOTTOM BE PLACED IN THE FLOOR SLAB.

WESTON

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CLIENT/SUBJECT Technology Co W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CDW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAT DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pack DEPT 0920 DATE 8/27/93

FOR THE BEAMS, DESIGN WILL BE BASED UPON THE ASSUMPTION THAT THEY CARRY THE LARGEST REACTION FORCE SHOWN IN THE SLAB STRIP ANALYSIS AS AN EVENLY DISTRIBUTED LOAD ON THE LENGTH OF THE BEAMS.

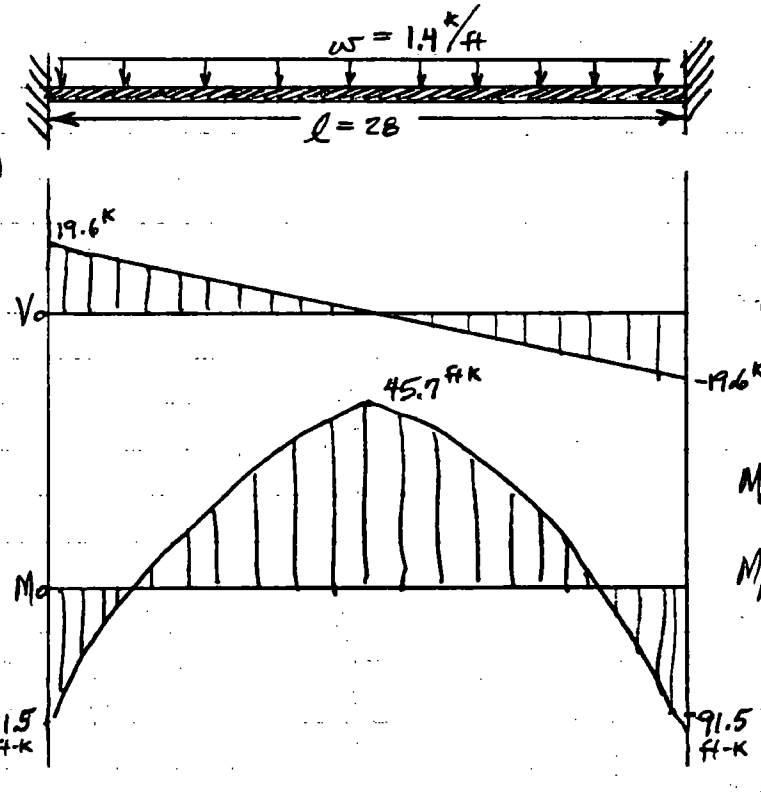
ASSUMPTIONS: A) BEAM WIDTH = 10"; DEPTH = 18" ⇒ d = 15.5"
B) ENDS OF BEAM ARE FIXED

① DETERMINE FACTORED LOADS:

$$\text{BEAM wt.} = \frac{(18\text{in})(150\,\text{lb}/\text{ft}^3)(.83\,\text{ft wide})}{12\,\text{in}/\text{ft}}(1.4) = .26\ \text{k}/\text{ft}\ \text{DIST. LOAD}$$

② PREVIOUS ANALYSIS REVEALED THAT THE DISTRIBUTED LOAD CONTRIBUTED BY THE SLAB IN AREA #1 = 1.33 k/ft; AREA #2 = .9 k/ft. POINT LOADING ADDED ANOTHER .235 k/ft TO THE BEAM. FOR A FIXED END, SINGLE SPAN BEAM:

NOTE: DUE TO THE VARIABLE LOAD DISTRIBUTION ON THE BEAM, THE SUPERPOSITION METHOD WILL BE USED TO DETERMINE V_{MAX} & M_{MAX}



LOAD CONDITION "A" ASSUMES THE BEAM IS ONLY INFLUENCED BY AREA #2 AND THE POINT LOAD

$w = .26\,\text{k}/\text{ft} + .9\,\text{k}/\text{ft} + .235\,\text{k}/\text{ft}$

$$V = \frac{wl}{2} = \frac{(1.4)(28)}{2} = 19.6$$

$$M_{CENTER} = \frac{wl^2}{24} = \frac{(1.4)(28)^2}{24} = 45.7\ \text{ft-k}$$

$$M_{MAX} = \frac{wl^2}{12} = \frac{(1.4)(28)^2}{12} = 91.5\ \text{ft-k}$$

WESTON

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CLIENT/SUBJECT TECHALLOY Co. W.O. NO. 01989-010-0

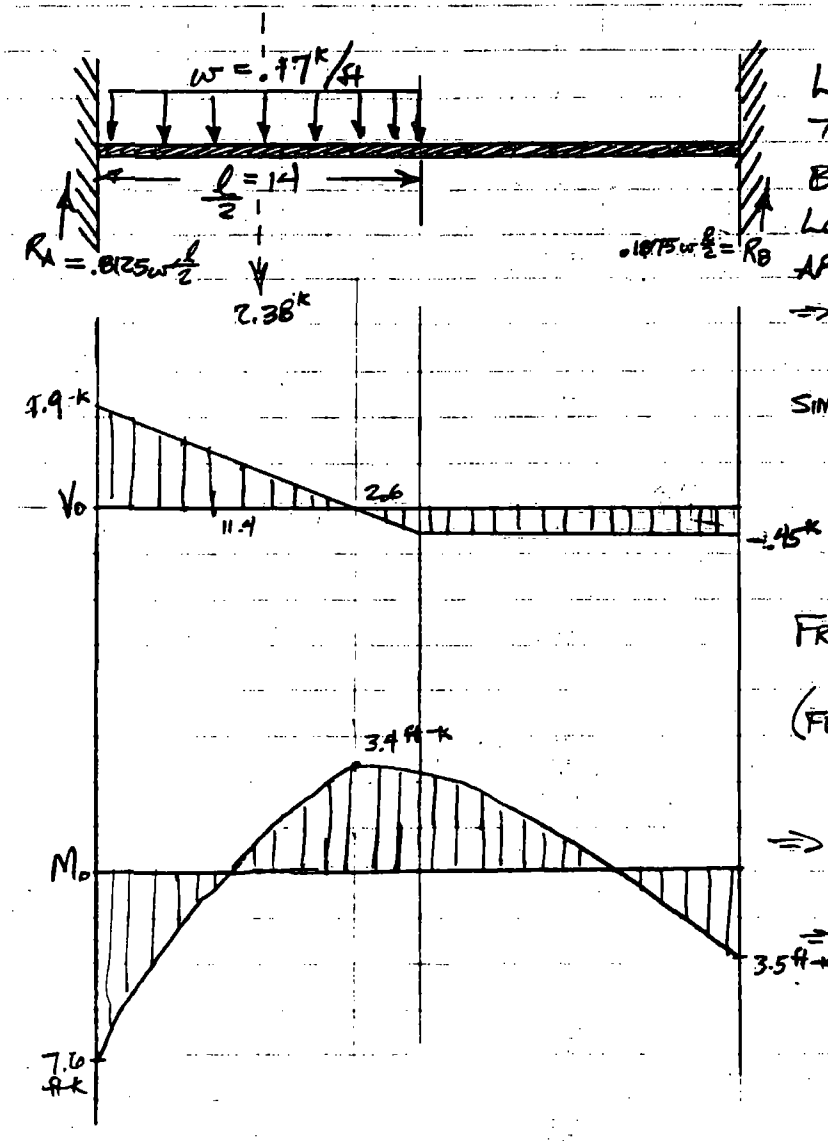
TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAM DEPT 920 DATE 8/27/93

METHOD REV. BY MSA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pack DEPT 0920 DATE 8/27/93



LOAD CONDITION "B" ASSUMES THE BEAM IS INFLUENCED BY THE DIFFERENCE OF LOAD CONDITION "A" AND THE AREA #1 LOAD + POINT LOAD

$\Rightarrow w = (1.33^k/ft + .235^k/ft) - 1.4^k/ft$

SIMILAR TRIANGLES: $\frac{1.9}{14-x} = \frac{1.45}{x}$

$\Rightarrow 4.22 = \frac{14-x}{x} \Rightarrow x = \frac{14}{5.22} = 2.$

FROM THE FIXED END MOMENT CHART

$(FEM)_{AB} = \frac{11 w l^2}{192}$ AND $(FEM)_{BA} = \frac{5 w l^2}{192}$

$\Rightarrow \frac{(11)(.17)(28)^2}{192} = 7.6^{ft-k}$

$\Rightarrow \frac{(5)(.17)(28)^2}{192} = 3.5^{ft-k}$

BY SUPERPOSITION, $V_{MAX} = 19.6^k + 1.9^k = 21.5^k$

$-M_{MAX} = 91.5^{ft-k} + 7.6^{ft-k} = 99.1^{ft-k}$

$+M_{MAX} = 45.7^{ft-k} + 3.4^{ft-k} = 49.1^{ft-k}$

RFW 10-05-003/A-5/85

WESTON

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CLIENT/SUBJECT TECHALLOY Co. W.O. NO. 01789-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CDW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DMM DEPT 920 DATE 8/27/93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pack DEPT 0920 DATE 8/27/93

③ CHECK BEAM DEPTH REQ'D. FOR MOMENT:

⇒ FROM PREVIOUS CALCULATIONS, $K_u = 492$

$$\Rightarrow bd^2 = \frac{M_u(12{,}000)}{K_u} = \frac{(49)(12{,}000)}{492} = 2415\,in^3$$

⇒ BEAM IS 10" WIDE ⇒ $b = 10''$

$$\Rightarrow d_{MIN} = \sqrt{\frac{2415}{10}} = 15.5\,in \le d_{ASSUMED} \Rightarrow \underline{OK}!$$

∴ BEAM IS DEEP ENOUGH TO KEEP $\rho \le 0.01$

④ CHECK BEAM DEPTH REQ'D. FOR SHEAR ($\phi V_c \ge V_u$):

$$\Rightarrow \phi V_c = .85\left(2\sqrt{f_c'}\, b_w d\right)$$

$$\Rightarrow (.85)(2)(\sqrt{4000})(10)(15.5) = 16.7^k \le 20.8^k \Rightarrow \underline{\text{NO GOOD}}$$

BEAM IS <u>NOT</u> DEEP ENOUGH TO RESIST SHEAR FORCE

ANALYSIS: TO MAINTAIN THE ASSUMED BEAM DIMENSIONS, MORE STEEL THAN 1% OF CROSS SECTION AREA WILL BE USED, AND WEB REINFORCING STIRRUPS WILL BE REQUIRED TO RESIST SHEAR IN THE BEAM.

① DESIGN REINFORCEMENT FOR POSITIVE MOMENT (BOTTOM STEEL):

$$F = \frac{bd^2}{12{,}000} = \frac{(10)(15.5)^2}{12{,}000} = .20$$

$$K_u = \frac{M_u}{F} \Rightarrow \frac{49.1}{.20} = 246 \Rightarrow a_u = 4.31$$

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CLIENT/SUBJECT TECHALLOY Co. W.O. NO. 01989-010-[illegible]

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CRW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DMM DEPT 920 DATE 8/27/93

METHOD REV. BY MAS DEPT 0920 DATE 8/27/93

APPROVED BY M. Allen Pacl DEPT 0920 DATE 8/27/93

$$A_s = \frac{M_u}{a_u d} \Rightarrow \frac{49.1}{(4.31)(15.5)} = .73 in^2$$

⇒ USE 3 - #5 BARS @ BOTTOM OF BEAM

② DESIGN REINFORCEMENT FOR NEGATIVE MOMENT (TOP STEEL):

$$F = .20 \Rightarrow K_u = \frac{99}{.2} = 495 \Rightarrow a_u = 4.10$$

$$\Rightarrow A_s = \frac{99}{(4.10)(15.5)} = 1.56 in^2$$

⇒ USE 6 - #5 BARS @ TOP OF BEAM

③ CHECK FOR STIRRUP REQUIREMENT:

$$\Rightarrow V_n = \frac{V_u}{\phi} \Rightarrow \frac{21.5}{.9} = 23.9^k$$

NO STIRRUPS REQ'D. IF $V_n \leq \frac{V_c}{2}$ AND $V_c = 2\sqrt{f'_c}\, b_w d = 16.7^k$

$$\Rightarrow \frac{16.7^k}{2} = 8.35^k \leq V_n \Rightarrow$$ STIRRUPS ARE REQ'D.

④ USE #4 REBAR FOR DOUBLE-LEG STIRRUPS:

$$\Rightarrow A_v = 2 \times .20 in^2 = .40 in^2$$

⑤ DETERMINE REQ'D. STIRRUP SPACING:

$$s = \frac{A_v f_y d}{V_u/\phi - V_c} = \frac{(.40)(60{,}000)(15.5)}{(23.9-16.7)(1000)} = 51.7 in \Rightarrow$$

MAX SPACING IF $\frac{d}{2}$ OR 24" ⇒ $\frac{15.5"}{2} = 7.75"$

CONSERVATIVE ANALYSIS ALLOWS THE USE OF #4 STIRRUPS @ 8" o/c

RFW 10-05-003/A-5/85

WESTON

SHEET 25 of 36

CLIENT/SUBJECT TECHALLOY Co. W.O. NO. 01989-010-002

TASK DESCRIPTION TASK NO. 0200

PREPARED BY CDW DEPT 920 DATE 27 AUG 93

MATH CHECK BY DAT DEPT 920 DATE 8/27/93

METHOD REV. BY MAA DEPT 0920 DATE 8/27/93

APPROVED BY M. Allingpack DEPT 0920 DATE 8/27/93

LAP SPLICES FOR JOINT REINFORCEMENT

① DETERMINE BASIC DEVELOPMENT LENGTH (l_{db})

⇒ FOR #11 BAR & SMALLER, $l_{db} = .04 A_b f_y / \sqrt{f_c'}$

⇒ #5 BARS ARE USED AT BOTTOM SLAB / WALL JOINT

⇒ $(.04)(.31)(60{,}000)/\sqrt{4000} = 11.8$ in

② SPACING OF WALL REINFORCEMENT = 6" o/c

⇒ $3d_b = 3(.625") = 1.88"$ ⇒ SPACING IS ADEQUATE

③ COVER ON BARS IN SLAB AND WALLS EXPOSED TO EARTH IS 3"; EXPOSED TO MOISTURE ON INSIDE IS 2"

⇒ $2d_b = 2(.625") = 1.25"$ ⇒ COVER IS ADEQUATE

THUS, ACI 12.2.3.1 FACTOR = 1.0

④ CHECK CLEAR SPACING NOT LESS THAN $5d_b$

⇒ $5d_b = 5(.625") = 3.13"$

CLEAR SPACING = 6" − .625" = 5.38" ⇒ CLEAR SPACING OK!

⑤ CHECK COVER FROM FACE OF MEMBER TO EDGE BAR NOT LESS THAN $2.5d_b$

⇒ $2.5d_b = 2.5(.625") = 1.56"$ ⇒ OK ⇒ ACI 12.2.3.4 = 0.8

RFW 10-05-003/A-5/85

WESTON
MANAGERS DESIGNERS/CONSULTANTS

CLIENT/SUBJECT TECHALLOY Co. W.O. NO. 01989-010-
TASK DESCRIPTION TASK NO. 0200
PREPARED BY CBW DEPT 920 DATE 27 AUG 93
MATH CHECK BY DAM DEPT 920 DATE 8/27/93
METHOD REV. BY MAA DEPT 0920 DATE 8/27/93
APPROVED BY M. Allenspach DEPT 0920 DATE 8/27/93

⑥ CHECK MODIFIED LENGTH NOT LESS THAN $.03 d_b f_y / \sqrt{f'_c}$

$\Rightarrow (11.8\text{ in})(1.0)(.8) = 9.44\text{ in}$

$\Rightarrow (.03)(.625")(60{,}000)/\sqrt{4000} = 17.79\text{ in}$

MODIFIED LENGTH IS LESS THAN 17.8" ⇒ MIN. LENGTH CONTROLS

⇒ DOWEL PROJECTION SHALL BE 18" ABOVE T.O.C. ON BOTTOM SLAB FOR SPLICING WITH VERTICAL REINFORCEMENT IN WALLS

LENGTH OF STANDARD HOOK IN TENSION

① DETERMINE BASIC DEVELOPMENT LENGTH (l_{hb})

$\Rightarrow l_{hb} = 1200 d_b / \sqrt{f'_c}$

$\Rightarrow (1200)(.625")/\sqrt{4000} = 11.9\text{ in}$

② FACTOR FOR CONCRETE COVER ≥ 2.5" = 0.7

③ CHECK MODIFIED LENGTH NOT LESS THAN $8d_b$ OR 6"

$\Rightarrow l_{dh} = (11.9")(.07) = \underline{8.3\text{ in}}$

$\Rightarrow 8d_b = 8(.625") = 5\text{ in}$

⇒ HOOK LENGTH SHALL BE 9" (MINIMUM) AT THE BOTTOM SLAB/WALL JOINT

Table 2
Minimum Uniformly Distributed Live Loads, L_o

Occupancy or Use	Live Load (lbf/ft^2)
Apartments (see residential)	
Armories and drill rooms	150
Assembly areas and theaters:	
Fixed seats (fastened to floor)	60
Lobbies	100
Movable seats	100
Platforms (assembly)	100
Stage floors	150
Balconies (exterior)	100
On one- and two-family residences only, and not exceeding 100 ft^2	60
Bowling alleys, poolrooms, and similar recreational areas	75
Corridors:	
First floor	100
Other floors, same as occupancy served except as indicated	
Dance halls and ballrooms	100
Decks (patio and roof)	
Same as area served, or for the type of occupancy accommodated	
Dining rooms and restaurants	100
Dwellings (see residential)	
Fire escapes	100
On single-family dwellings only	40
Garages (passenger cars only)	50
For trucks and buses use AASHTO* lane loads (see Table 3 for concentrated load requirements)	
Grandstands (see stadium and arena bleachers)	
Gymnasiums, main floors and balconies	100
Hospitals:	
Operating rooms, laboratories	60
Private rooms	40
Wards	40
Corridors above first floor	80
Hotels (see residential)	
Libraries:	
Reading rooms	60
Stack rooms – not less than §	150
Corridors above first floor	80
Manufacturing:	
Light	125
Heavy	250
Marquees and canopies	75
Office buildings:	
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	
Lobbies	100
Offices	50
Penal Institutions:	
Cell blocks	40
Corridors	100
Residential:	
Dwellings (one- and two-family)	
Uninhabitable attics without storage	10
Uninhabitable attics with storage	20
Habitable attics and sleeping areas	30
All other areas	40
Hotels and multifamily houses	
Private rooms and corridors serving them	40
Public rooms and corridors serving them	100
Schools:	
Classrooms	40
Corridors above first floor	80
Sidewalks, vehicular driveways, and yards, subject to trucking†	250
Stadium and arena bleachers‡	100
Stairs and exitways	100
Storage warehouses:	
Light	125
Heavy	250
Stores:	
Retail	
First floor	100
Upper floors	75
Wholesale, all floors	125
Walkways and elevated platforms (other than exitways)	60
Yards and terraces (pedestrians)	100

*American Association of State Highway and Transportation Officials.

†AASHTO lane loads should also be considered where appropriate.

‡For detailed recommendations, see American National Standard for Assembly Seating, Tents, and Air-Supported Structures, ANSI/NFPA 102-1978.

§The weight of books and shelving shall be computed using an assumed density of 65 lb/ft^3 (pounds per cubic foot, sometimes abbreviated pcf) and converted to a uniformly distributed load; this load shall be used if it exceeds 150 lbf/ft^2.

Table 3-2 Reinforcing Bars

Bar Size Designation No.	Grades	Weight (lb/ft)	Nominal Dimensions[a] Diameter (in.)	Nominal Dimensions[a] Cross-Sectional Area (in.^{2})
3	40, 60	0.376	0.375	0.11
4	40, 60	0.668	0.500	0.20
5	40, 60	1.043	0.625	0.31
6	40, 60	1.502	0.750	0.44
7	60	2.044	0.875	0.60
8	60	2.67	1.00	0.79
9	60	3.40	1.128	1.00
10	60	4.30	1.270	1.27
11	60	5.31	1.410	1.56
14	60	7.65	1.693	2.25
18	60	13.60	2.257	4.00

[a] The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same weight per foot as the deformed bar.

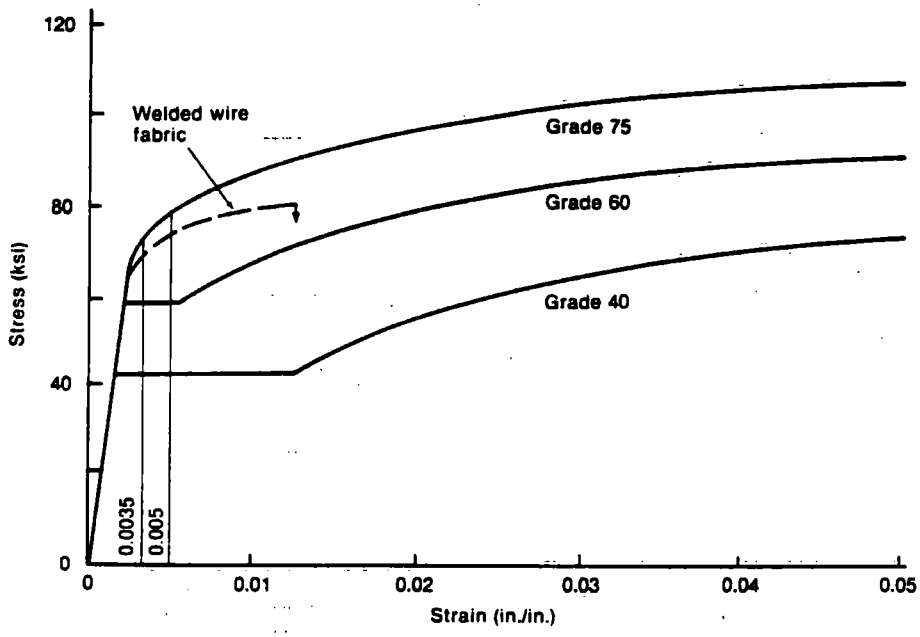


Fig. 3-25
Stress–strain curves for reinforcement.

The ASTM Specifications for reinforcing bars define the yield strength as the stress at a strain of 0.005. ACI Secs. 3.5.3.2 and 3.5.3.4 to 3.5.3.6 define the yield strength as the stress at a strain of 0.0035. This is done because concrete crushes at a strain of roughly this value, and when bars are used in compression, as in columns, a strain of 0.005 may never be reached. As can be seen from Fig. 3-25, the 0.005 strain yield strength often exceeds the 0.0035 yield strength for high-strength bars. Thus yield strengths determined in accordance witht the ASTM Specifications may be higher than those allowed by the ACI Code.

Figure 3-26 is a histogram of mill test yield strengths of Grade 60 reinforcement with a nominal yield strength of 60 ksi. As shown in this figure, there is a considerable variation in yield strength, with about 10% of the tests having a yield

Table A-6 Cross-Sectional Areas, A_s, for Various Combinations of Bars (in.^{2})[a]

	A			B					
No. of Bars	Bar No.	0	5	Bar No.	1	2	3	4	5
1		0.20	1.20		0.31	0.42	0.53	0.64	0.75
2		0.40	1.40		0.51	0.62	0.73	0.84	0.95
3	4	0.60	1.60	3	0.71	0.82	0.93	1.04	1.15
4		0.80	1.80		0.91	1.02	1.13	1.24	1.35
5		1.00	2.00		1.11	1.22	1.33	1.44	1.55
1		0.31	1.86		0.51	0.71	0.91	1.11	1.31
2		0.62	2.17		0.82	1.02	1.22	1.42	1.62
3	5	0.93	2.48	4	1.13	1.33	1.53	1.73	1.93
4		1.24	2.79		1.44	1.64	1.84	2.04	2.24
5		1.55	3.10		1.75	1.95	2.15	2.35	2.55
1		0.44	2.64		0.75	1.06	1.37	1.68	1.99
2		0.88	3.08		1.19	1.50	1.81	2.12	2.43
3	6	1.32	3.52	5	1.63	1.94	2.25	2.56	2.87
4		1.76	3.96		2.07	2.38	2.69	3.00	3.31
5		2.20	4.40		2.51	2.82	3.13	3.44	3.75
1		0.60	3.60		1.04	1.48	1.92	2.36	2.80
2		1.20	4.20		1.64	2.08	2.52	2.96	3.40
3	7	1.80	4.80	6	2.24	2.68	3.12	3.56	4.00
4		2.40	5.40		2.84	3.28	3.72	4.16	4.60
5		3.00	6.00		3.44	3.88	4.32	4.76	5.20
1		0.79	4.74		1.39	1.99	2.59	3.19	3.79
2		1.58	5.53		2.18	2.78	3.38	3.98	4.58
3	8	2.37	6.32	7	2.97	3.57	4.17	4.77	5.37
4		3.16	7.11		3.76	4.36	4.96	5.56	6.16
5		3.95	7.90		4.55	5.15	5.75	6.35	6.95
1		1.00	6.00		1.79	2.58	3.37	4.16	4.95
2		2.00	7.00		2.79	3.58	4.37	5.16	5.95
3	9	3.00	8.00	8	3.79	4.58	5.37	6.16	6.95
4		4.00	9.00		4.79	5.58	6.37	7.16	7.95
5		5.00	10.00		5.79	6.58	7.37	8.16	8.95
1		1.27	7.62		2.27	3.27	4.27	5.27	6.27
2		2.54	8.89		3.54	4.54	5.54	6.54	7.54
3	10	3.81	10.16	9	4.81	5.81	6.81	7.81	8.81
4		5.08	11.43		6.08	7.35	8.08	9.08	10.08
5		6.35	12.70		7.35	8.35	9.35	10.35	11.35
1		1.56	9.36		2.83	4.10	5.37	6.64	7.91
2		3.12	10.92		4.39	5.66	6.93	8.20	9.47
3	11	4.68	12.48	10	5.95	7.22	8.49	9.76	11.03
4		6.24	14.04		7.51	8.78	10.05	11.32	12.59
5		7.80	15.60		9.07	10.34	11.61	12.88	14.15

[a] For directions on how to use this table, see Table A-4, footnote b.
Source: Based on a table from Ref. 4-11; used with the permission of the American Concrete Institute.

Table A-7 Areas of Bars in a Section 1 ft Wide (in.²/ft)

Bar Spacing (in.)	Bar No. 3	4	5	6	7
4	0.33	0.60	0.93	1.32	1.80
4½	0.29	0.53	0.83	1.17	1.60
5	0.26	0.48	0.74	1.06	1.44
5½	0.24	0.44	0.68	0.96	1.31
6	0.22	0.40	0.62	0.88	1.20
6½	0.20	0.37	0.57	0.81	1.11
7	0.19	0.34	0.53	0.75	1.03
7½	0.18	0.32	0.50	0.70	0.96
8	0.17	0.30	0.47	0.66	0.90
8½	0.16	0.28	0.44	0.62	0.85
9	0.15	0.27	0.41	0.59	0.80
9½	0.14	0.25	0.39	0.56	0.76
10	0.13	0.24	0.37	0.53	0.72
10½	0.13	0.23	0.35	0.50	0.69
11	0.12	0.22	0.34	0.48	0.65
11½	0.11	0.21	0.32	0.46	0.63
12	0.11	0.20	0.31	0.44	0.60
13	0.10	0.18	0.29	0.41	0.55
14	0.09	0.17	0.27	0.38	0.51
15	0.09	0.16	0.25	0.35	0.48
16	0.08	0.15	0.23	0.33	0.45
17	0.08	0.14	0.22	0.31	0.42
18	0.07	0.13	0.21	0.29	0.40

Table A-8 Limiting Values of d'/a for Checking if Compression Steel Yields[a]

f_y (psi)	f'_c (psi) ≤4000	5000	6000	8000
40,000	0.636	0.675	0.720	0.831
50,000	0.500	0.532	0.567	0.654
60,000	0.365	0.388	0.414	0.477

[a] If d'/a exceeds the values given in this table, the compression steel will not yield before failure; calculated using Eq. 5-7.

Table A-9 Minimum Effective Beam Depth, d (in.), to Provide Development Length Required for Vertical Stirrups ($f'_c \geq 2500$ psi)[a]

	Stirrup Bar Size		
f_y (psi)	No. 3	No. 4	No. 5
	90° hooks with or without bars inside the hook and 135° or 180° hooks without bars inside the hook (ACI Sec. 12.13.2.1)		
40,000	11.3	14.0	16.8
60,000	14.3	18.0	21.8
	135° or 180° hooks with bars inside the hook (ACI Sec. 12.13.2.3)		
40,000		No minimum embedment	
60,000	11.2	13.9	16.7

[a] Values based on clear cover of 1.5 in. on compression surface of beam.

Table A-10 Basic Tension Development Length, ℓ_{db} (in.)[a]

$\ell_d = \ell_{db} \times$ (factors in ACI Secs. 12.2.3 and 1.2.4)[b]

	f'_c = 3000 psi		f'_c = 4000 psi		f'_c = 5000 psi		f'_c = 6000 psi	
Bar No.	Bottom Bar	Top Bar	Bottom Bar	Top Bar	Bottom Bar	Top Bar	Bottom Bar	Top Bar
	f_y = 60,000 psi, normal-weight concrete, bars spaced < 6 in.							
3	12(9)	13	12(9)	13	12(9)	13	12(9)	13
4	12	17	12	17	12	17	12	17
5	15	21	15	21	15	21	15	21
6	19	27	18	25	18	25	18	25
7	26	37	23	32	21	29	21	29
8	35	49	30	42	27	38	24	34
9	44	61	38	53	34	48	31	43
10	56	78	48	68	43	60	39	55
11	68	96	59	83	53	74	48	68
14	93	130	81	113	72	101	66	92
18	121	169	104	146	93	131	85	119
	f_y = 40,000 psi, normal-weight concrete, bars spaced < 6 in.							
3	12(6)	12(8.4)	12(6)	12(8.4)	12(6)	12(8.4)	12(6)	12(8.4)
4	12(8)	12(11.2)	12(8)	12(11.2)	12(8)	12(11.2)	12(8)	12(11.2)
5	12(10)	14	12(10)	14	12(10)	14	12(10)	14
6	13	18	12	17	12	17	12	17

[a] Values given in parentheses are to be used with factors in ACI Sect. 12.2.3 and 12.2.4.
[b] Lengths must be multiplied by factors in ACI Sec. 12.2.3 and 12.2.4. Resulting length to be not less than 12 in. except in computation of lap splices by ACI Sec. 12.16 and development of web reinforcement by ACI Sec. 12.13.

Table A-11 Basic Compression Development Length, ℓ_{dbc} (in.)[a]

Bar No.	$\ell_d = \ell_{dbc} \times$ (factors in ACI Sec. 12.3.3) f'_c (psi) 3000	4000	5000 psi and up
	f_y = 60,000 psi		
3	8	8	8
4	11	9	9
5	14	12	11
6	16	14	14
7	19	17	16
8	22	19	18
9	25	21	20
10	28	24	23
11	34	27	25
14	37	32	30
18	49	43	41
	f_y = 40,000 psi		
3	8	8	8
4	8	8	8
5	9	8	8
6	11	9	9

[a] Lengths may be reduced if excess reinforcement is anchored or if the splice is enclosed in a spiral. See ACI Sect. 12.3.3. Reduced length shall not be less than 8 in.

Table A-12 Basic Development Lengths for Hooked Bars, ℓ_{hb}

$\ell_{dh} = \ell_{hb} \times$ (factors in 12.5.3)[a]
Normal-weight concrete, f_y = 60,000 psi
Standard 90° or 180° Hooks

Bar No.	f'_c (psi) 3000	4000	5000	6000
3	8.2	8(7.1)	8(6.4)	8(5.8)
4	11	9.5	8.5	8(7.8)
5	13.7	11.9	10.6	9.7
6	16.4	14.2	12.7	11.6
7	19.2	16.6	14.9	13.6
8	22	19	17	15.5
9	25	21	19	17.5
10	28	24	22	20
11	31	27	24	22
14	37	32	29	26
18	49	43	38	35

[a] ℓ_{dh} is defined in Fig. 8-12a. The development length of a hook, ℓ_{dh}, is the product of ℓ_{hb} from this table (using values in parentheses where they exist) and factors relating to bar yield strength, cover, presence of stirrups, and type of concrete given in ACI Sec. 12.5.3. The resulting length ℓ_{dh} shall not be less than the larger of 8 bar diameters or 6 in.

Flexure 1.2—Coefficients for rectangular sections without compression reinforcement

1.2

$\rho = \omega \frac{f'_c}{f_y} = \frac{A_s}{bd}$

$\frac{c}{d} = 1.18 \frac{\omega}{\beta_1}$

$\frac{a}{d} = \beta_1 \frac{c}{d}$

$\beta_1 = 0.85$

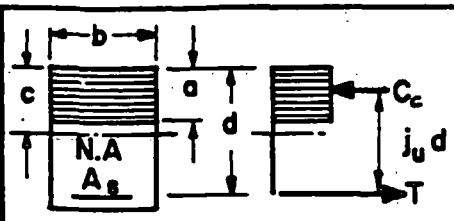
$K_u = \phi f'_c \omega (1 - .59\omega)$

$a_u = \phi f_y (1 - .59\omega)/12{,}000$

$A_s = \frac{M_u}{a_u d}$

$j_u = 1 - \frac{a}{2d}$

$F = \frac{M_u}{K_u} = bd^2/12{,}000$

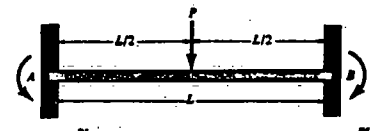


A_s in square inches and M_u is in ft - kips

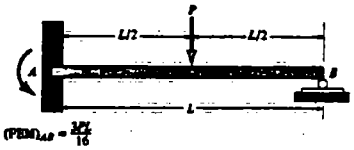
ω	K_u	$f'_c = 4{,}000$										
		$f_y = 40{,}000$		$f_y = 50{,}000$		$f_y = 60{,}000$		$f_y = 80{,}000$		c/d	a/d	j_u
		ρ	a_u	ρ	a_u	ρ	a_u	ρ	a_u			
.020	71	.0020	2.96	.0016	3.71	.0013	4.45	.0010	5.93	.028	.024	.988
.030	106	.0030	2.95	.0024	3.68	.0020	4.42	.0015	5.89	.042	.035	.982
.040	141	.0040	2.93	.0032	3.66	.0027	4.39	.0020	5.86	.056	.047	.976
.050	175	.0050	2.91	.0040	3.64	.0033	4.37	.0025	5.82	.069	.059	.971
.060	208	.0060	2.89	.0048	3.62	.0040	4.34	.0030	5.79	.083	.071	.965
.070	242	.0070	2.88	.0056	3.60	.0047	4.31	.0035	5.75	.097	.083	.959
.080	274	.0080	2.86	.0064	3.57	.0053	4.29	.0040	5.72	.111	.094	.953
.090	307	.0090	2.84	.0072	3.55	.0060	4.26	.0045	5.68	.125	.106	.947
.100	339	.0100	2.82	.0080	3.53	.0067	4.23	.0050	5.65	.139	.118	.941
.110	370	.0110	2.81	.0088	3.51	.0073	4.21	.0055	5.61	.153	.130	.935
.120	401	.0120	2.79	.0096	3.48	.0080	4.18	.0060	5.58	.167	.142	.929
.130	432	.0130	2.77	.0104	3.46	.0087	4.15	.0065	5.54	.180	.153	.923
.140	462	.0140	2.75	.0112	3.44	.0093	4.13	.0070	5.50	.194	.165	.917
.150	492	.0150	2.73	.0120	3.42	.0100	4.10	.0075	5.47	.208	.177	.912
.160	522	.0160	2.72	.0128	3.40	.0107	4.08	.0080	5.43	.222	.189	.906
.170	551	.0170	2.70	.0136	3.37	.0113	4.05	.0085	5.40	.236	.201	.900
.180	579	.0180	2.68	.0144	3.35	.0120	4.02	.0090	5.36	.250	.212	.894
.190	607	.0190	2.66	.0152	3.33	.0127	4.00	.0095	5.33	.264	.224	.888
.200	635	.0200	2.65	.0160	3.31	.0133	3.97	.0100	5.29	.278	.236	.882
.210	662	.0210	2.63	.0168	3.29	.0140	3.94	.0105	5.26	.292	.248	.876
.220	689	.0220	2.61	.0176	3.26	.0147	3.92	.0110	5.22	.305	.260	.870
.230	716	.0230	2.59	.0184	3.24	.0153	3.89	.0115	5.19	.319	.271	.864
.240	742	.0240	2.58	.0192	3.22	.0160	3.86	.0120	5.15	.333	.283	.858
.250	767	.0250	2.56	.0200	3.20	.0167	3.84	.0125	5.12	.347	.295	.853
.260	792	.0260	2.54	.0208	3.17	.0173	3.81	.0130	5.08	.361	.307	.847
.270	817	.0270	2.52	.0216	3.15	.0180	3.78	.0135	5.04	.375	.319	.841
.280	841	.0280	2.50	.0224	3.13	.0187	3.76	.0140	5.01	.389	.330	.835
.290	865	.0290	2.49	.0232	3.11	.0193	3.73			.403	.342	.829
.300	889	.0300	2.47	.0240	3.09	.0200	3.70			.416	.354	.823
.310	912	.0310	2.45	.0248	3.06	.0207	3.68			.430	.366	.817
.320	935	.0320	2.43	.0256	3.04	.0213	3.65			.444	.378	.811
.330	957	.0330	2.42	.0264	3.02					.458	.389	.805
.340	978	.0340	2.40	.0272	3.00					.472	.401	.799
.350	1000	.0350	2.38							.486	.413	.794
.360	1021	.0360	2.36							.500	.425	.788
.370	1041	.0370	2.35							.514	.437	.782

1. When $h_f / d \geq a/d$, beam is designed as rectangular section; when $h_f / d < a/d$, beam is designed as a T section (See Flexure 2).
2. Values of ρ above upper solid line are for percentages smaller than ρ min., ρ min. = $200/f_y$. See section 10.5, ACI 318-71.
3. Values of ρ below lower solid line would exceed ρ max. = 0.75 ρ_b. For values of ρ_{max} see values of $(\rho_w - 0.75\ \rho_f)$ max. in Flexure 2. See Section 10.3.2. ACI 318-71.
4. For deflection see Section 9.5 ACI 318-71 and "Deflection" chapter in this handbook.
5. Check for Crack Control where $f_y > 40{,}000$ See Section 10.6. ACI 318-71 and under chapter "Reinforcement" in this handbook.
6. The capacity reduction factor $\phi = 0.9$ has been included in the table values.
7. For use of this Table, see Flexure Examples 1 to 10, 15, 16

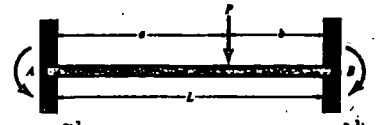
Fixed End Moments



$(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$

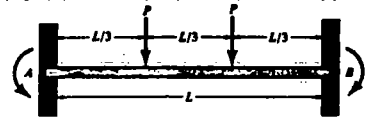


$(FEM)_{AB} = \frac{3PL}{16}$

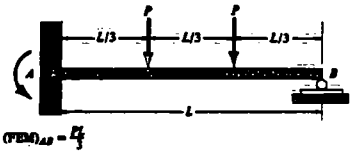


$(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$

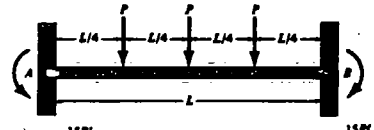
$(FEM)_{AB} = \left(\frac{P}{L^2}\right)\left(b^2a + \frac{a^2b}{2}\right)$



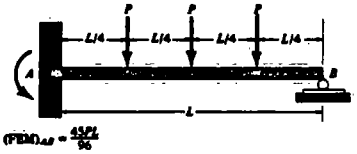
$(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$



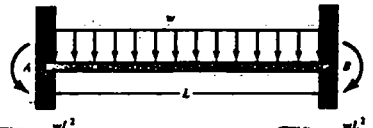
$(FEM)_{AB} = \frac{PL}{3}$



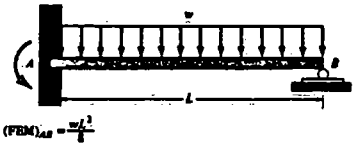
$(FEM)_{AB} = \frac{15PL}{48}$ $(FEM)_{BA} = \frac{15PL}{48}$



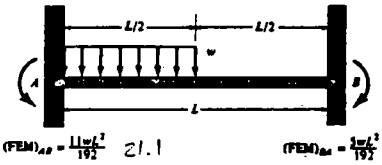
$(FEM)_{AB} = \frac{45PL}{96}$



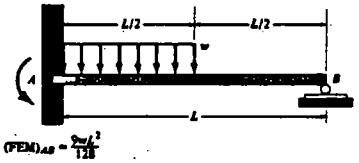
$(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$



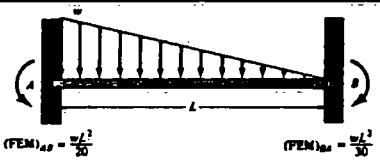
$(FEM)_{AB} = \frac{wL^2}{8}$



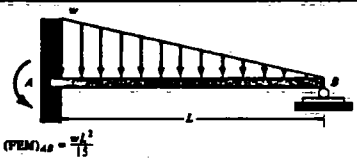
$(FEM)_{AB} = \frac{11wL^2}{192}$ 21.1 $(FEM)_{BA} = \frac{5wL^2}{192}$ 9.6



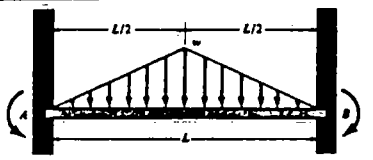
$(FEM)_{AB} = \frac{9wL^2}{128}$



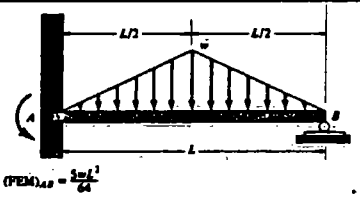
$(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$



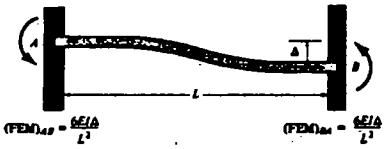
$(FEM)_{AB} = \frac{wL^2}{15}$



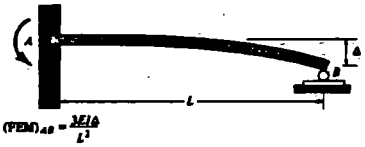
$(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$



$(FEM)_{AB} = \frac{5wL^2}{64}$



$(FEM)_{AB} = \frac{6EI\Delta}{L^2}$ $(FEM)_{BA} = \frac{6EI\Delta}{L^2}$



$(FEM)_{AB} = \frac{3EI\Delta}{L^2}$

Example 8–4

Draw the shear and moment diagrams for the beam shown in Fig. 8–8*a*. *EI* is constant. Neglect the effects of axial load.

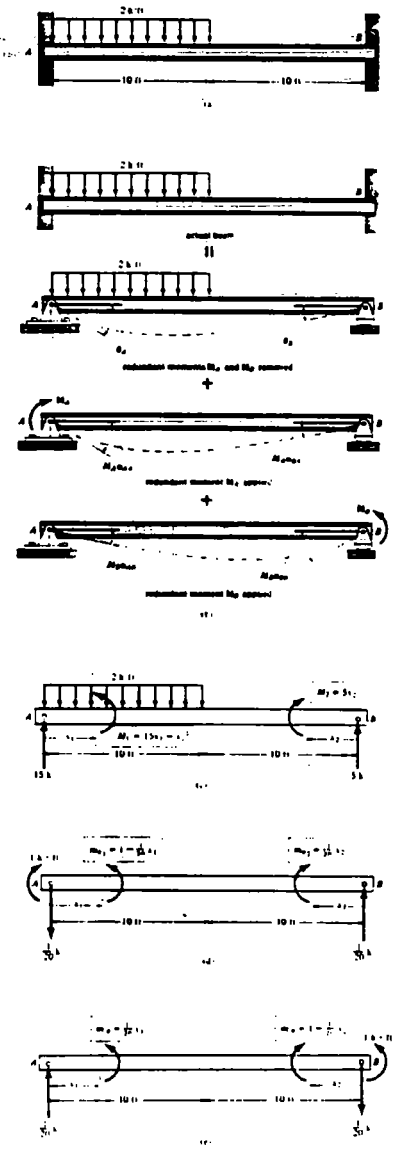


Fig. 8–8a,b,c,d,e

Solution

Principle of Superposition. Since axial load is neglected, the beam is indeterminate to the second degree. The two end moments at *A* and *B* will be considered as the redundants. The beam's capacity to resist these moments is removed by placing pins at *A* and *B* and the principle of superposition applied to the beam. Fig. 8–8*b*.

Compatibility Equations. Reference to points *A* and *B*, Fig. 8–8*b*, requires

$$(\circlearrowright +) \qquad 0 = \theta_A + M_A\alpha_{AA} + M_B\alpha_{AB} \qquad (1)$$

$$(\circlearrowleft +) \qquad 0 = \theta_B + M_A\alpha_{BA} + M_B\alpha_{BB} \qquad (2)$$

The deflection coefficients will be computed using the method of virtual work. The beam's *x* coordinates and internal moments are shown in Fig. 8–8*c* through *e*.

For θ_A we require application of the real loads, Fig. 8–8*c*, and a virtual unit couple at *A*, Fig. 8–8*d*. Thus,

$$\theta_A = \Sigma\int \frac{Mm_\theta}{EI}dx = \int_0^{10} \frac{(15x_1 - x_1^2)(1 - \frac{1}{20}x_1)dx_1}{EI} + \int_0^{10} \frac{(5x_2)(\frac{1}{20}x_2)dx_2}{EI}$$

$$= \frac{291.67}{EI} + \frac{83.33}{EI} = \frac{375}{EI}$$

For θ_B we require application of the real loads, Fig. 8–8*c*, and a virtual unit couple at *B*, Fig. 8–8*e*. Thus,

$$\theta_B = \Sigma\int \frac{Mm_\theta}{EI}dx = \int_0^{10} \frac{(15x_1 - x_1^2)(\frac{1}{20}x_1)dx_1}{EI} + \int_0^{10} \frac{(5x_2)(1 - \frac{1}{20}x_2)dx_2}{EI}$$

$$= \frac{125}{EI} + \frac{166.7}{EI} = \frac{291.7}{EI}$$

For α_{AA} we require application of a *real* unit couple acting at *A*, Fig. 8–8*d*, and a *virtual* unit couple acting at *A*, Fig. 8–8*d*. Using the x_2 coordinate, since it is easier to integrate, we have

$$\alpha_{AA} = \int \frac{m_\theta m_\theta}{EI}dx = \int_0^{20} \frac{(\frac{1}{20}x_2)^2 dx_2}{EI} = \frac{6.67}{EI}$$

In a similar manner for α_{BB}, Fig. 8–8*e*, we have

$$\alpha_{BB} = \int \frac{m'_\theta m'_\theta}{EI}dx = \int_0^{20} \frac{(\frac{1}{20}x_1)^2 dx_1}{EI} = \frac{6.67}{EI}$$

For α_{AB} we require application of a real unit couple acting at *B*, Fig. 8–8*e*, and a virtual unit couple acting at *A*, Fig. 8–8*d*. Since there is no discontinuity of loading across the beam for these loadings, we can use a single *x* coordinate. Choosing x_1, we have

$$\alpha_{AB} = \Sigma\int \frac{m'_\theta m_\theta}{EI}dx = \int_0^{20} \frac{(\frac{1}{20}x_1)(1 - \frac{1}{20}x_1)dx_1}{EI}$$

$$= \frac{3.33}{EI}$$

Note that $\alpha_{BA} = \alpha_{AB}$, a consequence of Maxwell's theorem of reciprocal deflections.

Substituting the data into Eqs. (1) and (2) yields

$$0 = \frac{375}{EI} + M_A\left(\frac{6.67}{EI}\right) + M_B\left(\frac{3.33}{EI}\right)$$

$$0 = \frac{291.7}{EI} + M_A\left(\frac{3.33}{EI}\right) + M_B\left(\frac{6.67}{EI}\right)$$

Canceling *EI* and solving these equations simultaneously, we have

$$M_A = -45.8 \text{ k} \cdot \text{ft} \qquad M_B = -20.8 \text{ k} \cdot \text{ft} \qquad \textit{Ans.}$$

Using these results, the end shears are calculated, Fig. 8–8*f*, and the shear and moment diagrams plotted.

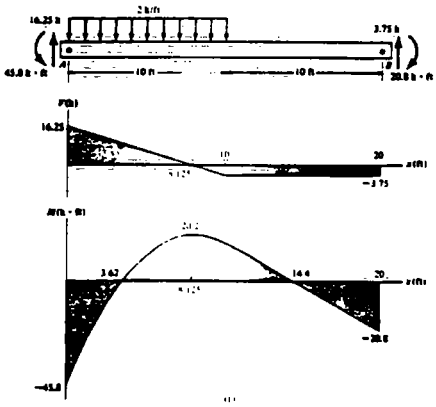


Fig. 8–8f

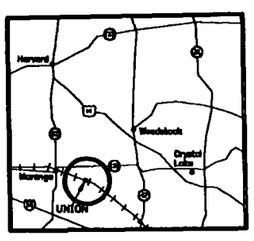
APPENDIX F

CONSTRUCTION DRAWINGS

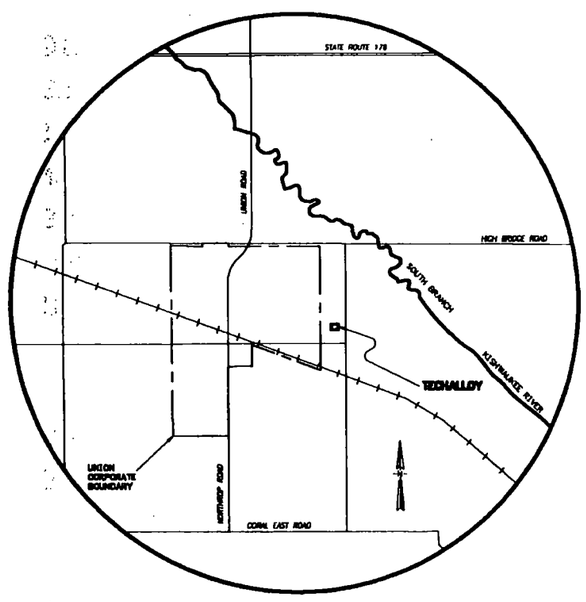
TECHALLOY COMPANY, INC.

GROUNDWATER TREATMENT SYSTEM INTERIM MEASURES

Union, Illinois
August 1993



McHENRY COUNTY



UNION

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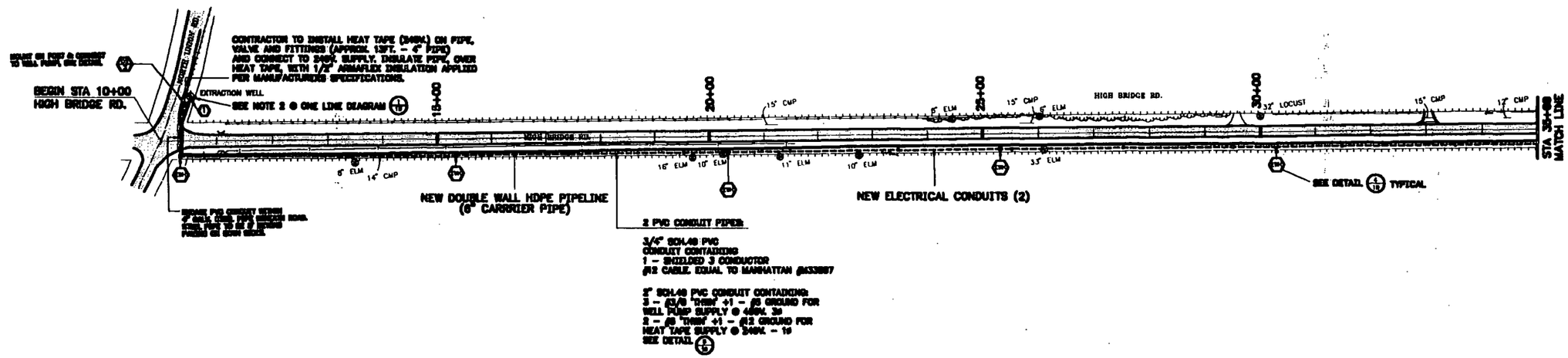
1. GENERAL SITE PLAN and LEGEND
2. GENERAL SITE PLAN
3. PIPING PLAN and DETAILS – HIGHBRIDGE ROAD
4. PIPING PLAN and DETAILS – OLSON ROAD
5. TREATMENT BUILDING PLOT AND SITE PLAN
6. TREATMENT BUILDING FLOOR PLAN
7. TREATMENT BUILDING ELEVATIONS AND PROCESS FLOW DIAGRAM
8. TREATMENT BUILDING ELECTRICAL PLAN
9. ELECTRICAL SYSTEM MATERIAL LIST
10. ELECTRICAL DETAILS
S1. STRUCTURAL FLOOR PLAN
S2. STRUCTURAL SECTIONS AND DETAILS
S3. STRUCTURAL SECTIONS AND DETAILS
S4. AIR STRIPPER FOUNDATION

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061



LEGEND

- TAR AND CHIP ROADWAY
- 15" CMP — CORRUGATED METAL PIPE
- FENCE
- RIGHT OF WAY
- EXISTING TELEPHONE
- TREELINE
- CULVERT
- ROADWAY GUARDRAIL
- UTILITY POLE
- NEW ELECTRICAL LINE
- NEW WIRE PULLING HANDHOLE (EWH)

0 100' 200'
1"=100'

REV	DATE	BY	DESCRIPTION

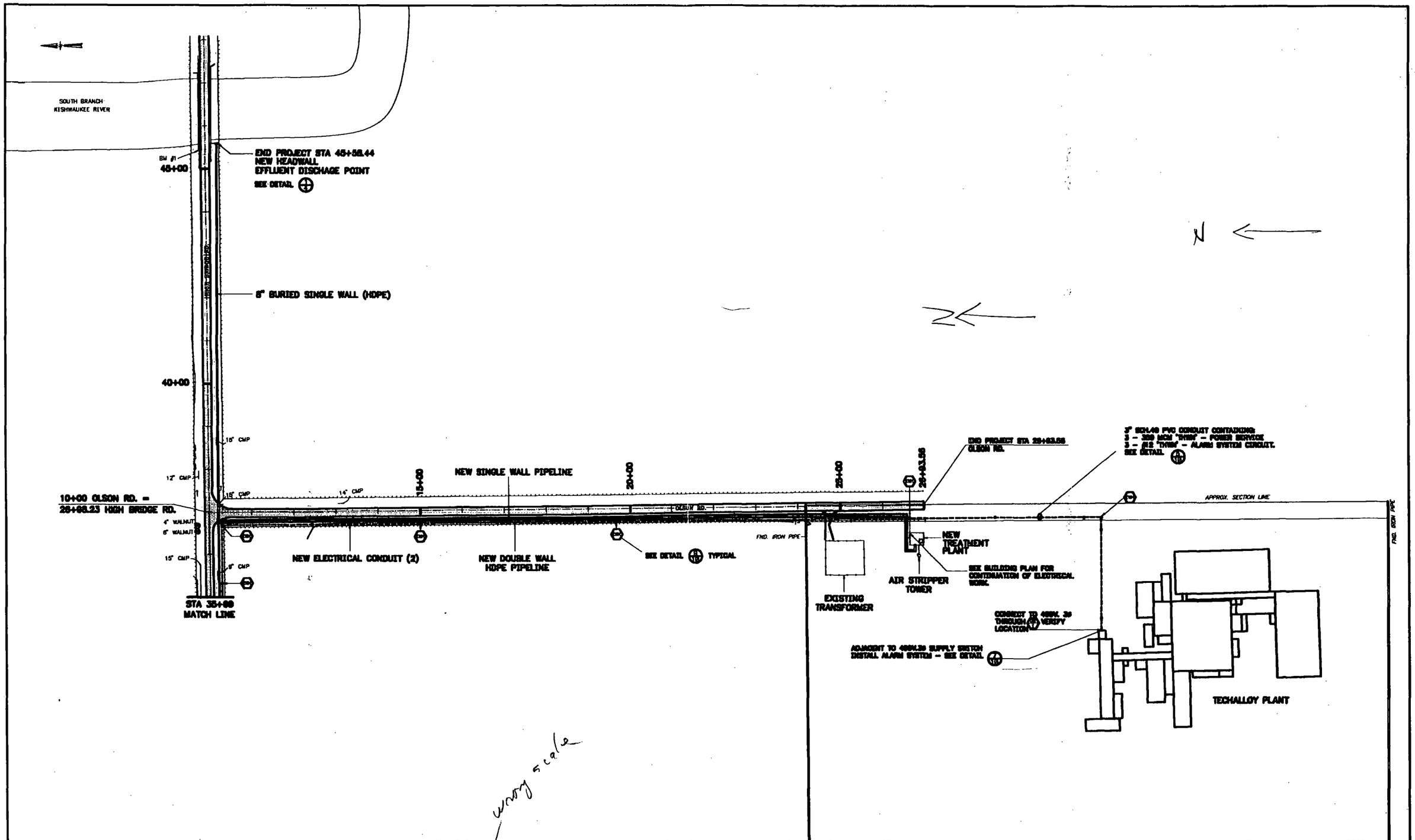
WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

GENERAL SITE PLAN AND LEGEND

TECHALLOY COMPANY, INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
1" = 100'	R.J.B	08-25-93	72593	SHEET 1 OF 14



REV.	DATE	BY	DESCRIPTION

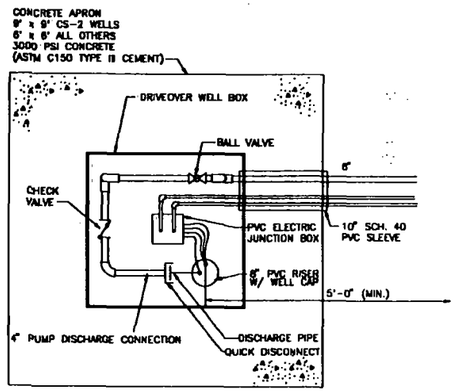
WESTON
MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

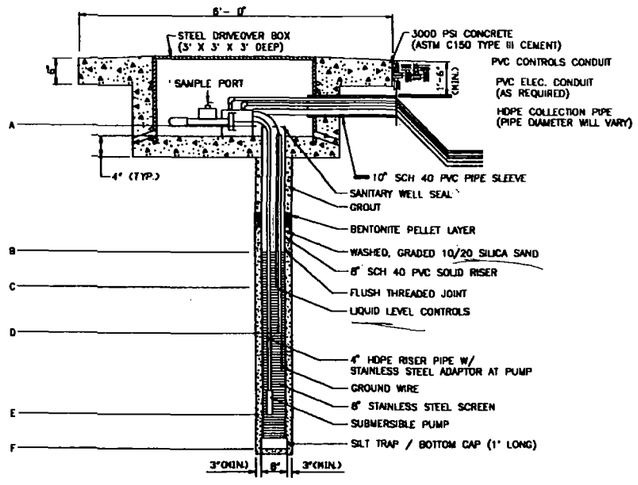
GENERAL SITE PLAN

TECHALLOY COMPANY, INC.
Union, Illinois

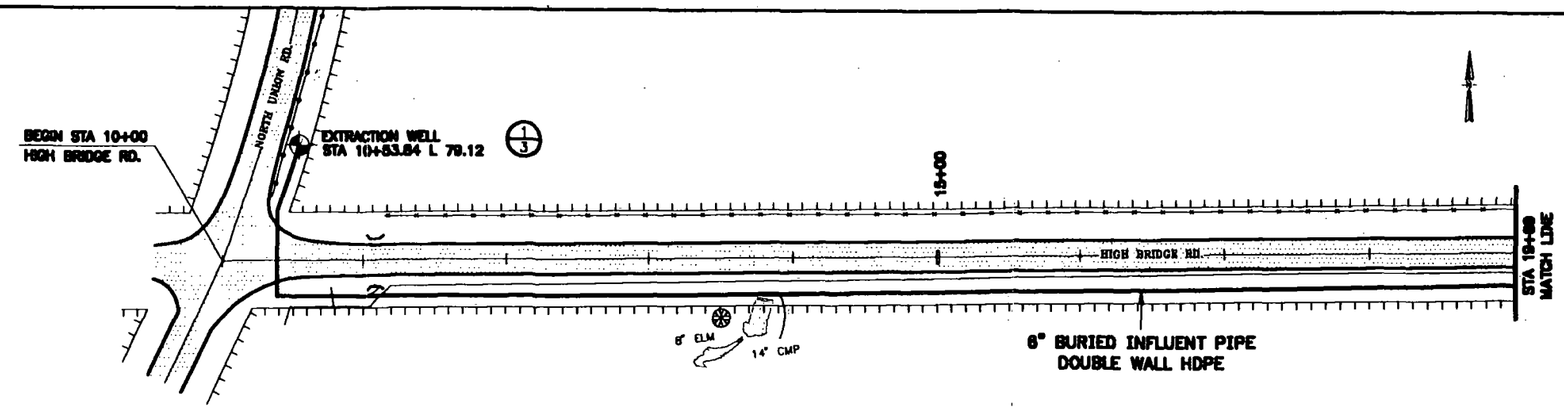
SCALE:	DRAWN:	DATE:	DWG. NO.	
1" = 100'	R.LB	08-25-93	74193	SHEET 2 OF 14

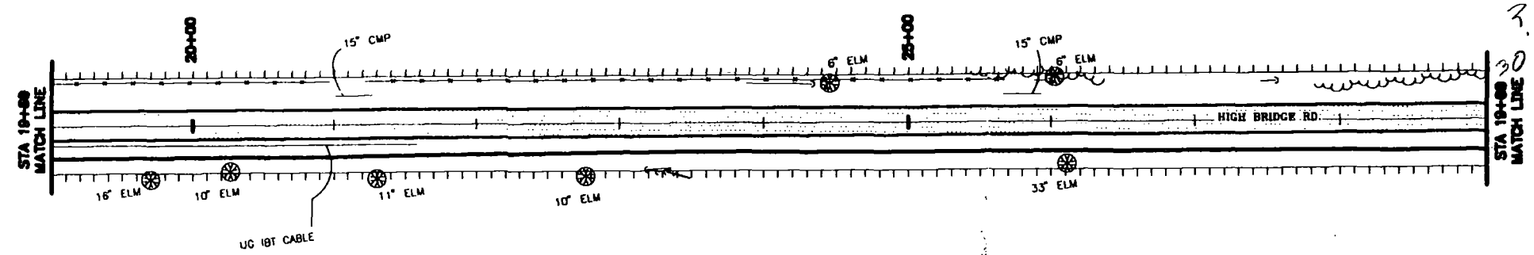


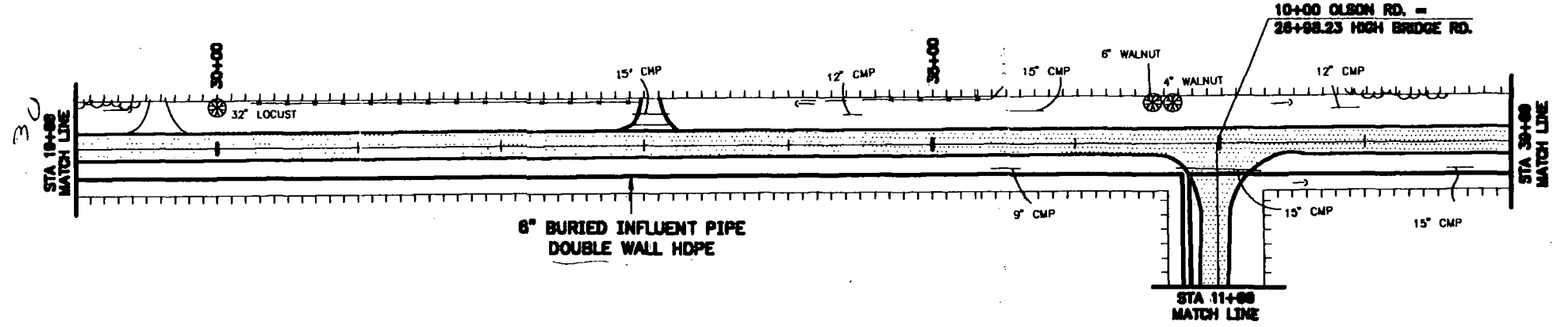
PLAN

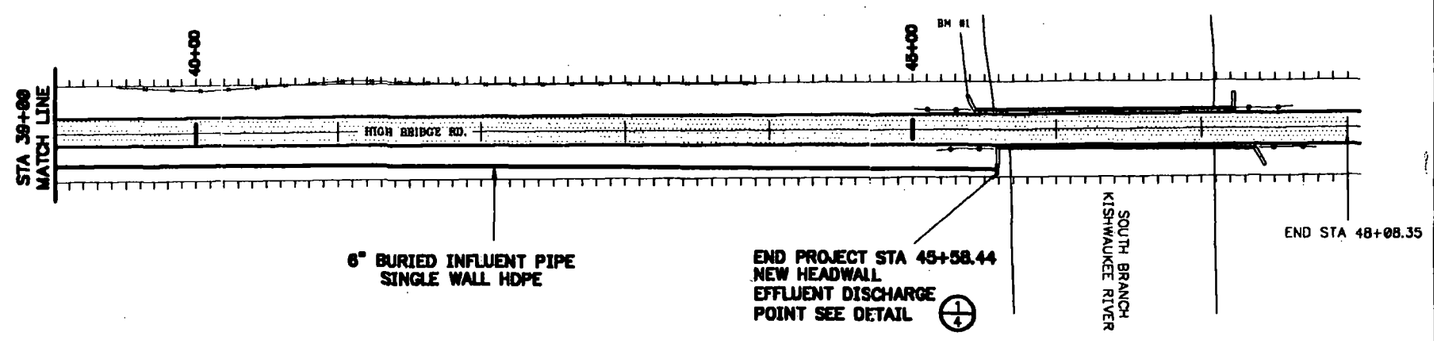


EXTRATION WELL DETAIL 1/3
NTS









0 50' 100'
1"=50'

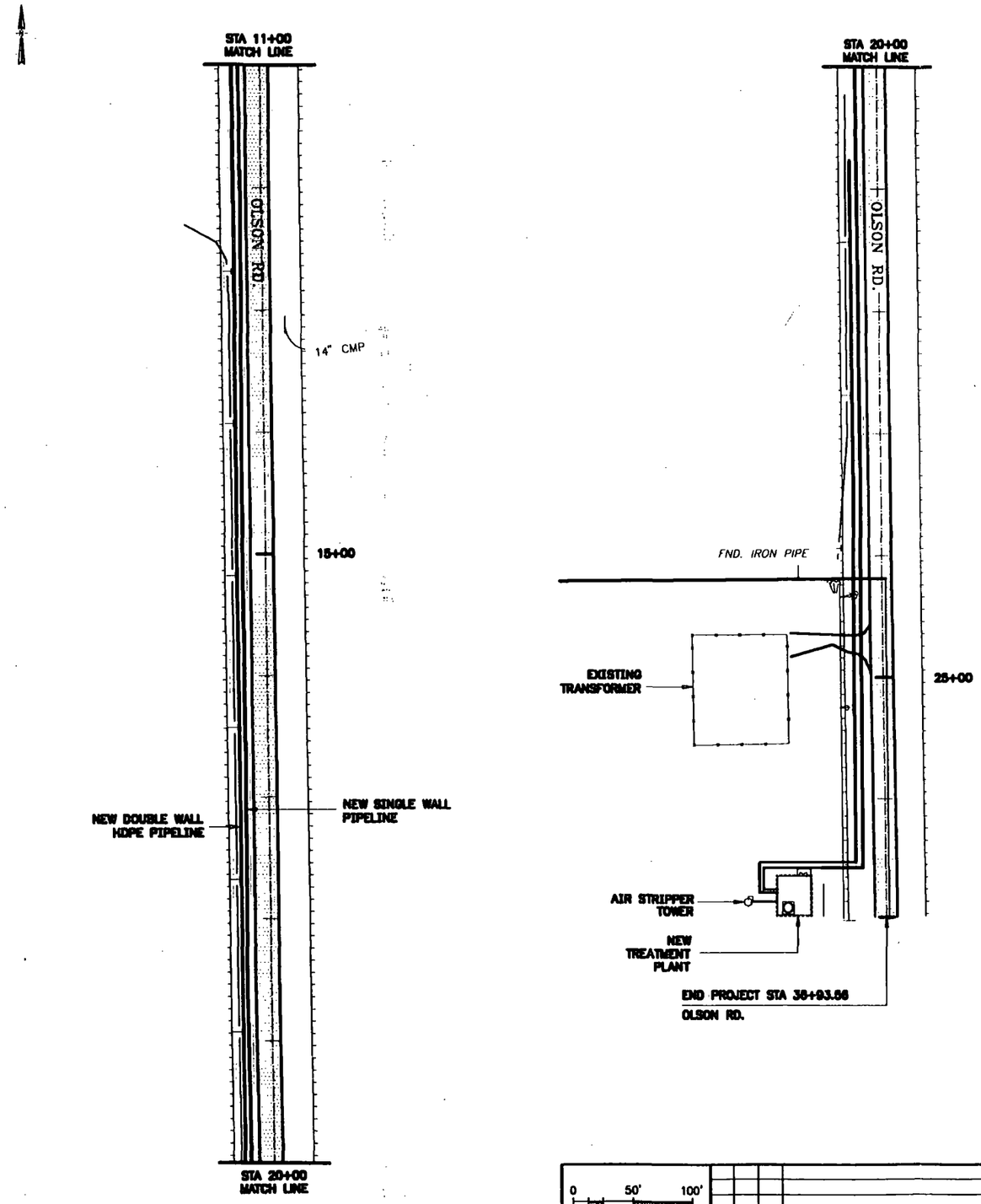
REV.	DATE	BY	DESCRIPTION

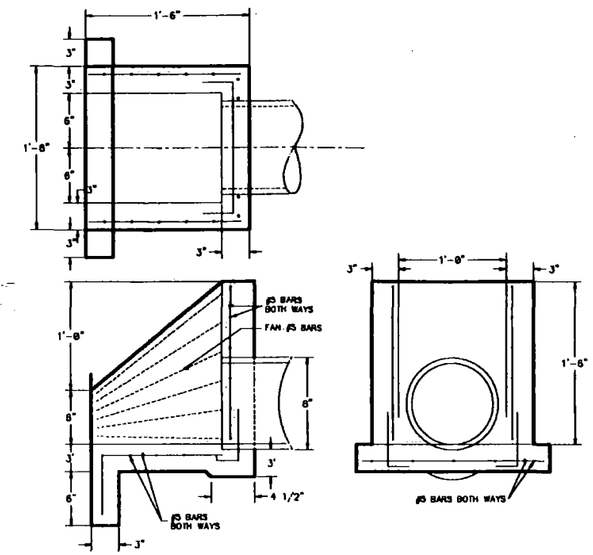
WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

PIPING PLANS AND DETAILS
HIGHBRIGE ROAD
TECHALLOY COMPANY, INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
1" = 50'	R.J.B	08-25-93	73293	SHEET 3 OF 14





REINFORCED CONCRETE HEADWALL 1/4
NTS

0 50' 100'
1"=50'

REV	DATE	BY	DESCRIPTION

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

PIPING PLAN AND DETAILS
OLSON ROAD
TECHALLOY COMPANY, INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
1" = 100'	R.J.B	08-25-93	74693	SHEET 4 OF 14

834

EDGE OF DRIVE TO EXISTING ROAD AND MATCH IN ELEVATION

18'-6" RAD.

18'-6" RAD.

+834.33

SLOPE TO EXISTING ROAD

AGGREGATE DRIVE

18'-6"

CARRIER PIPE FROM GROUNDWATER EXTRACTION WELL

+834.50

A/6

6" EFFLUENT TO SOUTH BRANCH KISHWAUKEE RIVER

2" & 3/4" CONDUIT TO GROUNDWATER EXTRACTION WELL

62'-6"

25'-6"

TOP OF PAD 838.00

FLOOR ELEV. 834.50

PIPING TO/FROM AIR STRIPPER

32'-6"

32'-6"

43'-6"

15'-6"

4'-6"

835

STATION 27+00

28'-5"

28'-10"

834

834

28'-6"

64'-6"

3" CONDUIT TO TECHALLOY PLANT

834

ELEVATIONS AS CALLED FOR ON SITE PLAN

4" AGGREGATE SURFACE COURSE ILLINOIS DEPTMENT OF TRANSPORATION CLASS IDOT CA9 (COMPACTED TO 95%)

8" IDOT CA1 BASE COURSE

18'-6"

1/4"/FT

SECTION A/6

0 5' 10'

1"=5'-0"

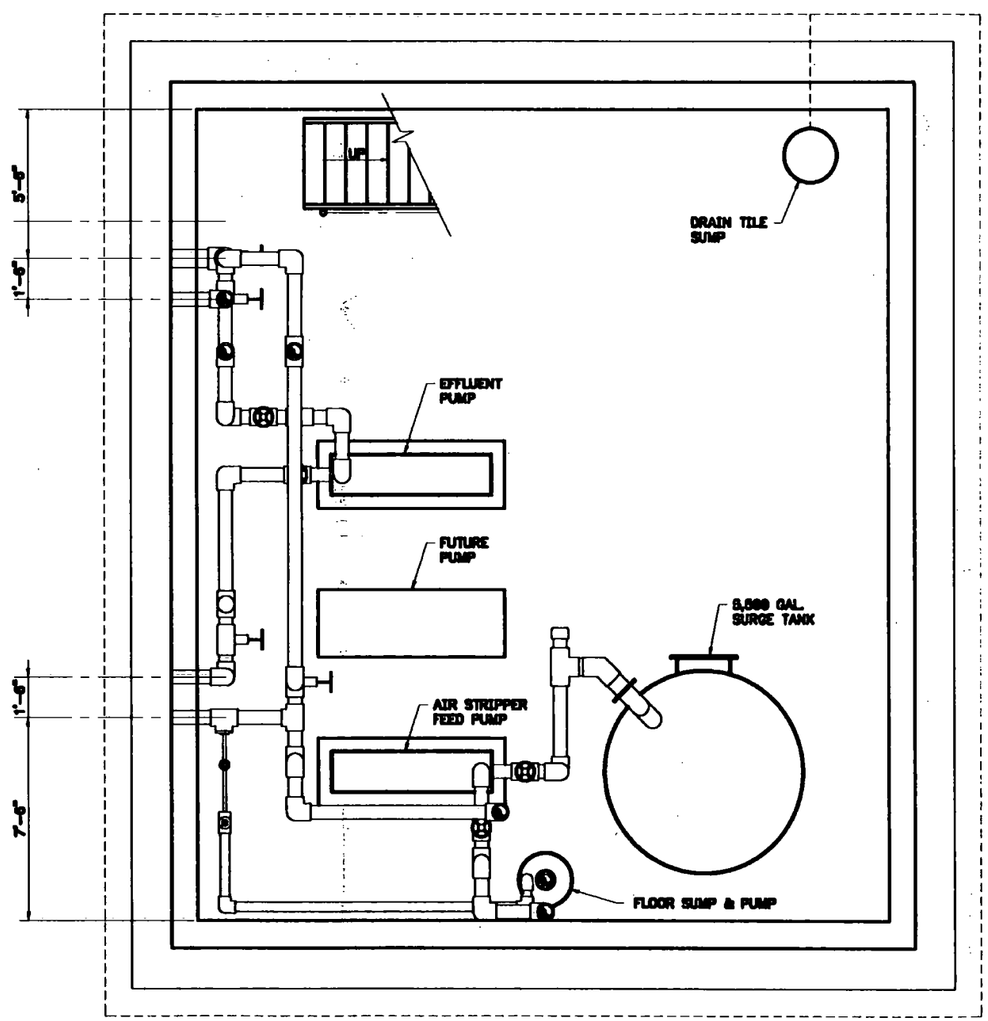
REV.	DATE	BY	DESCRIPTION

WESTON MANAGERS DESIGNERS/CONSULTANTS

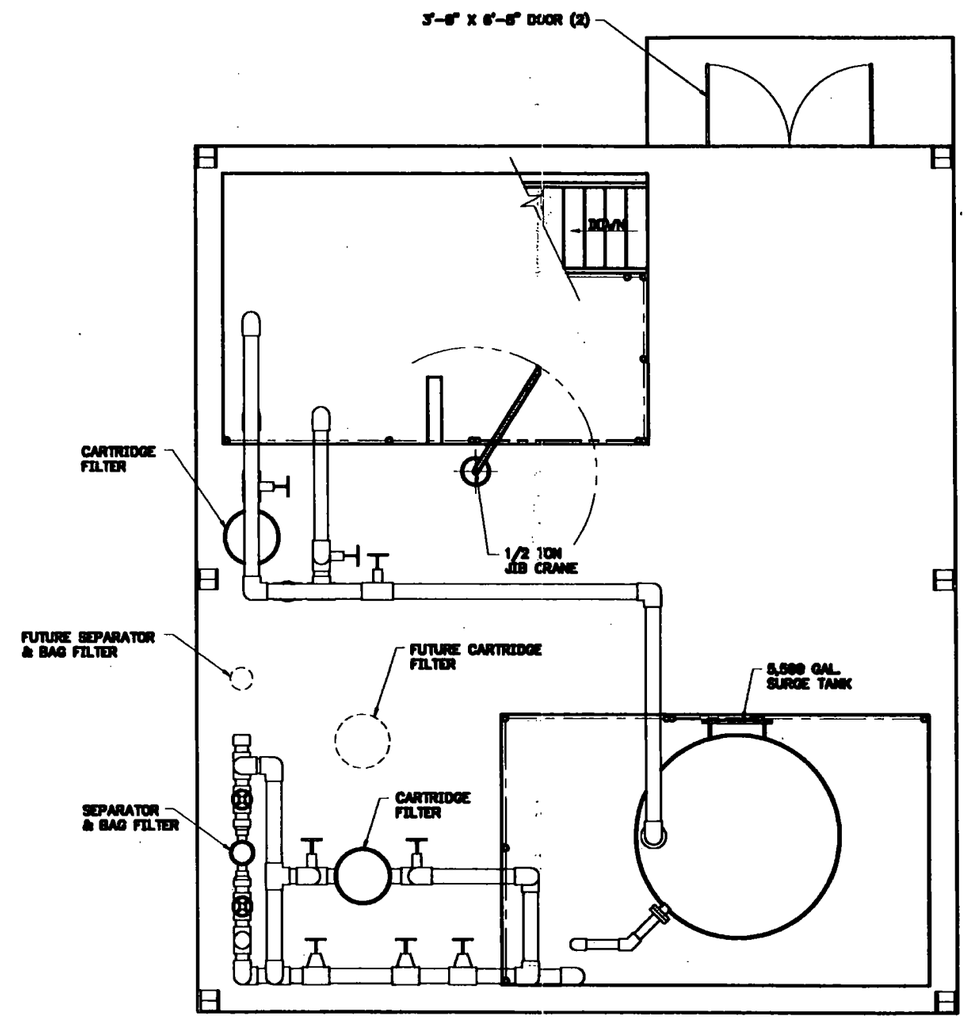
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

TREATMENT BUILDING PLOT AND SITE PLAN
TECHALLOY COMPANY INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
1"=5'-0"	T.A.D.	28 AUG 93	72093	SHEET 5 of 14



BASEMENT PLAN
3/8" = 1'-0"



1st FLOOR PLAN
3/8" = 1'-0"

0 2' 5'
3/8"=1'-0"

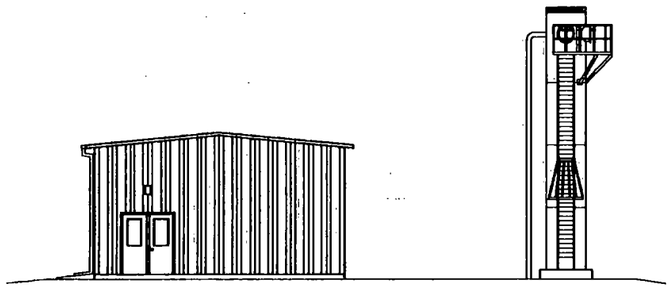
WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

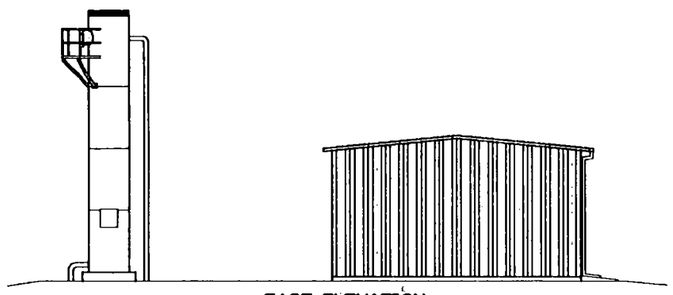
TREATMENT BUILDING FLOOR PLAN

TECHALLOY COMPANY INC.
Union, Illinois

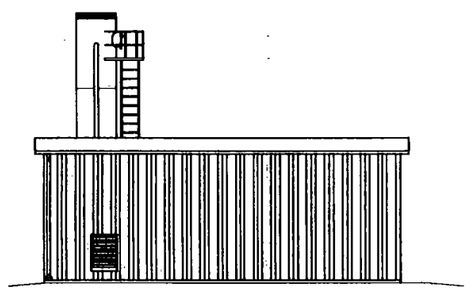
SCALE:	DRAWN:	DATE:	DWG. NO.	
3/8" = 1'-0"	T.A.D.	24 AUG 93	72193	SHEET 6 of 14



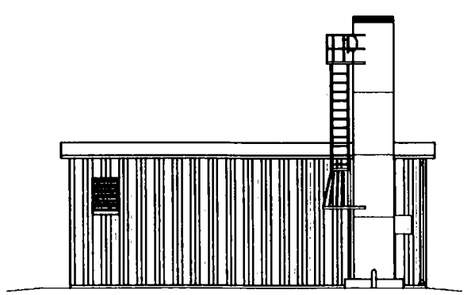
WEST ELEVATION
1/8" = 1'-0"



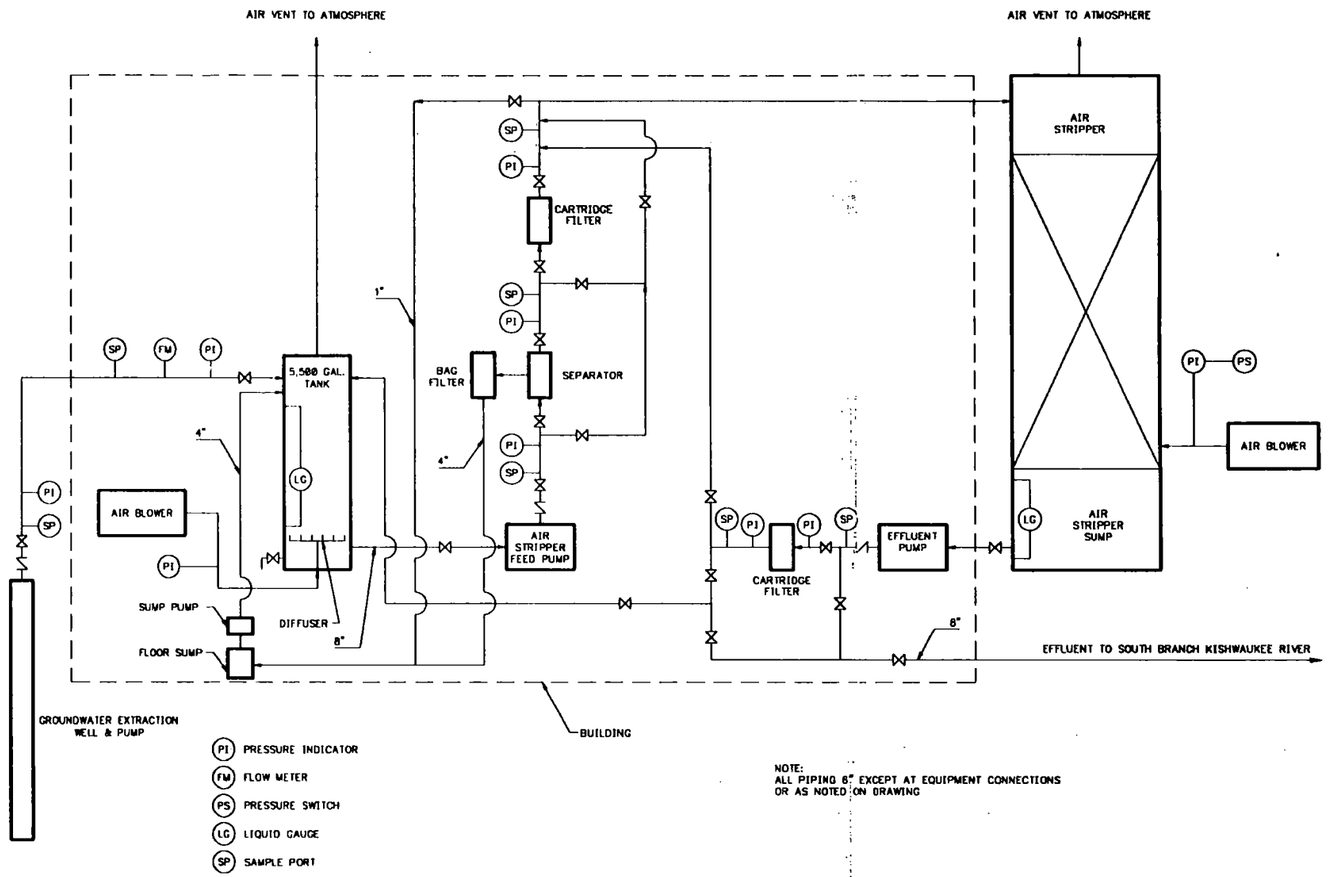
EAST ELEVATION
1/8" = 1'-0"



NORTH ELEVATION
1/8" = 1'-0"



SOUTH ELEVATION
1/8" = 1'-0"



NOTE:
ALL PIPING 8" EXCEPT AT EQUIPMENT CONNECTIONS OR AS NOTED ON DRAWING

PROCESS FLOW DIAGRAM

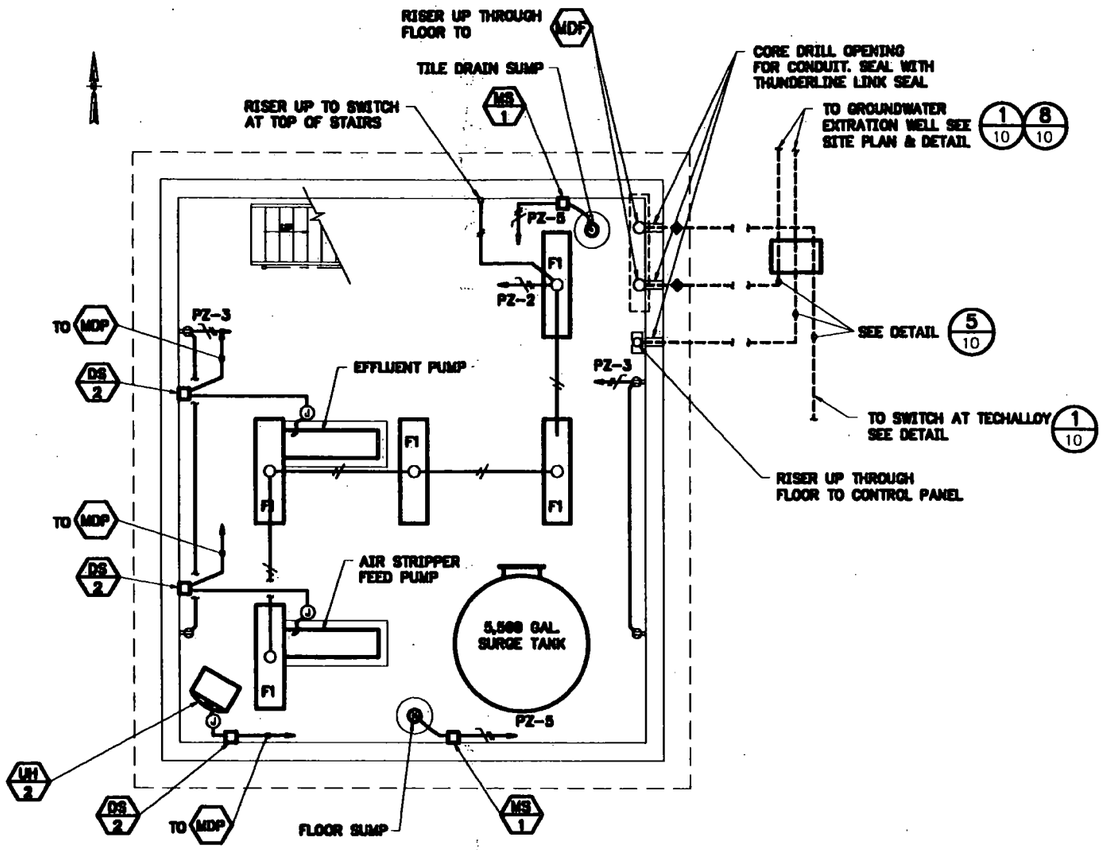
0 8' 16'
1/8"=1'-0"

REV.	DATE	BY	DESCRIPTION

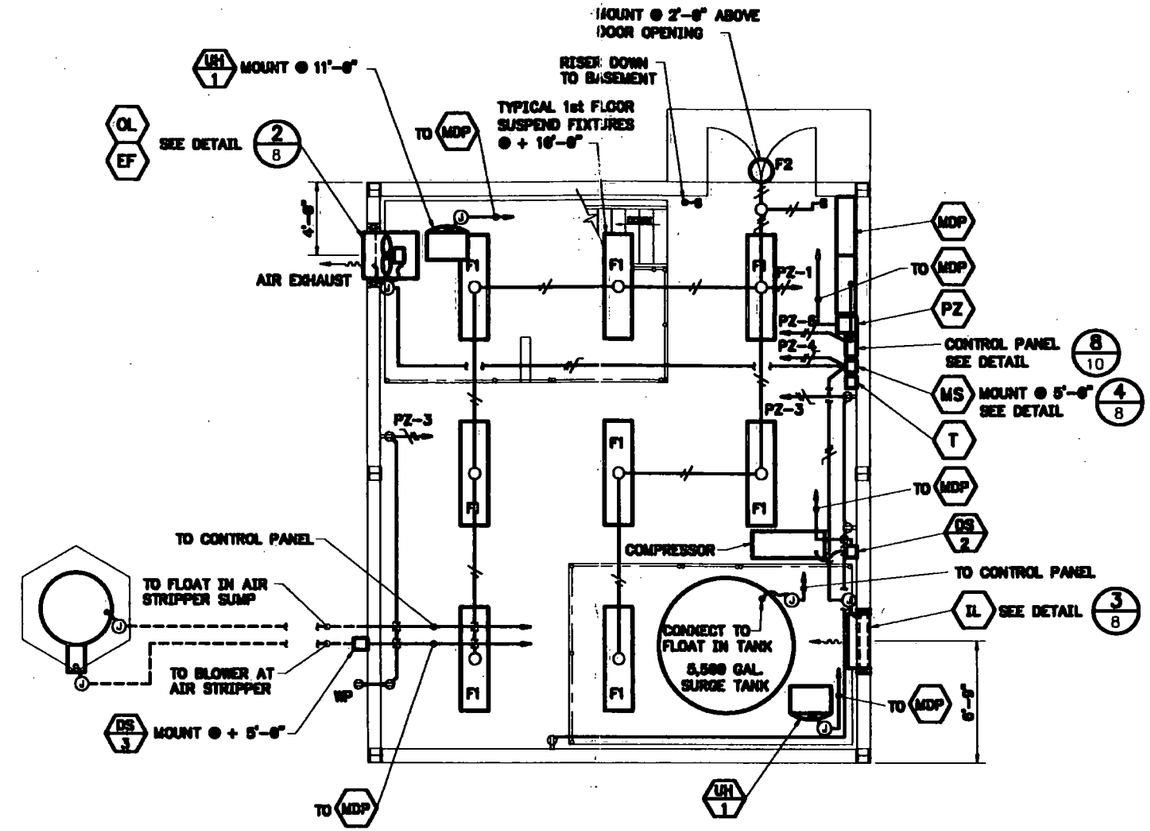
WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

TREATMENT BUILDING ELEVATIONS AND PROCESS FLOW DIAGRAM
TECHALLOY COMPANY INC.
Union, Illinois

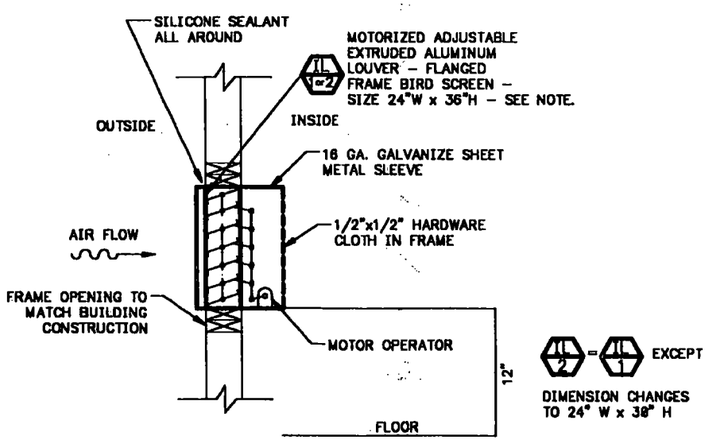
SCALE:	DRAWN:	DATE:	DWG. NO.	
1/8" = 1'-0"	T.A.D.	30 AUG 93	75693	SHEET 7 of 14



BASEMENT PLAN
1/4" = 1'-0"

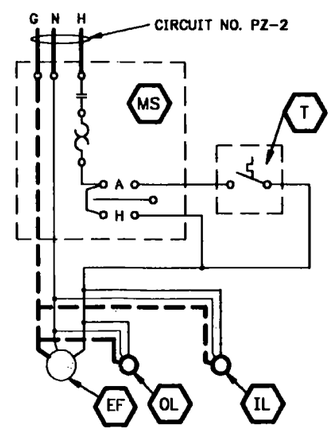


1st FLOOR PLAN
1/4" = 1'-0"

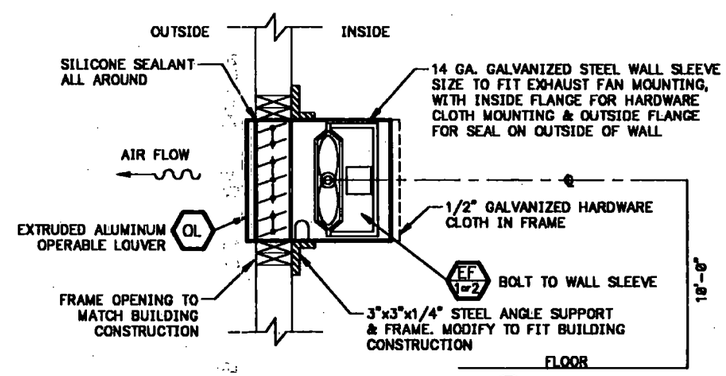


LOUVER DETAIL 3/8
NTS

IL 2 = IL 1 EXCEPT DIMENSION CHANGES TO 24" W x 38" H



EXHAUST FAN SCHEMATIC CONTROL DIAGRAM 4/8
NTS



EXHAUST FAN MOUNTING DETAIL 2/8
NTS

0 4' 8'
1/4" = 1'-0"

WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

TREATMENT BUILDING ELECTRICAL PLAN

TECHALLOY COMPANY INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
1/4" = 1'-0"	T.A.D.	29 AUG 93	75593	SHEET 8 of 14

GENERAL INSTALLATION NOTES:

1. ALL ELECTRICAL CONDUCTORS SHALL BE COPPER.
2. INDICATES NUMBER OF WIRES IN CONDUIT.

3. CIRCUIT NUMBERS ARE SHOWN FOR CIRCUIT IDENTIFICATION. CIRCUITING SHALL AGREE WITH NUMBERING ON THE PANEL PROVIDED. WHERE COMMON NEUTRAL IS USED FOR TWO OR THREE CIRCUITS, EACH SHALL ORIGINATE FROM OPPOSITE PHASE LEGS OF THE PANEL BUS. BALANCE THE LOAD ON PANEL AS EVENLY AS POSSIBLE BETWEEN EACH PHASE.
4. A #12 GREEN INSULATED GROUND CONDUCTOR SHALL BE INSTALLED WITH CIRCUIT CONDUCTORS TO ALL RECEPTACLES.
5. MOUNT ALL TOGGLE SWITCHES AT +40" FROM FLOOR (℄ DIMENSION), EXCEPT WHERE OTHERWISE NOTED.
6. MOUNT ALL DUPLEX RECEPTACLES AND TELECOMMUNICATION OUTLETS AT +18" FROM FLOOR (℄ DIMENSION), EXCEPT WHERE OTHERWISE NOTED.
7. CONTRACTOR SHALL VERIFY ALL EQUIPMENT LOCATIONS PRIOR TO MAKING THE ACTUAL ELECTRICAL INSTALLATION AND SHALL ADJUST OUTLET OR CONNECTION LOCATIONS TO ACCOMMODATE EQUIPMENT.
8. ELECTRICAL EQUIPMENT SHALL BE MOUNTED SO AS TO AVOID IMPEDANCE OF OPERATION OF AND/OR ACCESS TO ELECTRICAL AND MECHANICAL EQUIPMENT. ALL MOUNTING OF ELECTRICAL GEAR ON EQUIPMENT SUPPLIED BY ANOTHER CONTRACTOR SHALL BE APPROVED IN ADVANCE BY THE OTHER CONTRACTOR.
9. ALL FINAL ELECTRICAL CONNECTIONS TO MOTORS SHALL BE MADE WITH FLEXIBLE METAL CONDUIT. USE LIQUIDTIGHT CONDUIT AND FITTINGS. ROUTE GROUND WIRE FROM CIRCUIT GROUND TO MOTOR GROUND THROUGH FLEXIBLE CONDUIT. FLEXIBLE CONDUIT SHALL NOT EXCEED 6' IN LENGTH.
10. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN WALLS. ALL OPENINGS SHALL BE REPAIRED TO MATCH EXISTING BY A QUALLIFIED CONTRACTOR AT THE EXPENSE OF THIS CONTRACTOR. CONDUITS SHALL BE GROUTED OR SEALED INTO OPENINGS.
11. REFER TO MATERIAL LIST AND SPECIFICATIONS FOR FULL DESCRIPTIONS AND MANUFACTURES OF ALL DEVICES.
12. ALL CONDUIT SHALL BE IMC (INTERMEDIATE GALVANIZED STEEL) OR RGS (RIGID GALVANIZED STEEL)

MATERIAL LIST

THE SYMBOLS AND THE MATERIAL LIST ARE FOR THE CONVENIENCE OF THE CONTRACTOR. EACH CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF QUANTITIES AND SHALL FURNISH ALL MATERIAL REQUIRED, WHETHER SPECIFIED OR NOT, TO PRODUCE A SATISFACTORY WORKING SYSTEM.

CATALOG NUMBERS SHALL NOT BE CONSIDERED COMPLETE BUT ARE GIVEN ONLY TO AID THE CONTRACTOR IN THE SEARCH FOR MATERIAL. NO MATERIAL SHALL BE ORDERED BY MANUFACTURER AND CATALOG NUMBER ONLY. EACH CONTRACTOR SHALL FIRST READ THE COMPLETE DESCRIPTION OF THE MATERIAL ON THESE DRAWINGS AND IN THE SPECIFICATIONS. THE FIRST MANUFACTURER LISTED IS THE BASIS OF DESIGN. "STANDARD COLOR" INDICATES FACTORY FINISH COLORS AVAILABLE AT NO ADDITIONAL CHARGE.

WHERE SEVERAL DEVICES ARE GANGED TOGETHER, THE PLATE SHALL BE OF THE GANGED STYLE FOR THE NUMBER OF DEVICES USED.

ITEM	SYMBOL	DESCRIPTION	MANUFACTURER & CATALOG NO.
1	F1	2/40 W – 4' Industrial type fluorescent fixture – 120 V 60Hz – HPF – rapid start ballast – porcelain enameled reflector with 10% up light – cool white lamps	Day-Brite #FL-1024-4U Lithonia Hubbell
2	F2	70 W. high pressure sodium wall mounted fixture – 120V – 60Hz – normal power factor ballast – –40°F starting – injection molded polycarbonate or aluminum housing – high reflective aluminum reflector – UV light stabilized prismatic polycarbonate refractor – Vandal resistant set screws – photo-electric sensor – outdoor weatherproof service	Hubbell #NRG-307-pc Day Brite Lithonia
3		Duplex receptacle outlet – 20 Amp. – 125V. Three wire grounding specification type. Mount in FS or FD box with cast cover plate– Mount @ =18".	Hubbell #5362 Arrow P & S G.E.
4	WP	Duplex receptacle outlet – 20 Amp. – 125V. Three wire grounding specification type. Flush mount in building siding and provide a weatherproof cover – Mount @ =18".	Hubbell #5362 plus #5205 WO P & S Arrow G.E.
5	S	Single pole wall switch – 120/277V. – 20 Amp. Specification grade. Mount in FS or FD box with steel cover – Mount @ +48".	Hubbel #1221 P & S Arrow G.E.
6	DS 1	200 Amp – 480V. – 3 pole Heavy Duty fusible switch–NEMA–12 enclosure	Sq. D.
7	DS 2	30 Amp – 480V. – 3 pole heavy duty non-fused switch – NEMA – 1 enclosure	Sq. D.
8	DS 3	30 Amp – 480V. – 3 pole heavy duty non-fused switch – NEMA – 3R enclosure	Sq. D.
9	MDP	Main service and distribution switchboard– 480 volt – 3 phase – Dead front type – to contain the following – 1–200 Amp. fused main switch – ground bar – Neutral bar – 200 amp. bus through out 4–30 Amp. fused distribution switches – 2–size 1 combination fused switch and magnetic motor starter, primary and secondary fused control transformer (120V. sec.), 2 extra auxiliary contacts, 3 overload elements, H–O–A selector switches and red push to test pilot light in cover. 2–size 2 combination fused switch and magnetic motor starter, primary and secondary fused control transformer (120V. sec.), 2 extra auxiliary contacts, 3 overload elements, H–O–A selector switches and red push to test pilot light in cover. 1–space for future size 2 combination starter. Unused space to have provision for future addition of switches and/or combination starter. Switchboard to be free standing and will be set on a concrete housekeeping pad. Phase failure/reversal relay with contacts to interlock with the five starter coils.	Sq. D. See one line diagram and specifications.
10	L.A.	Lightning arrester – for 480v. – 3 phase service	Sq. D. 8671–SP3650
11	MS	Manual motor starter 120 V. – 60Hz – thermal motor overloads sized for motor current – H.O.A. selector switch – Nema 1 enclosure	Sq. D. #2510–fg71 Westinghouse G.E.

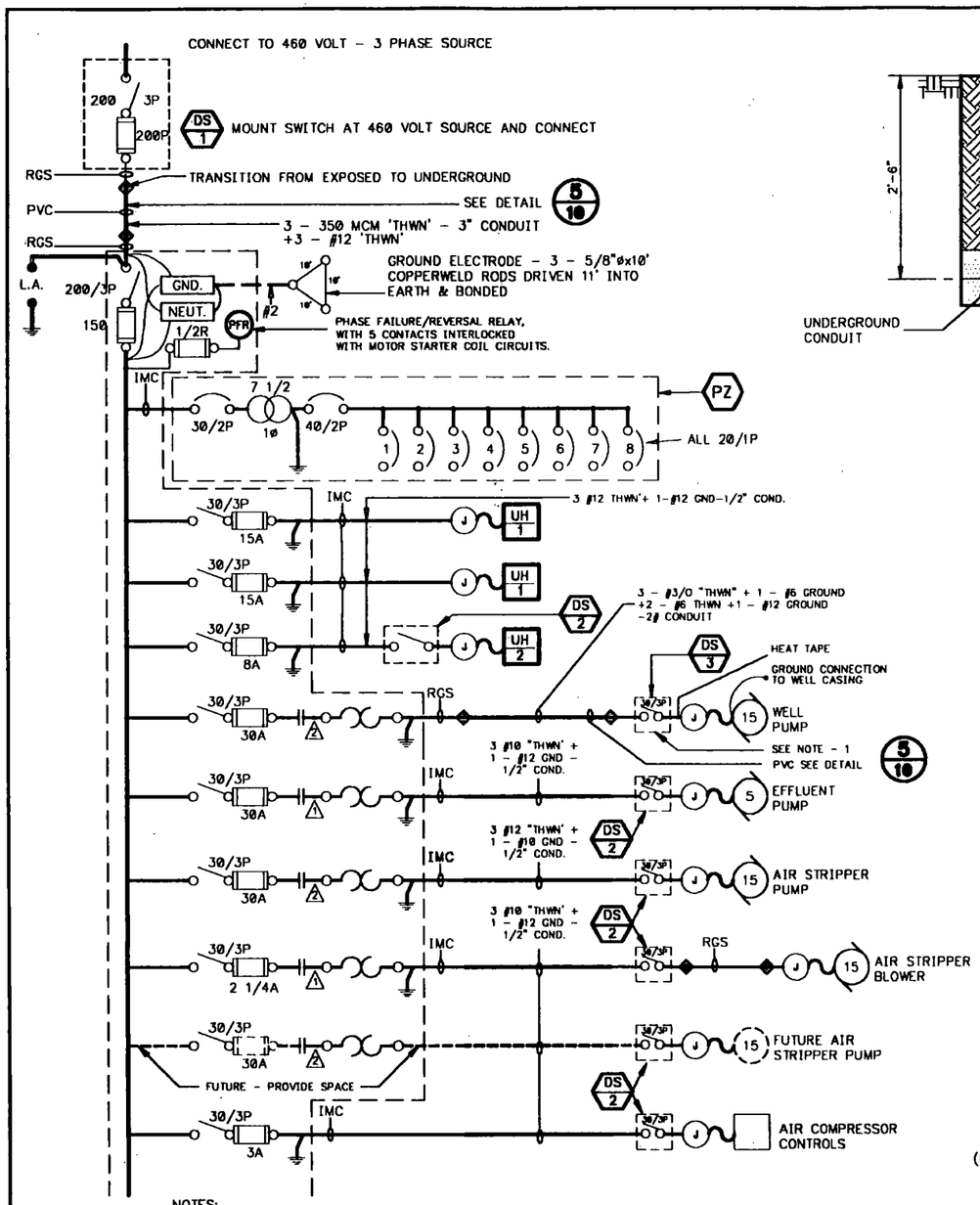
ITEM	SYMBOL	DESCRIPTION	MANUFACTURER & CATALOG NO.
12	MS 1	Manual motor switch – 120V. 60Hz – Nema 1 enclosure.	Sq. D. #2510–KG–1 Westinghouse G.E.
13	UH 1	7–1/2KW – 480 Volt – 3 phase electric unit heater – suspended type – built in power controls – metal sheathed heating elements – adjustable discharge louvers – element protection – magnetic contractor – integral thermostat – dynamically balanced fan – built in overload protection – ceiling mounting bracket	Q'Mark # MUH–07–4 plus #MT–1
14	UH 2	Same as UH/1 except 5.0 KW	Q'Mark # MUH–05–41 plus #MT–1
15	EF	Panel type wall exhaust fan – 2669 cfm @ 1/8" S.P– direct drive – 1/6 HP – 120V – 60Hz	Cook type AWD–20A11D
16	OL	Extruded aluminum air outlet operable louver – standard mill finish – 0.081" extruded aluminum jambs, head and sill – 1/2" dia. shafts – nylon bearings – plated steel blade linkage – flange frame – 1/2" x 1/2" aluminum screen in frame on outside – vinyl blade edges to seal – 2 positions 120 Volt motor operator (not stall type) – size to match exhaust fan mounting sleeve	Dowco #AEK–4–1–0–3–5 Arrow
17	IL	Same as Item No. 16 except size = 36" wide x 42" high and with 1/2" x 1/2" aluminum screen in a frame on inside and outside	Dowco #AEK–4–1–0–3–5 Arrow
18	T	Line voltage thermostat 120 V. – 60Hz – 8.0 Amp. Mount on FS or FD box	Honeywell #T6051A
19	PZ	Power zone unit – 7 KVA single phase transformer and panelboard combination – 480 V. – 60Hz –30 Amp. primary circuit breaker (18KA) – 40 Amp. secondary circuit breaker – 2–5% FCBN taps – 6–20 Amp. – single pole circuit breaker panel distribution section	Sq. D. 7440–MPZ7S40F G.E.
20	EWH	Electrical wire pulling hand–hole	See detail on drawings.
21	–	Heat tape – to wrap approx. 13 ft. of 4" pipe – approx. 70' – 4ATV2, 1–PVC kit, 1–VCL end seal, 1–AMC–1B thermostat.	Chemelex
22	1	Alarm unit for location @ Techalloy	See Detail
23	2	Well water level control switch – 240 Volt–60 Hz – Solid state – Well electrodes – contractor to verify length required.	B/W Controls Model 1500–G

REV.	DATE	BY	DESCRIPTION

WESTON MANAGERS DESIGNERS/CONSULTANTS
2123 University Park Dr.
Okemos, Michigan
48864

ELECTRICAL SYSTEM MATERIAL LIST
TECHALLOY COMPANY, INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
NTS	R.W.S.	21 MAY 93	74793	SHEET 9 of 14



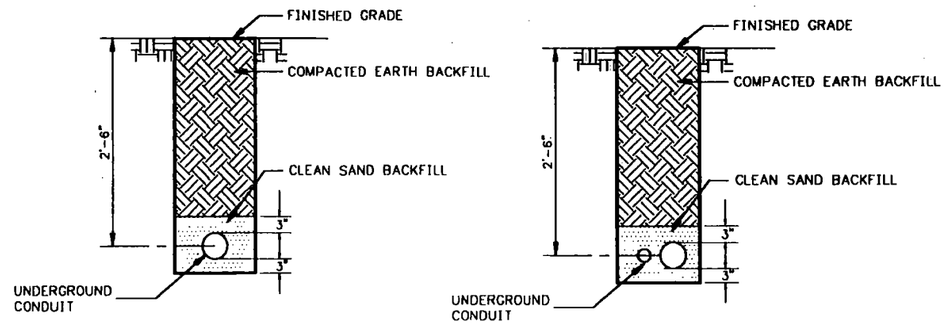
NOTES:

1 - PROVIDE WOLMANIZED OR CREOSOTE TREATED WOOD POST- (APPROX. 8" DIA. SET 4' INTO GROUND, 6' OUT OF GROUND) ADJACENT TO WELL. FLATTEN ONE SIDE AND MOUNT SWITCH TO POST USING NOT LESS THAN 4 - 3/8"ø GALV. LAG SCREWS.

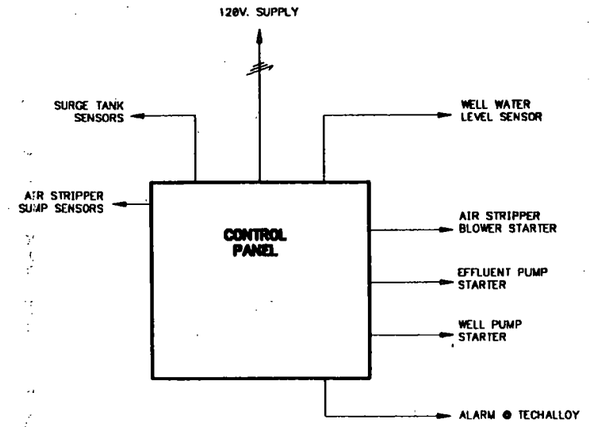
2 - IN THE UNDERGROUND CONDUIT RUN TO THE WELL PUMP MOTOR INCLUDE 2 - #6 'THWN' +1 - #12 GROUND (240 VOLT CIRCUIT FROM PZ) TO SUPPLY PIPE HEAT TAPE ON PIPING AT WELL PLUS POWER FOR POSSIBLE WELL WATER LEVEL SENSOR (VERIFY). MAKE CONNECTIONS.

RGS = RIGID GALVANIZED STEEL HEAVY WALL CONDUIT
IMC = INTERMEDIATE GALVANIZED STEEL CONDUIT
PVC = SCHEDULE 40 PVC CONDUIT

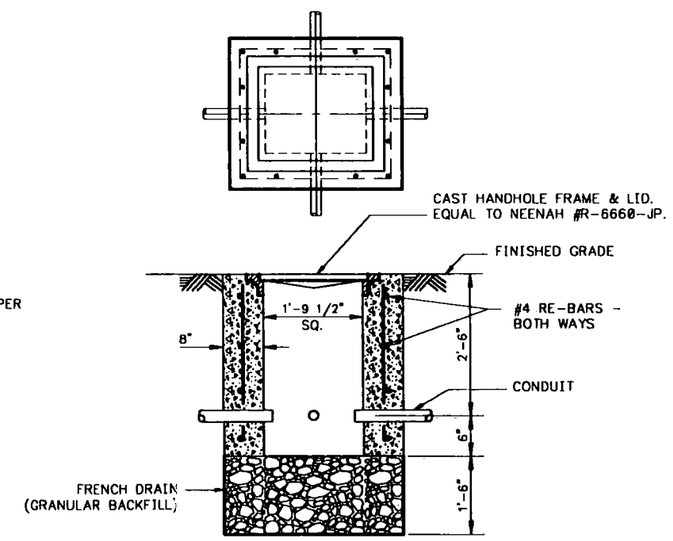
SINGLE LINE ELECTRICAL DIAGRAM 1/10
NTS



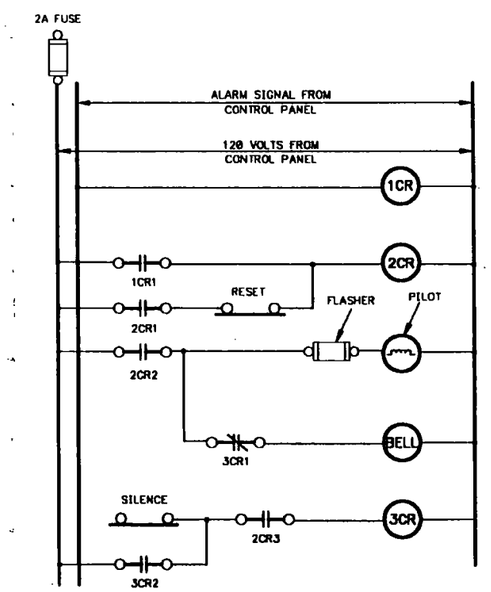
UNDERGROUND CONDUIT INSTALLATION (TYPICAL FOR POWER & TELEPHONE) 5/10
NTS



CONTROL PANEL SENSOR, CONTROL, ALARM DIAGRAM 8/10
NTS



TYPICAL WIRE PULLING HANDHOLE 9/10
NTS



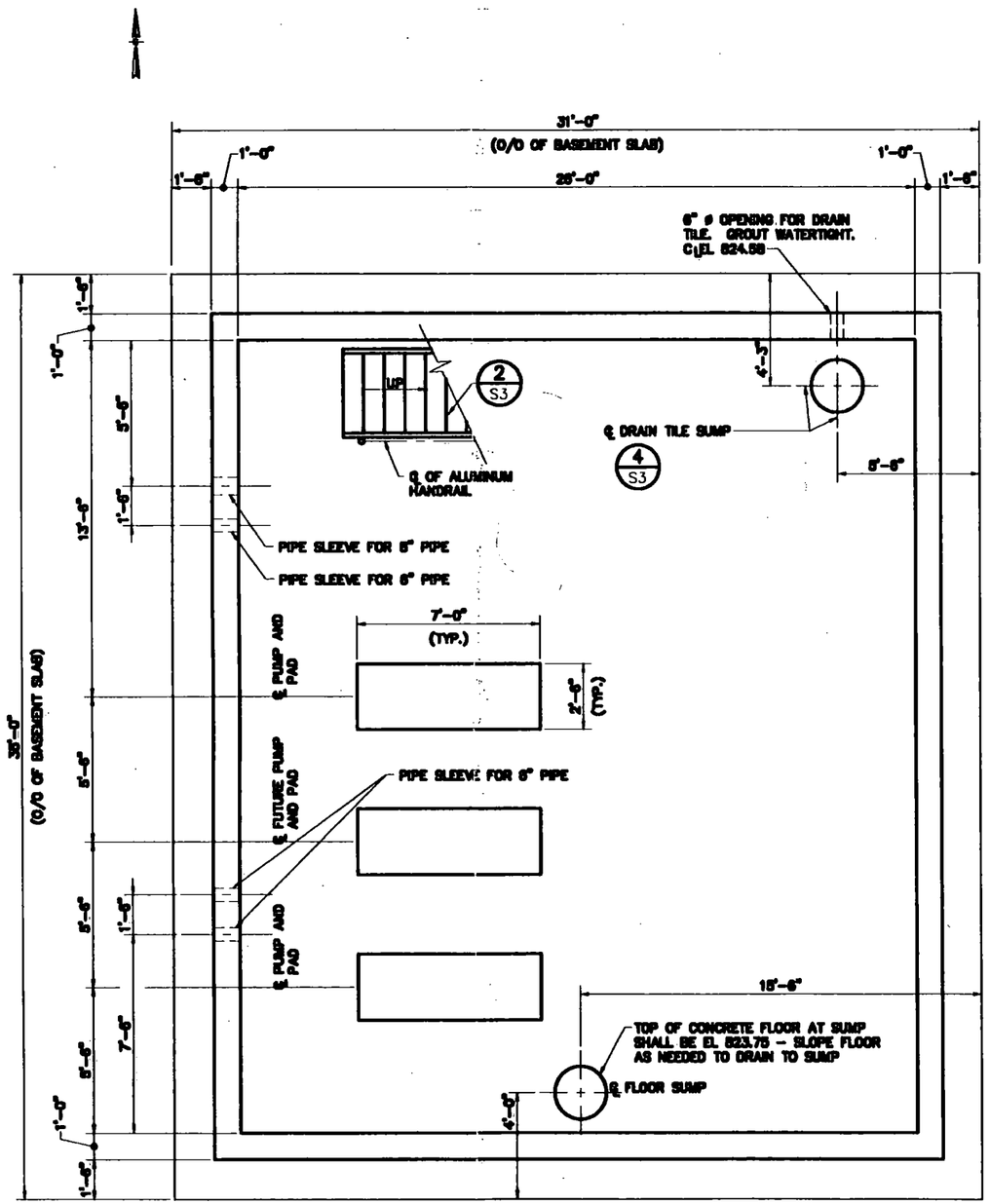
SCHEMATIC DIAGRAM FOR ALARM AT TECHALLOY 7/10
NTS

REV.	DATE	BY	DESCRIPTION

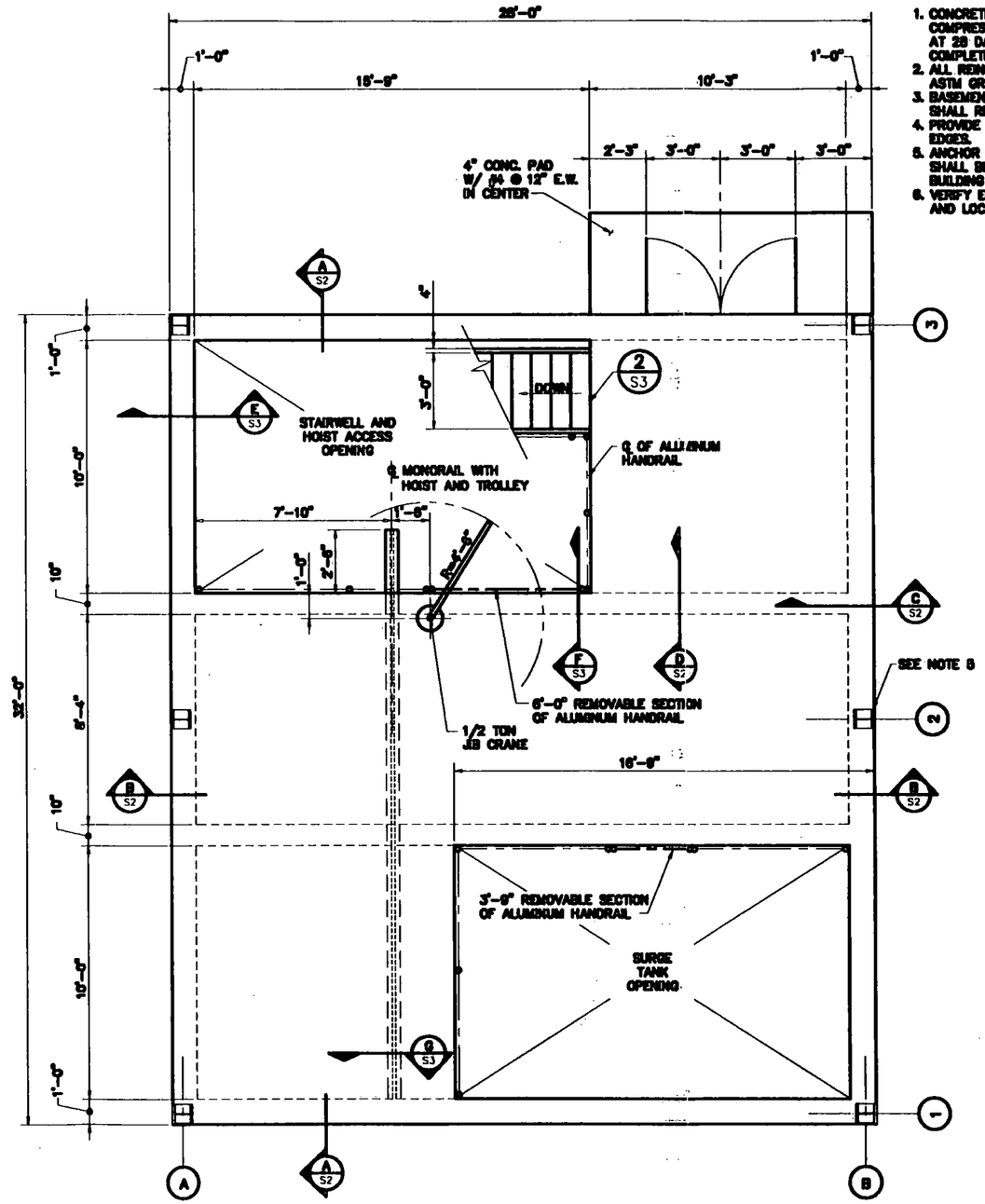
WESTON MANAGERS DESIGNERS/CONSULTANTS
2123 University Park Dr.
Okemos, Michigan
48864

ELECTRICAL DETAILS
TECHALLOY COMPANY, INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
NTS	T.A.D.	29 AUG 93	75393	SHEET 10 of 14



PLAN @ F.F. EL 823.83
3/8" = 1'-0"



PLAN @ F.F. EL 834.50
3/8" = 1'-0"

NOTES

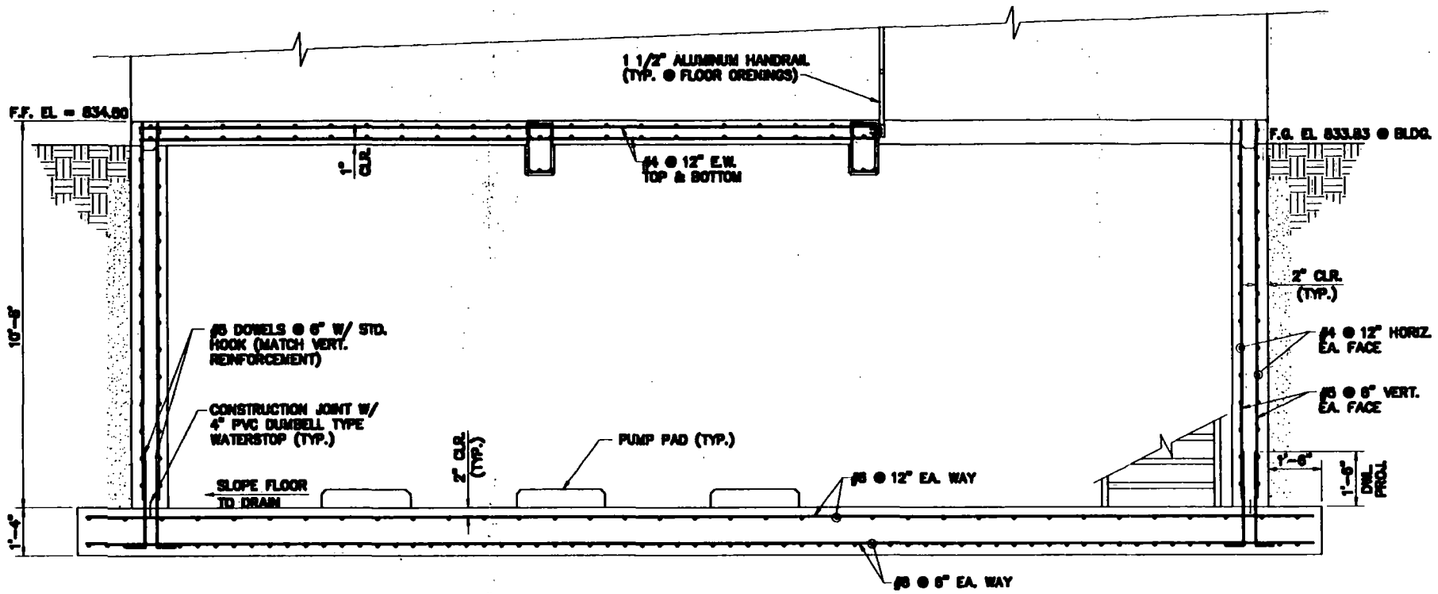
1. CONCRETE SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH (f'_c) OF 4,000 PSI AT 28 DAYS. (SEE SPECIFICATIONS FOR COMPLETE REQUIREMENTS)
2. ALL REINFORCING STEEL SHALL CONFORM TO ASTM GRADE 60 (f_y = 60,000 PSI)
3. BASEMENT AND FIRST FLOOR SURFACES SHALL RECEIVE STEEL TROWEL FINISH.
4. PROVIDE 3/4" CHAMFER AT ALL EXPOSED EDGES.
5. ANCHOR BOLTS FOR BUILDING COLUMNS SHALL BE SIZED & LOCATED PER BUILDING MFGR.
6. VERIFY EQUIPMENT ANCHORAGE SIZE AND LOCATION WITH MFGR.

0 2' 5'
3/8"=1'-0"

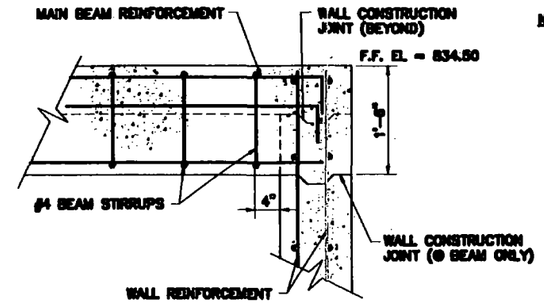
WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

STRUCTURAL FLOOR PLAN
TECHALLOY COMPANY INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
3/8" = 1'-0"	J.B.F.	27 AUG 93	74993	SHEET S1 of 14



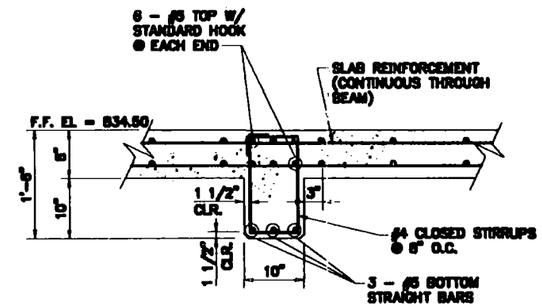
SECTION A (S1)
1/2" = 1'-0"



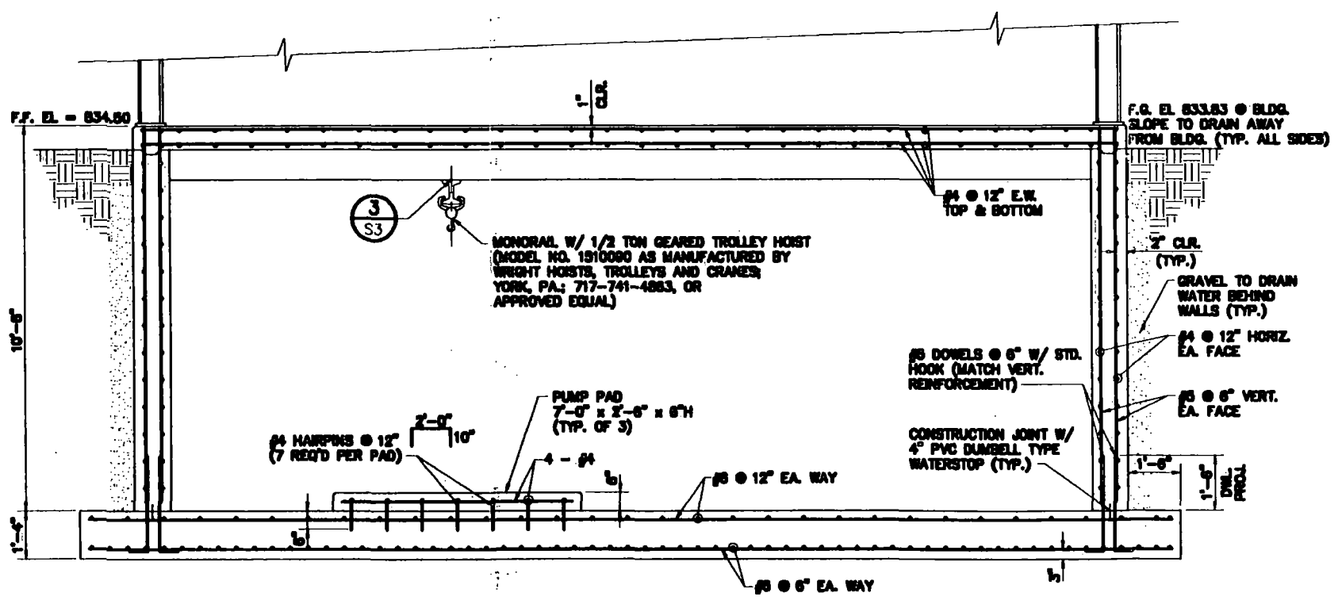
SECTION C (S1)
1" = 1'-0"

NOTES

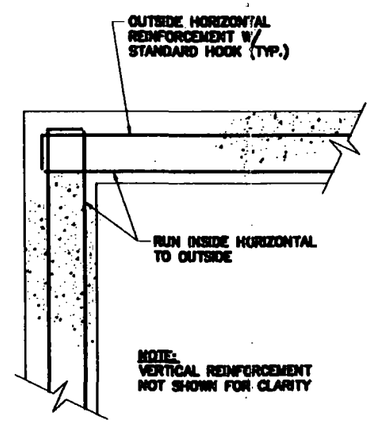
1. CONCRETE SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH (f'_c) OF 4,000 PSI AT 28 DAYS. (SEE SPECIFICATIONS FOR COMPLETE REQUIREMENTS)
2. ALL REINFORCING STEEL SHALL CONFORM TO ASTM GRADE 60 (f_y = 60,000 PSI)
3. PROVIDE 3/4" CHAMFER AT ALL EXPOSED EDGES.



SECTION D (S1)
1" = 1'-0"



SECTION B (S1)
1/2" = 1'-0"



CORNER REINFORCEMENT PLAN (1 / S2)
1" = 1'-0"

0 2 4
1/2"=1'-0"
0 1 2
1"=1'-0"

REV.	DATE	BY	DESCRIPTION

WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

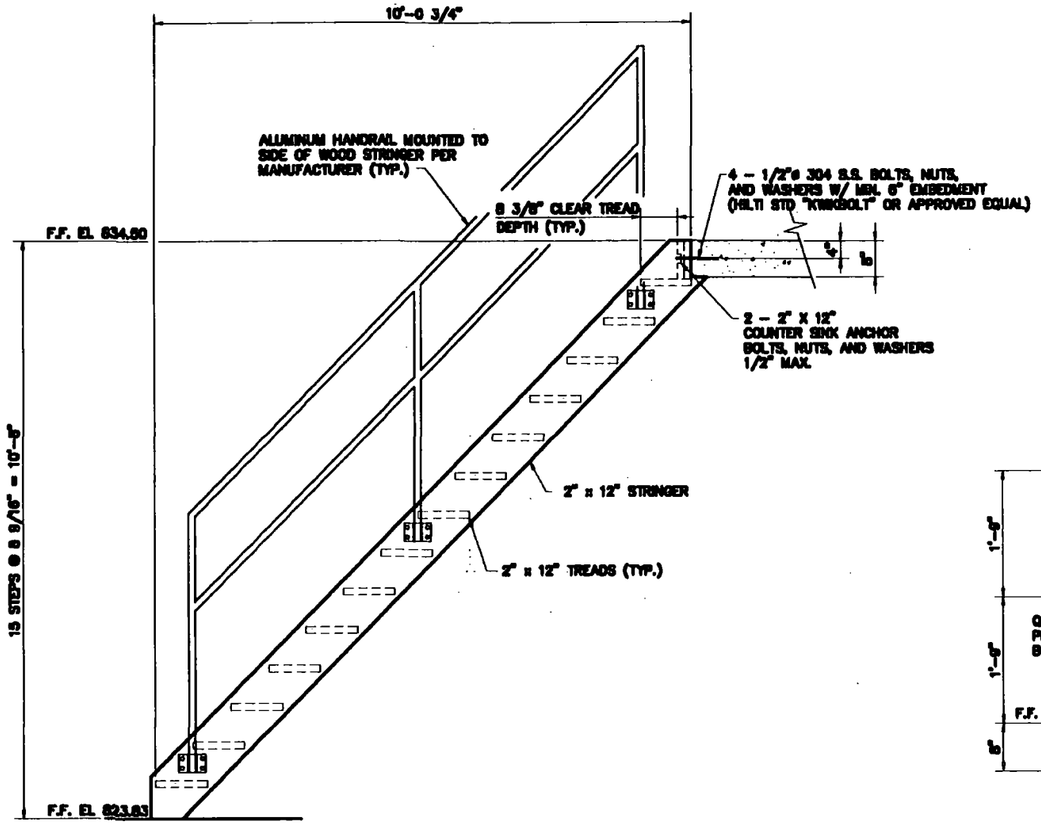
STRUCTURAL SECTIONS AND DETAILS

TECHALLOY COMPANY INC.
Union, Illinois

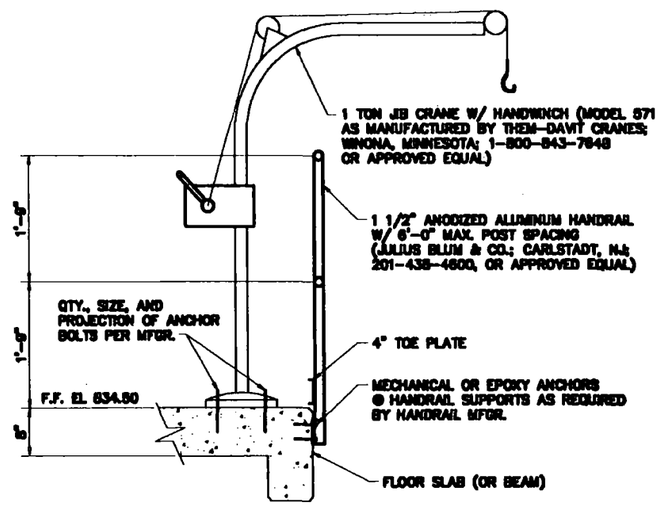
SCALE:	DRAWN:	DATE:	DWG. NO.	
AS SHOWN	J.B.F.	27 AUG 93	75093	SHEET S2 of 14

NOTES

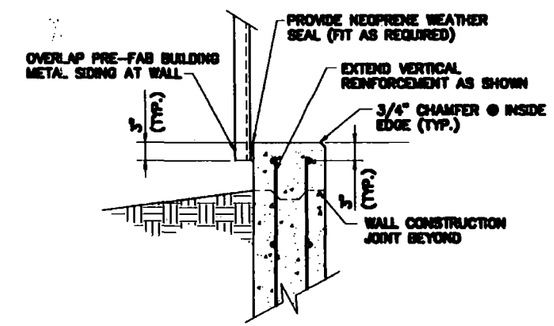
1. CONCRETE SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH (f'_c) OF 4,000 PSI AT 28 DAYS. (SEE SPECIFICATIONS FOR COMPLETE REQUIREMENTS)
2. ALL REINFORCING STEEL SHALL CONFORM TO ASTM GRADE 60 (f_y = 60,000 PSI)
3. PROVIDE 3/4" CHAMFER AT ALL EXPOSED EDGES.
4. ALL STAIRWAY COMPONENTS (EXCLUDING HANDRAIL) SHALL BE CONSTRUCTED OF PRESSURE TREATED PINE, AND CONNECTED WITH GALVANIZED NAILS.



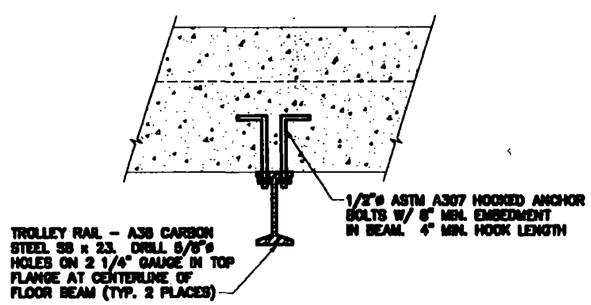
STAIRWAY DETAIL 2/S1
3/4" =1'-0"



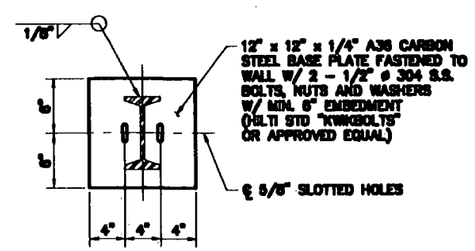
SECTION F/S1
1" = 1'-0"



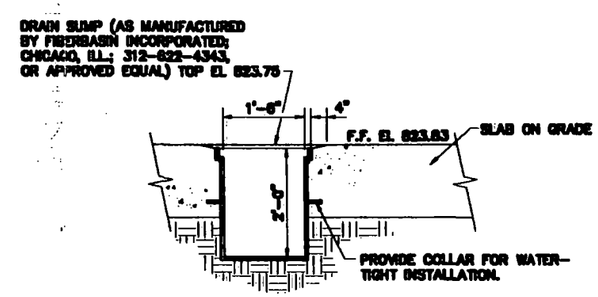
SECTION E/S1
1" = 1'-0"



MONORAIL CONNECTION TO BEAM 3/S3
1 1/2" = 1'-0"



SECTION G/S1
1 1/2" = 1'-0"



TYPICAL DRAIN SUMP 3/S1
3/4" =1'-0"

0 0.5 1
1 1/2"=1'-0"
0 1 2
1"=1'-0"
0 1 3
3/4"=1'-0"

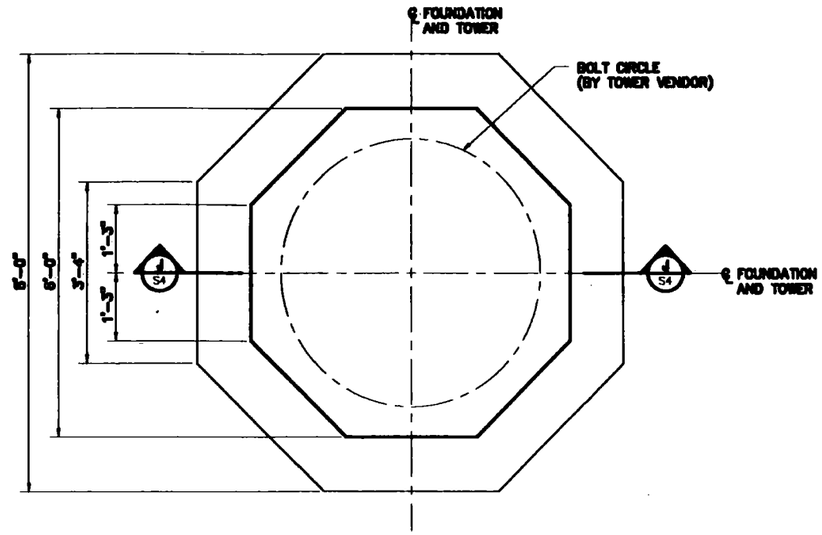
REV.	DATE	BY	DESCRIPTION

WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

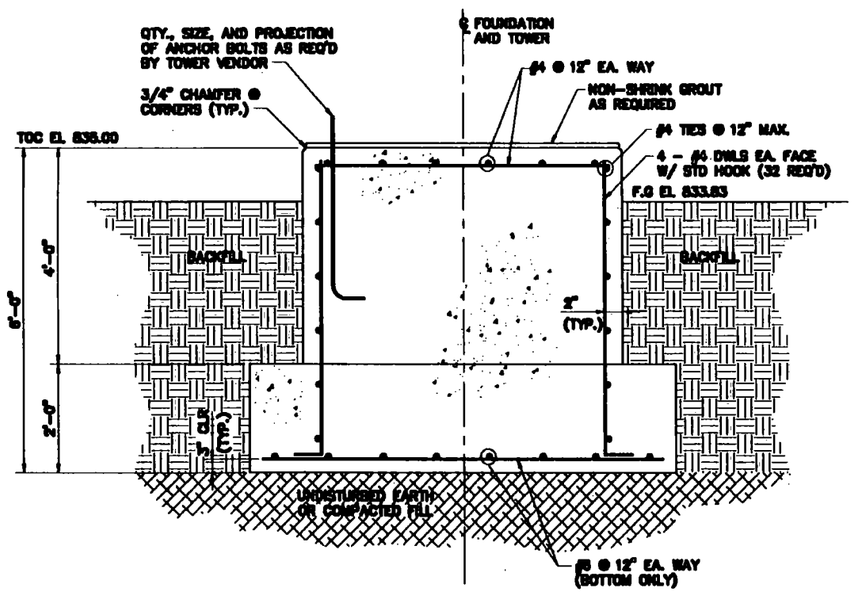
STRUCTURAL SECTIONS AND DETAILS

TECHALLOY COMPANY INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
3/4" = 1'-0"	J.B.F.	27 AUG 93	75193	SHEET S3 of 14



STRIPPER FOUNDATION PLAN
3/4" = 1'-0"



SECTION J/S4
3/4" = 1'-0"

NOTES

1. CONCRETE SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH (f'_c) OF 4,000 PSI AT 28 DAYS. (SEE SPECIFICATIONS FOR COMPLETE REQUIREMENTS)
2. ALL REINFORCING STEEL SHALL CONFORM TO ASTM GRADE 60 (f_y = 60,000PSI)
3. BASEMEMENT AND FIRST FLOOR SURFACES SHALL RECEIVE STEEL TROWEL FINISH.
4. PROVIDE 3/4" CHAMFER AT ALL EXPOSED EDGES.

0 1 3
3/4"=1'-0"

REV.	DATE	BY	DESCRIPTION

WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

AIR STRIPPER FOUNDATION

TECHALLOY COMPANY INC.
Union, Illinois

SCALE:	DRAWN:	DATE:	DWG. NO.	
3/4" = 1'-0"	J.B.F.	27 AUG 93	75293	SHEET S4 of 14

APPENDIX G

TECHNICAL SPECIFICATIONS

TECHALLOY COMPANY, INC.
GROUNDWATER TREATMENT SYSTEM
INTERIM MEASURES
UNION, ILLINOIS

TABLE OF CONTENTS

DOCUMENT NO.	DOCUMENT TITLE
DIVISION 1	**GENERAL REQUIREMENTS**
01010	Summary of Work
01027	Application for Payment
01040	Mobilization
01200	Project Meetings
01300	Submittals
01310	Construction Scheduling
01340	Shop Drawings, Product Data and Samples
01370	Schedule of Values
01390	Health and Safety
01391	Work Plan
01410	Testing Laboratory Services
01500	Temporary Facilities and Services
01620	Product Delivery, Storage and Handling
01630	Substitutions and Product Options
01657	Starting Process Systems
01669	Testing Process Systems
01700	Contract Closeout
01710	Cleaning
01720	Project Record Documents
01730	Operation and Maintenance Data
DIVISION 2	**SITE WORK**
02050	Roadway Preparation
02110	Clearing and Stripping
02200	Earthwork

DOCUMENT NO.	DOCUMENT TITLE
02220	Excavation, Backfilling and Compaction for Pipelines
02221	Excavation, Backfilling and Compaction for Structures
02227	Waste Material Disposal
02511	Asphaltic Concrete Paving
02710	Extraction Well
DIVISION 3	**CONCRETE**
03100	Concrete Formwork
03200	Concrete Reinforcement
03300	Cast-In-Place Concrete
DIVISION 6	**WOOD AND PLASTICS**
06100	Rough Carpentry
DIVISION 7	**THERMAL AND MOISTURE PROTECTION**
07600	Flashing and Sheet Metal Work
07920	Sealants and Caulking
DIVISION 8	**DOORS AND WINDOWS**
08710	Finish Hardware
DIVISION 9	**FINISHES**
09900	Paintings and Coatings
DIVISION 11	**EQUIPMENT**
11001	Air Stripping Tower Assembly
11021	Submersible Well Pump
11024	Fiberglass Tank
11120	~~Leak Detection and Location System~~
11215	Process Pumps
11331	Cartridge Filters
11332	Separator System
11370	Air Compressor
11501	Sump Pumps

DOCUMENT NO.	DOCUMENT TITLE
DIVISION 13	SPECIAL CONSTRUCTION
13600	Pre-Engineered Metal Building
DIVISION 15	MECHANICAL
15001	General Requirements for Piping Systems
15100	Valves
15311	Coarse Bubble Diffuser
15400	Plumbing
DIVISION 16	ELECTRICAL
16010	Basic Electrical Requirements
16111	Conduit
16120	Wire and Cable
16130	Boxes
16141	Wiring Devices
16190	Supporting Devices
16195	Electrical Identification
16440	Disconnect Switches
16470	Panelboards/Transformer Assembly
16480	Motor Control
16510	Lighting Fixtures
16830	Electric Unit Heater
16840	Exhaust Fan
16850	Inlet Louver

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 PROJECT DESCRIPTION

A. This project includes the construction of a pre-engineered metal building with foundation, piping, and equipment necessary to recover and treat contaminated groundwater.

1.02 SCOPE OF WORK

A. Construct one groundwater treatment plant in accordance with the specifications herein and the Contract Drawings.

B. Install influent and effluent piping in accordance with the specifications herein and the contract drawings.

C. Test all systems to insure that they perform as specified herein, make necessary adjustments and leave in proper working order.

D. Apply for and obtain all required permits to accomplish the scope of work including but not limited to:

1. Village of Union, Illinois building permits.

2. McHenry County, Illinois building permits.

E. Provide and pay for:

1. Labor, materials and equipment.

2. Tools, construction equipment and machinery.

3. Water, heat and utilities required for construction.

4. Coordination and supervision of all trades.

5. Field surveying required for support of construction operation.

6. Other facilities and services necessary for proper execution and completion of the project, including testing of all equipment supplied.

1.03 CONTRACTS

A. Construct work under a single LUMP SUM contract.

1.04 USE OF PREMISES

A. Confine operations at site to areas permitted by:

1. Site limits shown on the PLANS.

2. Owners's written permission for all other locations.

B. Do not unreasonably encumber site with materials or equipment.

C. Use of site is exclusive and complete, for execution of work, except where activity would interfere with the operation of existing facilities.

D. Coordinate use of premises under direction of the Owner.

E. Assume full responsibility for the protection and safekeeping of Products under this Contract, stored on the site.

F. Move any stored Products, under Contractor's control, which interfere with operations of the property owner.

G. Obtain and pay for the use of additional storage or work areas needed for operations.

H. All excess spoil and excavated material may be spread on site or used as fill in low spots to aid in proper site drainage. Unclassified material shall be disposed of as directed by the Engineer.

1.05 ACCESS ROADS

A. Construction traffic shall maintain a minimum of usage of roads through adjoining neighborhoods.

B. Temporary access, easements, right-of-ways and crossing permission are the responsibility of the Contractor.

C. Erect and maintain barricades, signs, fences, warning lights and other devices necessary for protection of all persons and traffic.

D. Keep roadways clear and unobstructed. Clean all streets and the access roads of construction debris at the end of each day.

E. Maintain access roads during construction. Resurface as shown on PLANS upon completion of project.

1.06 LINES AND GRADES

A. Perform all work to the lines, grades and elevations shown on the PLANS.

B. Use basic horizontal and vertical control points shown on the PLANS as datum for work under this contract.

C. Provide experienced survey crews as well as necessary instruments, tools, stakes and other material required to complete the survey, layout and measurement work.

D. Remove and replace any work improperly located when ordered by Owner, at no additional cost to the Owner.

1.07 CONSTRUCTION LOADS AND STRESSES

A. Prevent overstress of new or existing Work during construction.

B. Provide temporary connections, supports and braces to assure safety and stability of new and existing Work.

C. Do not apply loads to reinforced concrete until it has aged for at least 7 days unless otherwise noted.

1.08 SEQUENCING

A. Construction Sequence

1. Contractor shall sequence construction to allow work to progress in a timely manner. Contractor shall include detailed sequencing in the Construction Schedule submittal.

1.09 OCCUPANCY

A. Schedule operations for completion of portions of the Work, as required and approved by the Owner, for the Owner's occupancy prior to Substantial Completion of the entire Work.

B. Provide access for property owner's personnel, other contractors and for all regulatory agency employees performing Work as representatives of cognizant authority.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01027

APPLICATION FOR PAYMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit Applications for Payment to Owner in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

1.02 RELATED REQUIREMENTS

A. Agreement between Owner and Contractor: Lump Sum and Unit Prices.

B. General Conditions:

C. Section 01310: Construction Scheduling.

D. Section 01370: Schedule of Values.

E. Section 01700: Contract Closeout.

1.03 FORMAT AND DATA REQUIRED

A. Submit applications in the form required by Owner, with itemized data typed on 8-1/2 in. x 11 in. white paper continuation sheets.

B. Provide itemized data on continuation sheet:

1. Format, schedules, line items and values: Those of the Schedule of Values accepted by Owner.

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

A. Application Form:

1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.
2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.
3. Execute certification with signature of a responsible officer of Contract firm.

B. Continuation Sheets:

1. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored. Round off values to nearest dollar, or as specified for Schedule of Values.
3. List each Change Order executed prior to date of submission, at the end of the continuation sheets. List by Change Order Number, and description, as for an original component item of work.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner requires substantiating data, submit suitable information, with a cover letter identifying:

1. Project.
2. Application number and date.
3. Detailed list of enclosures.
4. For stored products:
   a. Item number and identification as shown on application.
   b. Description of specific material.

B. Submit one copy of data and cover letter for each copy of application.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in Application form as specified for progress payments.

B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01700 - Contract Closeout.

1.07 SUBMITTAL PROCEDURE

A. Submit Application for Payment to Owner at the times stipulated in the Agreement.

B. Number: Six copies of each Application.

C. When Owner finds Application properly completed and correct, it will transmit certificate for payment to Contractor.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01040

MOBILIZATION

PART 1 GENERAL

1.01 DESCRIPTION

A. The work covered by this part includes furnishing all labor, materials and equipment, under the following provisions, to qualify for the Mobilization payment described in the Contract Unit Price schedule.

1.02 MEASUREMENT

A. Mobilization payment to the Contractor will be authorized after written request for payment by the Contractor certifying that all conditions in each case described below have been met. The Engineer will make a physical inspection before approving the Contractor's request for payment.

B. The Contractor's request for payment shall be based on the approved Schedule of Values and in accordance with Section 01370.

1.03 PAYMENT

A. Payments for Mobilization will be included in the Contract lump sum price.

B. The Mobilization payment shall not exceed the lump sum amount established in the bid proposal. This amount has been established to be applied to the Contractor's cost of preparation and mobilization to perform the work.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Owner will schedule and administer pre-construction meeting, pre-work meeting, periodic progress meetings, and specially called meetings throughout progress of the work. Owner will also:

1. Prepare agenda for meetings.
2. Distribute written notice of each meeting four days in advance of meeting date.
3. Make physical arrangements for meetings.
4. Preside at meetings.
5. Record the minutes; include significant proceedings and decisions.
6. Reproduce and distribute copies of minutes after each meeting.
   a. To participants in the meeting.
   b. To parties affected by decisions made at the meeting.
   c. Furnish copies of minutes to Design Engineer.

B. Representatives of contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. Design Engineer may attend meetings to ascertain that Work is expedited consistent with Contract Documents and construction schedules.

1.02 PRE-CONSTRUCTION MEETING

A. Schedule after the Award of Contract, but prior to the Notice to Proceed.

B. Time and Location: A central site, convenient for all parties, mutually agreed upon.

C. Attendance:

1. Owner
2. Design Engineer.
3. Resident Project Representative.
4. Contractor's Project Manager and Project Superintendent.
5. Major Subcontractors.
6. Major suppliers and manufacturers as appropriate.
7. Governmental representatives as appropriate.
8. Others as appropriate.

D. Unless previously submitted to the Owner, Contractor will bring the following items:

1. Construction schedule.
2. Schedule of Values.

E. Agenda will include:

1. Distribution and discussion of:
   a. List of major subcontractors and suppliers.
   b. Projected Construction Schedules.
2. Construction Schedule and Critical work sequencing.
3. Major equipment deliveries and priorities.
4. Designation of responsible personnel.
5. Procedures and processing of:
   a. Field decisions.
   b. Proposal requests.
   c. Submittals.
   d. Change Orders.
   e. Applications for Payment.
6. Adequacy of distribution of Contract Documents.
7. Procedures for maintaining Record Documents.
8. Use of premises:
   a. Office, work and storage areas.
   b. Owner's requirements.
9. Construction facilities, controls and construction aids.
10. Temporary utilities.
11. Safety and first-aid procedures.
12. Security procedures.
13. Housekeeping procedures.

F. Work Plan (WP) and Health and Safety Plan (HASP).

1. Prior to Pre-Work Meeting and no later than 10 working days after Pre-Construction Meeting, the Contractor shall submit the WP and HASP in accordance with Sections 01390 and 01391 to the Owner for review.
2. Submit samples of the following:
   a. Daily progress summaries.
   b. Weekly site safety summaries.
   c. Summary of Contractor's Quality Control System.

1.03 Pre-Work Meeting

A. Schedule after the Notice to Proceed has been issued but prior to commencement of work on site.

B. Attendance:

1. Owner.
2. Design Engineer.
3. Contractor's Superintendent and Project Manager.
4. Major Subcontractors.
5. Major suppliers and manufacturers as appropriate.
6. Quality control and safety personnel.

C. Agenda will include:

1. Define contractor's quality control system.
2. Review the WP.
3. Develop understanding of the requirements established by the contract.
4. HASP understanding and implementation.
5. Schedule of work.
6. Administrative requirements.

1.03 PROGRESS MEETINGS

A. Owner will schedule regular periodic meetings at least monthly or as required.

B. Location of the meetings: Meetings will be held at project site unless otherwise directed by Owner.

C. Attendance:

1. Design Engineer, and his professional consultants as needed.
2. Subcontractors if necessary.
3. Suppliers if necessary.
4. Others.

D. Purpose of Meeting:

1. Review, approval of minutes of previous meeting.
2. Review of work progress since previous meeting.
3. Field observations, problems, conflicts.
4. Problems which impede Construction Schedule.
5. Review of off-site fabrication, delivery schedules.
6. Corrective measures and procedures to regain projected schedule.
7. Revisions to Construction Schedule.
8. Progress, schedule, during succeeding work period.
9. Coordination of schedules.
10. Review submittal schedules; expedite as required.
11. Maintenance of quality standards.

12. Pending changes and substitutions.
13. Review proposed changes for:
    a. Effect on Construction Schedule and on completion date.
    b. Effect on other contracts of the Project.
14. Other business.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.01 PRIOR TO BEGINNING WORK

Submit the following items with signed agreement forms as a prerequisite to starting the work. The minimum number of copies required of each submittal is three. The location of information concerning each submittal is referenced.

A. Performance Bond. Bidding Documents, Contract Forms, General Conditions and Supplemental Conditions.

B. Statutory Payment Bond. Bidding Documents, Contract Forms, General Conditions and Supplemental Conditions.

C. Certificate of Insurance. General Conditions, Special Conditions and Supplemental Conditions.

D. List of Subcontractors. General Conditions, Supplemental Conditions and Special Provisions.

E. Schedule of Values. General Conditions and as specified in the section of Schedule of Values in Division 1 - General Requirements.

F. Construction Schedule. General Conditions and as specified in the section of Construction Schedules in Division 1 - General Requirements.

G. Work Plan and Health and Safety Plan in accordance with Sections 01390 and 01391.

1.02 DURING CONSTRUCTION

During the progress of the work, make the following submittals in a timely manner to prevent any delay in the work.

A. Construction Schedule. Submit progress schedules monthly as an evidence that the project will meet schedules and the date of substantial completion. Three copies are required plus any copies required by the contractor.

B. Shop Drawings, Product Data and Samples. Submit in accordance with Section 01340.

C. Application for Payment. Submit applications for partial payment as specified in Section 01027. Each application shall include:

1. Itemized cost detail.
2. Numbering system established during preconstruction.

D. Change Order Request. A request for a change to the original work may be submitted to the Engineer whenever a need arises. The request must be in writing, on the form provided by Owner if appropriate, and must include sufficient information to assess the need for a change in the work, the contract time or the contract sum.

E. Operation and Maintenance Data. In addition to the specific data required by the various sections of the specifications, the following information shall be provided for each piece of equipment which requires periodic maintenance.

1. Manufacturer's Data.
   a. Name and description
   b. Size and/or model number
   c. Manufacturer's name, address, and telephone number
   d. Supplier's name, address and telephone number
   e. All equipment serial numbers

2. Nameplate Data. Supply all applicable information for each piece of equipment listed in paragraph above.

   a. Volts
   b. Amps
   c. Watts
   d. Phases
   e. Hertz
   f. Frame
   g. Type
   h. PSI
   i. Other pertinent information

3. Manufacturer's operations, maintenance and repair literature and other information. The information provided shall include as a minimum, but not limited to, the following:

   a. Manufacturer's recommended preventive maintenance procedures and maintenance intervals. Maintenance intervals shall be given in terms of both calendar time and operation time.

b. Parts information.

(i) Exploded-view assembly drawing(s) of the equipment. All parts including maintainable subassembly parts shall be clearly shown in the drawing(s). All subassemblies shall be considered maintainable unless the Owner acknowledges in writing to the Contractor that the subassembly is disposable. All parts shall be identified with a number or letter which references the Parts List Table described in section (ii) below.

(ii) A Parts List Table which includes all of the following information:

- A reference number or letter from the exploded-view drawing.
- Brief description of part.
- Manufacturer's part number/drawing reference number.
- Standard part description if applicable, i.e. 1/2-inch hex head bolt.
- Quantity of each part contained in the equipment, assembly or subassembly.
- Manufacturer's recommendation for stocking of spare parts for each item in the Parts List Table.

c. Special Tools. List any special tools and/or equipment required to comply with the manufacturer's recommended maintenance instructions.

d. Overhaul Procedures. The Contractor shall provide step-by-step procedures by the manufacturers for complete disassembly, overhaul, and reassembly of the equipment.

e. Operating Procedures. Detailed information shall be provided on the following:

(i) Pre-startup checkout procedures.
(ii) Startup procedures.
(iii) During operation checks and procedures.
(iv) Shutdown procedures for the following:
- Routine shutdown.

- Emergency shutdown.
- Extended shutdown.

f. Safety Precautions.

g. Electrical and instrumentation wiring diagrams.

h. Test data and performance curves.

4. The required manufacturer's information shall be assembled in a logical format. Items 1 through 3 shall be provided in tabular form for each piece of equipment. The information provided shall be cross referenced to the manufacturer data submittals as required by Section 01340 of the specifications. All information shall be 8-1/2" x 11" or 11" x 17" in size and of quality suitable for reproductions. Items submitted by the Contractor which do not produce an acceptable quality reproduction will be returned for resubmittal. All information shall be bound in a suitable hard-covered, three-ring binder. Three copies of the above information shall be provided.

5. No separate payment will be made for any submittals or resubmittals required under this section. Include the cost of such work in contract LUMP SUM prices.

6. The Contractor, by way of his bid, acknowledges that any or all of the above Operation and Maintenance submittal requirements may be more extensive and more detailed than what the Contractor typically supplies. However, it is understood that, in the case of any piece of equipment requiring <u>periodic</u> maintenance. NO PAYMENT FOR THE SUPPLY, DELIVERY AND INSTALLATION OF SUCH EQUIPMENT WILL BE MADE UNTIL ALL REQUIREMENTS, SPECIFICALLY NOTED IN THIS TECHNICAL SPECIFICATION RELATING TO OPERATION AND MAINTENANCE DATA, ARE IN COMPLIANCE WITH THE SPECIFICATIONS.

F. Photographs

1. Prior to commencement of any construction, the Contractor shall take 35 mm color photographs of the entire area of the project and present one copy of prints and the negatives to the Owner for their use in contract administration and inspection.

2. A sufficient number of photographs shall be taken during each month, and, in addition, on the last day of work before the progress payment request to show the level of progress on each structure.

3. Information required on the photos shall be shown as follows:

   a. Job name or number on a chalkboard in the picture or a label attached.
   b. Building or structure description on a chalkboard in the picture or a label attached.
   c. Date fixed on negative by calendar attachment in camera (automatically includes date on film).

4. Photographs and negatives shall be bound in three-ring notebook within plastic pockets for easy viewing.

5. Photographing the project is incidental to construction and no extra payments for these items shall be made to the Contractor.

1.03 PROJECT CLOSEOUT

With a written notice of completion, submit the following items in the proper form as a condition of final acceptance of the work.

A. Project Record Documents. Submit in accordance with the Section 01720.

B. Guarantees, Warranties and Bonds. As required in the General and Supplementary Conditions and listed in various sections of the specifications.

C. Final invoice.

D. Consent of surety, guarantee, and statement form.

E. Final lien waivers.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULING

PART 1 GENERAL

1.01 BASIC REQUIREMENTS

A. Prepare and submit the following construction scheduling documents in accordance with the terms of this Section:

1. Bar Charts.
2. Monthly progress reports.
3. Schedule of estimated payments.

1.02 SIGNIFICANCE OF CONSTRUCTION SCHEDULING DOCUMENTS

A. The percentage completion reported for each activity as listed in the monthly progress report and in the Schedule of values will be used in part to determine the amount of each monthly payment to the Contractor.

B. The bar charts, and monthly progress reports will be primary references in evaluating claims for delay and requests for time extensions.

C. No payments will be made to the Contractor until acceptable bar charts, the initial schedule of estimated payments and the initial monthly progress report have been received and approved by the Owner.

1.03 PAYMENT

A. Include the costs of preparing and submitting the specified construction scheduling documents in the lump sum price of this Contract.

1.04 BAR CHARTS

A. Preparation of Bar Charts

1. Plot all activities on bar charts graduated in weeks.
2. Organize the bar charts so that activities in a given subnetwork are plotted in numerical order on a given bar chart or charts.
3. Represent each subnetwork by a single bar on a summary bar chart.
4. Show the following information on each bar chart:
   a. Project title and number.
   b. Sheet title, i.e. summary sheet or title of appropriate subnetwork.
   c. Date of preparation

d. Identification number (I-J code) and abbreviated title for each activity.
e. Percentage completion of each activity on date bar chart was prepared.
f. Week ending dates and vertical lines marking same.
g. Annotation or symbol which indicated when an activity was actually finished.
h. Annotation or symbol to flag critical activities.
i. Symbol and abbreviation legend.

5. Use a solid line to show the original schedule for each activity. Use a dashed line to show when an activity has been rescheduled to finish later than originally scheduled.
6. Prepare bar charts no larger than 24 inch by 36 inch sheets.
7. Show 52 weeks on each bar chart.

B. Updating and Submittal of Bar Charts

1. For each submittal include 4 black-on-white prints of each bar chart.
2. Update the bar charts each month when a change in schedule has occurred and submit with the monthly progress reports.

1.05 MONTHLY PROGRESS REPORTS

A. Preparation of Monthly Progress Reports

1. Begin preparation of monthly progress reports promptly after the last working day of each monthly period.
2. Include the following information in the letter of transmittal
   a. Progress summary in major construction activity
   b. Problem areas
   c. Anticipated delays
   d. Impact of a. and b. on schedule
   e. Recommended actions

B. Submittal of Monthly Progress Reports

1. Submit three copies to Owner within 5 working days after the end of the reporting period.
2. Submit reports for each month of the contract period.

1.07 SCHEDULE OF ESTIMATED PAYMENTS

A. Preparation

1. Indicate the estimated amount of each progress payment to be made to the Contractor during each month of the contract period. Also, indicate the amount of the final payment.

2. Base schedule on approved Schedule of Values and bar charts.

B. Submittal and Updating

1. Submit initial schedule within ten working days after receipt of approved schedule of values and bar chart.
2. Submit on 8 1/2 inches by 11 inch paper either typewriter or computer prepared.
3. Update and resubmit schedule once each quarter.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 GENERAL

1.01 GENERAL

A. Comply with the general requirements in this Section when preparing, processing and submitting shop drawings, product data and samples.

B. Also comply with the supplemental requirements relating to shop drawings, product data and samples as specified in the technical specification sections.

C. Shop drawings and product data are not contract docu-ments.

1.02 RELATED REQUIREMENTS

A. Section 01310: Construction Scheduling.

B. Section 01410: Testing Laboratory Services.

C. Section 01720: Contract Record Documents.

1.03 CONTRACTOR RESPONSIBILITIES

A. Confirm and correlate fabrication processes, techniques of construction and coordination of work between trades.

B. Shop Drawings, Product Data and Samples.

1. Review prior to submission.
2. Coordination between trades.
   a. Assemble shop drawings of interdependent trades, cross check, coordinate and obtain required corrections. Transmit to Owner as a single submittal.
   b. Alternately, make composite drawings showing interrelationship of the concerned trades. Subsequent shop drawings must confirm to the reviewed composite drawing.
   c. Fragmentary or piecemeal transmittals for individual trades will be returned unchecked and will not be considered as submission.

C. Determine and verify:
1. Field measurements.
2. Field construction criteria.

3. Catalog numbers and similar data.
4. Conformance with specifications.

D. Coordinate each submittal with requirements of the Work and of the Contract Documents.

E. Notify the Owner in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.

F. Contractor's responsibility for deviations from requirements of Contract Documents is not relieved by Owner's review of submittals. The Contractor may submit specific deviations to the Owner for review, but such deviations will require the Owner's written acceptance.

G. Begin no fabrication or work which requires submittals until return of submittals with Architect/Engineer approval.

1.04 OWNER'S DUTIES

A. The Owner's duties relative to shop drawings product data and samples are as follows:

1. Review for general conformance with design concepts and Contract documents.
2. Affix stamp and initials or signature indicating the review of submittal.
3. Return submittals to Contractor for distribution.

B. Disposition will be one of the following: No Exception Taken, Make Corrections Noted, Rejected, Revise and Resubmit, or Submit Specified Item.

C. Review of a separate item does not constitute review of an assembly in which the item functions.

D. The Owner will attempt to review submittals within thirty (30) days from receipt of submission. The Contractor will be notified if additional time is required.

1.05 SUBMITTAL REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. Prepare and submit, within 30 days following Award of Contract, a separate schedule listing dates for submission of each shop drawing or submittal required.

C. Schedule submissions at least 30 days before reviewed submittals will be needed.

D. Number of submittals required:

1. Shop Drawings: Submit three (3) copies plus copies required for contractor.
2. Product Data: Submit three (3) copies plus copies required for contractor.
3. Samples: Submit the number stated in each specification section.

E. Include in the submittal:

1. The date of submission and the dates of any previous submissions.
2. The Project title and number.
3. Contract identification.
4. The names, addresses, and phone numbers of:
   a. Contractor
   b. Subcontractor
   c. Supplier
   d. Manufacturer.
5. Identification of the specification section number governing the submittal.
6. Field dimensions, clearly identified as such.
7. Relation to adjacent or critical features of the Work or materials.
8. Applicable standards, such as ASTM or Federal Specification numbers.
9. Identification of deviations from Contract Documents.
10. Identification of revisions on resubmittals.
11. A 5 in. x 5 in. blank space for engineer's stamp.
12. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents.

F. Accompany submittals with a transmittal letter, in duplicate.

1.06 RESUBMITTAL REQUIREMENTS

A. Make any corrections or changes in the submittals required by and at no cost to the Owner and resubmit until approved.

B. Shop Drawings and Product Data:

1. Revise initial drawings or data, and resubmit as specified for the initial submittal.
2. Indicate any changes which have been made including those requested by the Owner.

C. Samples: Submit new samples as required for initial submittal.

D. Accompany resubmittals with a transmittal letter in duplicate. In the transmittal letter, show the number assigned to the original submittal.

1.07 PREPARATION REQUIREMENTS

A. Shop Drawings

1. Preparation by a qualified detailer is required.
2. Identify details by reference to sheet and detail numbers shown on Contract Drawings and/or section number of the Specifications.
3. Sheet size to 24" x 36" or 8 1/2" x 11".
4. Reproductions for submittals to be opaque diazo prints or blueprints.
5. All shop drawings and submittal data are to be in the English language. Use standard English system of measurements for all dimensions, weights, flows, forces and capacities.

B. Product Data

1. Preparation
   a. Clearly mark each copy to identify pertinent products or models.
   b. Show performance characteristics and capacities.
   c. Show dimensions and clearances required.
   d. Show wiring or piping diagrams and controls.
2. Manufacturer's standard schematic drawings and diagrams:
   a. Modify drawings and diagrams to delete information which is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01390

HEALTH AND SAFETY

1.0 GENERAL

1.1 WORK INCLUDED

A. Minimum Health and Safety Requirements for Contractor. Health and safety is the sole responsibility of the Contractor. Contractor shall take precautions to prevent damage, injury or loss to all employees on the work site and other persons who may be affected thereby. The Contractor can assume Level D or Modified Level D protection is required for bidding purposes; however, the Contractor shall be prepared to upgrade in accordance with the requirements of the Health and Safety Plan.

B. Principal Work Items.

1. Project specific Health and Safety Plan (HASP) development and implementation.
2. Excavation protection plan development and implementation.

C. See articles 3.2b, Site Description; 3.2c, Project Description; and 3.2d, Hazard Assessment for other specific work included.

1.2 REFERENCES

A. All applicable OSHA requirements.

1. 29 CFR 1926 - Safety and Health Regulations for Construction, latest version.
2. 29 CFR 1910 - Occupational Safety and Health Standards (General Industry).
3. 29 CFR 1910.120 - Hazardous Operations and Emergency Response.
4. All Occupational Safety and Health Standards enforced by the Michigan Department of Labor and the Michigan Department of Public Health.

B. Requirements for Worker Health and Safety included in the National Oil and Hazardous Substances Contingency Plan (40 CFR 300.38).

C. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities NIOSH Publication No. 85-115, October 1985.

D. The Standard Operating Safety Guides, U.S. EPA, November 1984.

1.3 SUBMITTALS

A. Contractor shall submit proposed Health and Safety Plan within 10 working days from the date of Pre-construction Meeting.

B. Name, qualifications and telephone number of Contractor's physician.

C. Employee training documentation.

D. Employee compliance agreements.

E. Excavation Protection Plan.

F. Logs and Reports.

1. Safety Inspection Log.
2. Weekly Health and Safety (H&S) Report.
3. Check In/Check Out Log for the Site.

G. Qualifications of Health and Safety Officer.

H. Qualifications of Site Safety Officer.

1.4 DEFINITIONS

A. Health and Safety Officer (HSO). Contractor's representative responsible for development, submittal and implementation of the HASP.

B. Site Safety Officer. Contractor's representative directly responsible for the daily implementation of the HASP.

C. Contaminated Material. Material which cannot legally be disposed of except in a Class 1, 2 or 3 Hazardous Waste Disposal facility.

D. Gaseous Conditions. (Use OSHA definition).

E. Potentially Gaseous Conditions. (Use OSHA definition).

F. Non-gaseous Conditions. (Use OSHA definition).

G. OSHA Permissible Exposure Limits (PEL). Time weighted average (TWA) concentrations to which most workers can be exposed for 8 hours per day, 40 hours per week on a permanent basis with no significant health effects. These concentrations are enforceable OSHA standards. (Source: NIOSH/OSHA; Pocket Guide to Chemical Hazards, June, 1990.)

H. Immediately Dangerous to Life and Health (IDLH). Concentrations representing a maximum level from which one could escape within 30 minutes without any escape impairing symptoms or irreversible health effects. (Source: NIOSH/OSHA; Pocket Guide to Chemical Hazards, June, 1990.)

I. Threshold Limit Values - Time Weighted Averaged (TLV-TWA). Time weighted average concentrations to which most workers can be exposed for 8 hours per day, 40 hours per week on a permanent basis with no significant health effects. They are similar to PELs except that they are not enforceable standards and are updated annually. (Source: ACGIH Threshold Limit Values and Biological Exposure Indices for (1990-91.)

1.5 SITE SAFETY REGULATIONS

A. Contractor shall report any suspected contaminated material to the Engineer upon discovery.

B. Contact with contaminated or suspected contaminated surfaces should be avoided.

C. Alcoholic beverages and controlled substances shall not be allowed on site.

D. A site HASP shall be developed for all phases of site operations and made available to all personnel.

E. All personnel shall be familiar with standard operating safety procedures and any additional instructions and information contained in the site HASP.

F. All personnel shall adhere to the site HASP.

G. All personnel going on site shall be adequately trained and thoroughly briefed on anticipated hazards, safety equipment to be employed, safety practices to be followed, emergency procedures and communications and responsible safety personnel on site.

H. Entrance and exit locations shall be designated and posted, and emergency escape routes shall be delineated. Warning signals for site evacuation must be established and communicated to all personnel.

1.6 MEDICAL CARE

Medical care is divided into routine health care and emergency medical care and treatment.

A. Routine Health Care. Routine health care shall provide special pre-assignment and periodic medical examinations. Any special tests needed depend on the chemical substance to which the individual could be or has been exposed as recommended by the physician. Care and counseling in the

case of potential, known or suspected exposure to toxic substances will also be provided.

B. Emergency Medical Care and Treatment. The Medical Program shall address emergency medical care and treatment of project personnel.

1. Posted name, address and telephone number of nearest medical facility with map, travel time and directions from each job site.
2. Investigation of local emergency organizations to respond to potential emergencies at the site. If local organizations are unable to adequately respond, other emergency prearrangements shall be made.
3. Arrangements shall be made to quickly obtain emergency services. Telephone numbers and procedures shall be posted.

1.7 PERSONNEL

A. Health and Safety Officer.

1. Qualifications.
   a. Two or more years relevant experience.
   b. The Health and Safety Officer shall be a Certified Safety Professional or a Certified Industrial Hygienist.
   c. Management/supervisor training course complete in accordance with 29 CFR 1910.120(e)(4).
2. Responsibilities.
   a. Develop, submit and implement HASP.
   b. Conduct site inspections to monitor compliance with HASP.
   c. Provide and coordinate training sessions.
   d. Conduct incident investigations and followup.
3. Authority.
   a. Suspend work due to HASP violations, health related incidents and other increased risk situations.
   b. Remove personnel from site if actions endanger.
   c. Authorize personnel to enter.

B. Site Safety Officer.

1. Qualifications.
   a. One or more years relevant experience.
   b. Current certification in First Aid and CPR procedures.
   c. Management/supervisor training course complete in accordance with 29 CFR 1910.120(e)(4).

2. Responsibilities.
   a. Direct H&S activities on-site.
   b. Report safety-related incidents to HSO and fill out incident forms as required.
   c. Implement HASP.
   d. Maintain H&S equipment.
   e. Perform air monitoring as required by the HASP under the supervision of the Health and Safety Officer.
3. Authority.
   a. Suspend field activities if health and safety of personnel are endangered.
   b. Suspend an individual from field activities for infractions of the HASP.

2.0 PRODUCTS

NOT USED.

3.0 EXECUTION

3.1 GENERAL

A. The written H&S Program shall contain and/or address the following:

1. An organizational structure.
2. A comprehensive work plan.
3. Project Specific HASP.
4. H&S Training Program.
5. The Medical Surveillance Program.
6. Standard Operating Procedures.
7. Any necessary interface between general program and site-specific activities.

B. 1. Minimum requirements are presented in this section. Contractor shall develop program using these elements as a basis, adding additional requirements as deemed necessary.
   2. Contractor shall ensure H&S Program meets all requirements of 29 CFR 1910.120(b).

3.2 HEALTH AND SAFETY PLAN

A. General.

1. Minimum requirements for HASP are presented in this section. Contractor shall develop HASP using these elements as a basis, adding additional requirements as deemed necessary by the Contractor.

Contractor shall not commence work prior to Engineer review of HASP.

2. The HASP shall establish guidelines for the safety of personnel during the conduct of work. Contractor shall make available a copy of the HASP to each employee. All employees shall be required to read and understand the HASP, sign a compliance agreement and abide by all provisions of the HASP. Plan may be modified by the HSO with written review and comments from of the Engineer in response to site conditions.

3. HASP shall include:

   a. Site Description. Physical description of site and site conditions. Site specific data pertaining to hazards. Identifies hazards known at time. If additional hazards are discovered, they should be added to this section by change order.

   b. Project Description. Project specific description of work to be performed.

   c. Hazard Assessment. Hazard assessment shall address strategies for protection of workers against the following hazards:

      1. For activities which involve no hazardous material contact, primary hazards are physical hazards associated with construction, use of heavy equipment and fire hazards.

      2. For activities which involve only limited or the potential for hazardous material contact, the following hazards shall be appropriately protected against:

         a. Physical hazards associated with construction, use of heavy equipment and fire hazards.
         b. Heat stress/cold stress.
         c. Inhalation of contaminants.
         d. Skin or eye contact with contaminants.
         e. Ingestion of contaminants.

      3. For activities which involve direct contact with hazardous materials, the following hazards shall be appropriately protected against:

         a. Physical hazards associated with construction, use of heavy equipment and fire hazards.
         b. Heat stress/cold stress.
         c. Inhalation of contaminants.
         d. Skin or eye contact with contaminants.
         e. Ingestion of contaminants.

   d. List of Key Personnel. HASP shall identify key Contractor personnel responsible for site safety as outlined in article 1.5. A list of the names, telephone numbers, organizations and addresses of these individual shall be conspicuously posted at the site.

e. Air Monitoring Program.

1. HASP shall designate personnel responsible for implementing the air monitoring program.
2. The Site Safety Officer shall be responsible for enforcing established Air Action Levels.
3. The Air Monitoring Program shall be described in detail in the HASP and as a minimum shall include:
   a. Work Area Monitoring Program during construction activities.
   b. Personnel monitoring, as appropriate.
4. During construction activities, a Work Area Monitoring Program shall be implemented including surveys of work areas and vicinity with at least the following:
   a. Combustible Gas Indicator.
   b. Photoionization Detector.
   c. Periodic measurements with detector tubes for specific compounds, as appropriate.
5. Action Levels.
   a. Combustible Gas Indicator (CGI) measurements are applicable to confined spaces on the site.
      i. The CGI shall measure concentrations of flammable gases in the air as a percentage of the Lower Explosive Limit (LEL).
      ii. Action Level: 10 percent or greater of the LEL, all ignition sources shall be shut off and personnel shall be restricted from the affected area.
   b. Photoionization Detector readings. The HSO shall use data from the Site Characteristics Summary to determine known and suspected air contaminants and to establish level of protection upgrade/downgrade action levels to be based on photoionization detector readings.

f. Emergency Response Procedures.

1. Emergency Response Procedures shall be included in the HASP.
2. Response actions to control releases of contaminants shall be included in the HASP.

g. Decontamination Procedures

Decontamination procedures shall be developed and implemented for all appropriate phases of work.

h. Confined Space Entry Procedures

Confined space entry procedures shall be developed and implemented in accordance with the 14 January 1993 Final Rule of 129 CFR 1910.146.

i. Spill Containment Program

Where spills may occur, a spill containment program shall be implemented to contain and isolate the entire volume of the potentially hazardous material, liquid, etc.

j. Personal Protective Equipment

A written personal protective equipment program (which is part of the H&S program) to address the protective equipment requirements for each of the site tasks and operations to be conducted.

k. Site Control Measures

A site control program and appropriate procedures shall be implemented to control employee exposure to hazardous substances as part of the H&S program.

3.3 TRAINING REQUIREMENTS

A. Contractor shall provide training to all of its employees and of its subcontractors that will be assigned to the project which complies with the requirements of 29 CFR 1926.21 and other applicable portions of 29 CFR 1910 and 1926. Training shall cover (at a minimum):

1. Names of personnel and alternates responsible for site health and safety.
2. Health and safety hazards present on site.
3. Personal protective equipment use, care and limitations.
4. Work practices that minimize risks from hazards.
5. Safe use of engineering controls and equipment on site.
6. Hazard Communication (right-to-know program).
7. Site control measures.
8. Site standard operating procedures.
9. Contingency plan.
10. Confined space entry procedures.
11. Identification and avoidance of harmful plants/animals and related first aid procedures.

In addition, employees who are responsible for responding to emergency situations shall be trained in how to respond to any anticipated emergency conditions. Also, employees who may be exposed to or contact potentially contaminated soil or groundwater shall be 24-hour or 40-hour trained in accordance with 29 CFR 1910.120(e)v as appropriate to duties.

B. Emergency Response Training.

1. Site Evacuation Drill. One site evacuation drill shall be conducted during the first full week of work to test the effectiveness of evacuation protocols.
2. Fire Extinguisher Training. At least one member of each crew shall be trained in the use of portable fire extinguishers in accordance with 29 CFR 1910.157(g).

C. Visitor Training. Contractor shall be responsible for training visitors to the site in order to make them aware of hazards associated with the site and explain emergency procedures.

3.4 STANDARD OPERATING PROCEDURES

Contractor shall develop and implement Standard Operating Procedures. At a minimum, the following Standard Operating Procedures shall be written:

A. Heat Stress/Cold Stress Prevention Plan.

B. Respiratory Protection Plan.

C. Hearing Conservation Plan

D. Bloodborne Pathogens Exposure Control Plan

E. Incident/Accident Reporting Procedures.

F. Site Control Procedures.

1. Security Procedures.
2. Communication Procedures.
3. Site Layout.
4. Work Zones.
5. Documentation of site access.

G. Emergency Preparedness.

1. Procedures to address the following emergency situations:
   a. Medical emergencies.
   b. Fires.
   c. Spills.

d. Accidents.
e. Safety equipment problems.

2. Provisions for emergency equipment such as (at a minimum):
   a. First aid kits.
   b. Fire extinguishers.
   c. Splints.
   d. Blankets.
   e. Eyewashes and emergency showers.
   f. Bloodborne pathogens kits (biohazard cleanup)

3.5 INSPECTIONS

It shall be the responsibility of the Contractor to determine and document that the Health and Safety Program is being followed in accordance with minimum requirements of this specification and any additional requirements of the Contractor HASP. This shall be accomplished through the use of inspections and audits conducted by the Site Safety Officer and staff on a daily basis and by the HSO as required.

3.6 RECORD KEEPING

Contractor shall maintain, as a minimum, the records specified in this section and any additional records required to develop, implement and maintain requirements of the Contractor HASP.

3.7 REPORTING

A. Contractor shall provide submittals in accordance with article 1.3 of this section.

B. Contractor shall notify Owner and the Engineer when work may affect adjacent properties. All damage, injury or loss of any property caused by the work shall be remedied by the Contractor at no additional cost to the Owner.

3.8 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01391

WORK PLAN

1.0 GENERAL

1.1 WORK INCLUDED

A Work Plan shall be developed that identifies personnel, procedures, instructions, records, and forms to be used in carrying out the requirements of this project.

1.2 RELATED WORK

A. Section 01200: Project Meetings

B. Section 01300: Submittals

C. Section 01310: Construction Scheduling

D. Section 01390: Health and Safety

1.3 SUBMITTALS

A. The contractor shall submit a Work Plan within 10 working days from the date of the pre-construction meeting.

B. Logs and Reports

1. Work Activity Log

2. Completion Inspection Reports

2.0 PRODUCTS

Not used.

3.0 EXECUTION

3.1 CONTENT OF THE WORK PLAN

1. A description of how the Contractor will achieve the tasks/requirements of the project.

2. The Contractor's project organizational structure including the names, qualifications, duties, responsibilities, and authorities of each person assigned to a project function. The organizational structure must clearly state the Contractor's qualifications, experience, and organization.

3. Procedures for scheduling and managing submittals, including those of subcontractors, off-site facilities, suppliers, and purchasing agents.

4. Reporting procedures including proposed reporting format.

3.2 ACCEPTANCE OF THE WORK PLAN

Acceptance of the Contractor's Work Plan by Owner is required prior to the start of any on-site construction. Acceptance of the Work Plan is conditional and will be dependent on satisfactory performance during the construction.

3.3 NOTIFICATION OF CHANGE

After acceptance of the Work Plan, Owner shall be notified in writing of any proposed change. Proposed changes are subject to the acceptance by Owner.

3.4 PROJECT ORGANIZATION

A. Project Manager

1. The Contractor shall identify an individual, within their organization at the work site, who shall be responsible for overall management of the work and have the authority to act for the Contractor.

2. The Project Manager for this contract shall be an engineer or comparable individual experienced in hazardous remedial actions whose responsibility is to ensure compliance with the contract plans and specifications.

3. The Project Manager or his designated representative shall be on site whenever work is in progress.

4. All the Contractor's submittals for approval shall be reviewed and modified or corrected as needed by the Project Manager prior to forwarding each submittal to Owner.

B. Personnel

1. A staff shall be maintained under the direction of the Project Manager to perform all project activities.

2. The actual number of staff personnel during any specific work period may vary to cover work phase needs.

3. The personnel shall be fully qualified by experience and technical training to perform their assigned responsibilities and shall be hired directly by and work for the Contractor.

3.5 PROJECT CONTROL

The Work Plan is the means by which the Contractor assures Owner that construction complies with the requirements of the contract plans and specifications. The plan shall be adequate to cover all construction operations.

3.6 COMPLETION INSPECTION

At the completion of all work or any increment thereof, the Project Manager and Owner shall conduct a completion inspection of the work and develop a "punch list" of items which do not conform to the approved plans and specifications. The form used to prepare this list shall be included in the Work Plan documentation, as required by Section 3.7 below, and shall include the estimated date by which the deficiencies will be corrected. The Project Manager or his staff shall make a second completion inspection with the Owner to ascertain that all deficiencies have been corrected. The completion inspection and any deficiency corrections required by this paragraph shall be accomplished within the time stated for completion of the entire work.

3.7 DOCUMENTATION

The Contractor shall maintain a daily log of work activities, including the work of suppliers and subcontractors. This log shall be on an acceptable form and indicate a description of trades working on the project, the number of personnel working, the weather conditions encountered, any delays encountered, and acknowledgement of deficiencies noted along with the corrective actions taken on current and previous deficiencies. In addition, the log shall include factual evidence that required activities have been performed including but not limited to the following:

1. Type and number of activities.
2. Nature of defects, causes for rejection, etc.
3. Proposed remedial action.
4. Corrective actions taken.

The log shall cover both conforming and defective or deficient features and shall include a statement that supplies and materials incorporated in the work comply with the contract. Legible copies of the log shall be furnished to Owner. The Contractor shall keep records of the completion inspection, including a "punch list" of items which do not conform to the approved plans and specifications. For each item on this list, the Contractor shall document the corrective actions taken.

3.8 NOTIFICATION OF NONCOMPLIANCE

Owner will notify the Contractor of any noncompliance with the foregoing requirements. After receipt of such notice, the Contractor shall immediately take corrective action. Such notice, when delivered to the Contractor or his representative at the site of the work, will be deemed sufficient for the purpose of notification. If

the Contractor fails or refuses to comply promptly, Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

3.9 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in the contract LUMP SUM price.

END OF SECTION

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Owner will employ and pay for the services of an Independent Testing Laboratory to perform specified testing.

1. Contractor will cooperate with the laboratory to facilitate the execution of its required services.
2. Employment of the laboratory in no way relieves Contractor's obligations to perform the Work of the Contract.

1.02 RELATED REQUIREMENTS

A. General Conditions.

B. Each specification section listed: Laboratory tests required, and standards for testing.

1.03 LABORATORY DUTIES

A. Cooperate with Owner and Contractor; provide qualified personnel after due notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction:

1. Comply with specified standards.
2. Ascertain compliance of materials with requirements of Contract Documents.

C. Promptly notify Owner and Contractor of observed irregularities or deficiencies of work or products.

D. Promptly submit three copies of written report of each test and inspection. Include in each report:

1. Date issued.
2. Project title and number.
3. Testing laboratory name, address and telephone number.
4. Name and signature of laboratory inspector.
5. Date and time of sampling or inspection.
6. Record of temperature and weather conditions.

7. Date of test.
8. Identification of product and specification section.
9. Location of sample or test in the Project.
10. Type of inspection or test.
11. Results of tests and compliance with Contract Documents.
12. Interpretation of test results, when requested by Owner.

E. Perform additional tests as required by the Owner.

1.04 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of Contract Documents.
2. Approve or accept any portion of the Work.
3. Perform any duties of the Contractor.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel, provide access to Work.

B. Assist laboratory in obtaining adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed for concrete and other material mixes which require control by the testing laboratory.

D. Furnish copies of Products test reports as required.

E. Furnish incidental labor and facilities:

1. To provide access to Work to be tested.
2. To obtain and handle samples at the Project site or at the source of the product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.

1. When tests or inspections cannot be performed after such notice, reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.

G. Make arrangements with laboratory and pay for additional samples and tests required for Contractor's convenience.

H. Pay for testing laboratory to perform additional inspections, sampling and testing required when initial tests indicate Work does not comply with Contract Documents.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND SERVICES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Electrical Service

B. Lighting

C. Heating and Ventilation

D. Telephone Service

E. Water

F. Sanitary Facilities

G. First Aid Facilities

H. Fire Protection

I. Project Identification

J. Field Offices and Sheds

1.02 RELATED WORK

A. Section 01010: Summary of Work

B. Section 01700: Contract Closeout

C. Section 01710: Cleaning

1.03 GENERAL REQUIREMENTS

A. Install work in neat and orderly manner.

B. Make structurally, mechanically and electrically sound throughout.

C. Maintain to give continuous service and to provide safe working conditions.

D. Modify and extend service as work progress requires.

E. Pay all costs associated with temporary facilities and services specified herein except that Owner will pay long distance telephone charges from Owner trailer phone.

1.04 ELECTRICAL SERVICE

A. Arrange for temporary service to be installed by Indiana Michigan Power.

B. Furnish all temporary electric power systems required to perform work.

1.05 LIGHTING

A. Provide lighting for construction operations and security.

B. Permanent lighting may be used when available.

C. Maintain lighting and make routine repairs.

1.06 HEATING AND VENTILATION

A. Provide as required to maintain specified conditions for construction operations.

B. Protect materials and finishes from damage due to temperature or humidity as specified in Section 01620.

C. Prior to operation of permanent facilities for temporary purposes, verify that installation is approved for operation and filters are in place.

D. Provide ventilation of enclosed areas to cure materials, disperse humidity and prevent accumulations of dust, fumes, vapors, or gases.

1.07 TELEPHONE SERVICE

A. Provide temporary telephone service for all construction needs throughout construction period.

B. Provide separate private line in Owner's field office.

C. Arrange for service with Illinois Bell Telephone Company.

D. Provide directory at each instrument, listing the name and business telephone number of:

1. Contractor and all subcontractors employed at work site.
2. Owners' representatives.

3. Medical Services:
   a. Physicians.
   b. Hospitals.
   c. Ambulance service companies.
4. Emergency numbers of all utilities.
5. Police
6. Fire Departments

1.08 WATER

A. Arrange for temporary connection to Owner's water system.

B. Provide temporary distribution system and taps as required.

1.09 SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures.

B. Do not use existing facilities.

C. Provide temporary sanitary facilities including:

1. Portable containers to dispense potable drinking water.
2. Enclosed toilet facilities for construction personnel.

1.10 FIRST AID FACILITIES

A. Provide first aid station in Contractors' field office or shed of equal quality.

B. Provide full compliment of first aid supplies in weather proof container at first aid station.

1.11 FIRE PROTECTION

A. Provide portable fire extinguishers, rated 2A minimum, in Owner's field office, Contractors' field office, and storage shed.

B. Provide means of notifying personnel in case of emergency.

C. Ensure internal combustion engine powered equipment is located at safe distance from combustible materials.

D. Prohibit smoking in locations and operations of potential fire hazard, and clearly post "No Smoking" or "Open Flame" signs.

E. Flammable/Combustible Liquids

1. Store flammable/combustible liquids in conformance with requirements of federal and local codes and regulations.
2. Provide approved metal safety containers for storage of flammable/combustible liquids in excess of 1 gallon.
3. Prohibit storage of flammable/combustible liquids near exits, stairways or common passageways.

1.12 PROJECT IDENTIFICATION

A. Provide project identification sign in conformance with Federal Register, Vol. 43, No. 188 included.

B. Erect on site at location established by Owner.

1.13 FIELD OFFICES AND SHEDS

A. Provide and maintain a separate field office for Owner and Engineer as well as separate office(s) for Contractor's use.

B. Furnish Owner's temporary office (minimum 150 sq. ft.) with the following furnishings a minimum:

1. double pedestal desk
2. phone
3. desk chair
4. desk lamp
5. 2-4 drawer letter filing cabinet with locks and keys
6. drafting table
7. drafting lamp
8. drafting stool
9. equipment locker with lock and keys, of suitable dimensions to accommodate storage of survey equipment
10. 3 side chairs
11. wastebasket
12. stick file for drawings/prints
13. Potable water dispenser

C. Provide field offices with the following features:

1. Weather-tight construction 4, Electric lighting
2. Doors with locks and convenience outlets (minimum of 4-one on each wall)
3. Air conditioning
4. Electric lighting and convenience outlets
5. Exterior lighting at entrance door

D. Provide storage sheds for products in conformance with 01620.

E. Provide storage sheds with the following features:

1. Weathertight construction
2. Heating, ventilating and air conditioning as required to comply with Section 01620.
3. Sufficient space to provide for inspection.
4. Electric lighting.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01620

PRODUCT DELIVERY, STORAGE AND HANDLING

PART 1 GENERAL

1.01 GENERAL

A. These specifications apply to all products furnished under this contract.

1.02 DELIVERY

A. Do not deliver products to the Owner.

B. Do not deliver products to project site until related shop drawings have been reviewed and approved by Owner.

C. Do not deliver products to the project site until required storage facilities as specified below have been reviewed by Owner.

D. Products shall be delivered to site in manufacturer's original, unopened, labeled containers.

E. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

1.03 STORAGE AND PROTECTION

A. General:

1. Store and protect products in accordance with the manufacturer's recommendations and the requirements specified herein. No on-site or existing storage facilities are available for use by the contractor. Furnish all on-site facilities if space is available in the area defined as the "Site Limits" for the Work.
2. When area for storage facilities is not available within the "Site Limits", provide, at no extra cost to Owner, acceptable, weatherproof storage facilities in accordance with the storage requirements for specific equipment as described in the Contract Documents.
3. Provide weatherproof storage for all spare parts, off site in a facility reviewed by Owner when area within the "Site Limits" for provision of such facilities does not exist. Provide for security of such spare parts and for the segregation of spare

parts from uninstalled products that will be used in the performance of the work.

4. Provide all equipment, spare parts and supplies that are to be delivered to the Owner in accordance with the Contract Documents in properly marked original packages that show the name of the item, the equipment, or system in which the item belongs, Owner's requisition number, the quantity and the Specification's Section number.
5. Do not store products in the structures being constructed unless approved in writing by the Owner.
6. Do not block or restrict the use of access roads with stored materials.
7. Do not store products where they will interfere with operations of Owner or other contractors or on Owner's property outside the "Site Limits" of the Work.
8. Protect stored materials from damage by vandals. Contractor is fully responsible for products.
9. Protect all products from damage or deterioration by weather.
10. Do not store any products directly on the ground.
11. Do not store any products in drainage ditches or areas where water may stand.
12. Label containers to identify materials inside using the terminology found in these Specifications.

B. Uncovered Storage:

1. The following types of materials may be stored out-of-doors without cover:
   a. Masonry units
   b. Reinforcing steel
   c. Structural Steel
   d. Piping
   e. Precast concrete items
   f. Castings
   g. Grating
   h. Hand Railing
2. Store the above materials on wood blocking.

C. Covered Storage:

1. The following types of materials may be stored out-of-doors if covered with material impervious to water:
   a. Rough Lumber
2. Tie down covers with rope and slope to prevent accumulation of water on covers.
3. Store materials on wood blocking.

D. Fully Protected Storage:

1. Store all products not named above in buildings or trailers which have a concrete or wooden floor, a roof and fully closed walls on all sides.
2. Provide heated storage space for materials which would be damaged by freezing.
3. Protect mechanical and electrical equipment from being contaminated by dust and dirt.
4. Maintain temperature and humidity at levels recommended by manufacturers for electrical and electronic equipment.
5. Temporarily connect equipment with built-in space heaters to a power source and keep heaters in operation.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01630

SUBSTITUTIONS AND PRODUCT OPTIONS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish and install products specified, under options and conditions for substitutions stated in this section.

1.02 RELATED REQUIREMENTS

A. Section 01340: Shop Drawings, Product Data and Samples.

B. Section 01720: Project Record Documents.

1.03 CONDITIONS OF PRODUCTS

A. Furnish only new materials and equipment for inclusion in this project, unless otherwise noted.

B. Use materials and equipment removed from existing facilities only if approved in writing by Owner.

1.04 PRODUCTS LIST

A. Within 30 days after award of Contract, submit to Owner three copies of complete list of major products which are proposed for installation.

B. All prefab components such as structural steel and steel stairs must be fabricated and marked for field identification.

C. Tabulate products by specification section number and title.

D. For products specified only by reference standards, list for each such product:
   1. Name and address of manufacturer.
   2. Trade name.
   3. Model or catalog designation.
   4. Manufacturer's data:
      a. Reference standards.
      b. Performance test data.

1.05 CONTRACTOR'S OPTIONS

A. For products specified only by reference standard, select product meeting that standard, by any manufacturer.

B. For products specified by naming several products or manufacturers, select any one of products and manufacturers named which complies with specifications.

C. For products specified by naming one or more products or manufacturers and stating "or equal", submit a request as for substitutions, for any product or manufacturer which is not specifically named.

1.06 SUBSTITUTIONS

A. Substitutions of equipment or materials other than those designated in the contract documents may be made only upon written consent of Owner.

B. Where a Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, which requires any redesign of any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings required therefore shall be prepared by the Contractor at his own expense.

C. Submit separate request for each substitution. Support each request with:
   1. Complete data substantiating compliance of proposed substitution with requirements stated in Contract Documents:
      a. Product identification, including manufacturer's name and address.
      b. Manufacturer's literature; identify:
         1) Product description.
         2) Reference standards.
         3) Performance and test data.
      c. Samples, as applicable.
      d. Name and address of similar projects on which product has been used, and date of each installation.

   2. Itemized comparison of the proposed substitution with product specified. List significant variations in a table of specification compliance. Each table of specification compliance shall list specification paragraph and indicate whether the proposed substitution is an enhancement, conforms to the specification, is a minor variation, is an alternative with equivalent function or is an exception to the specification.
   3. Data relating to changes in construction schedule.
   4. Any effect of substitution on separate contracts.
   5. List of changes required in other work or products.

6. Accurate cost data comparing proposed substitution with product specified.
   a. Amount of any net change to Contract Sum.
7. Designation of required license fees or royalties.
8. Designation of availability of maintenance services, sources of replacement materials.
9. For construction methods:
   a. Detailed description of proposed method.
   b. Drawings illustrating methods.

D. Substitutions will not be considered for acceptance when:
   1. They are indicated or implied on shop drawings or product data submittals without a formal request from Contractor.
   2. They are requested directly by a subcontractor or supplier.
   3. Acceptance will require substantial revision of Contract Documents.

E. Substitute products shall not be ordered or installed without written acceptance of Owner.

F. Owner will determine acceptability of proposed substitutions.

1.07 CONTRACTOR'S CERTIFICATION

A. In making formal request for substitution, Contractor shall certify that:
   1. He has investigated proposed product and has determined that it is equal to or superior in all respected to that specified.
   2. He will provide same warranties or bonds for substitution as for product specified.
   3. He will coordinate installation of accepted substitution into the Work, and will make such changes as may be required for the Work to be complete in all respects, without additional cost to Owner.
   4. He waives claims for additional costs caused by substitution which may subsequently become apparent.
   5. Cost data is complete and includes related costs under his Contract.

1.80 OWNER'S DUTIES

A. Review Contractor's requests for substitutions with reasonable promptness.

B. Notify Contractor, in writing, of decision to accept or reject requested substitution.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01657

STARTING PROCESS SYSTEMS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Section 01669: Testing Process Systems

1.02 MANUFACTURER'S RESPONSIBILITIES

A. Provide field representative to assist with start-up.

B. Check installation prior to start-up for conformance to Manufacturer's instructions.

C. Adjust or modify equipment to make equipment properly operational.

1.03 SUBMITTALS

A. Submit to Owner for approval start-up and test schedule minimum of two weeks in advance of commencing work specified in this Section.

B. Submit to Owner copies of test data and test records in accordance with Section 01340.

PART 2 PRODUCTS

2.01 LUBRICANTS

A. Flushing oil: Manufacturer's recommended, not detrimental to lubricating oil.

B. Oil and grease: Manufacturer's recommended.

2.02 CHECKOUT MEDIA

A. For mechanical checkout operate the system using water as a checkout media in lieu of the process media except for the blower. Use air as the checkout media for the blower.

PART 3 EXECUTION

3.01 PREPARATION

A. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment functions correctly under no load conditions.

B. Remove temporary bracing and supports.

C. Remove protective coatings and oils used for protection during shipment and installation if the coatings and oils are detrimental to the equipment operations.

D. Flush and fill lubricated systems in accord with Manufacturer's instructions.

E. Install temporary connections and devices required to fill, operate, checkout and drain the system.

F. Check equipment for correct direction of rotation and freedom of moving parts.

G. Align equipment to Manufacturer's tolerances.

3.02 EQUIPMENT RUN-IN

A. Operate equipment at a no load condition for a time in accord with Manufacturer's instructions.

B. Inspect and adjust equipment for proper operations.

C. Drain, flush, and refill lubrication when required in accord with Manufacturer's instructions.

3.03 MECHANICAL CHECKOUT

A. Make final corrections to equipment and complete the system installation necessary to apply the system loads to the equipment and verify the equipment functions correctly under non-process of water test conditions.

B. Fill, load or otherwise charge the system with the checkout media.

C. Perform non-operating checkout media leak or pressure tests on equipment. Adjust or correct equipment to conform to Manufacturer's specified limits.

D. Start equipment according to Manufacturer's instructions.

E. Place equipment in the system in operation until the entire system is functioning.

F. Operate the system through the full design performance range. Adjust, balance, calibrate and, in general, check out the equipment, safety devices, controls and process system to operate within the design conditions.

3.04 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01620

PRODUCT DELIVERY, STORAGE AND HANDLING

PART 1 GENERAL

1.01 GENERAL

A. These specifications apply to all products furnished under this contract.

1.02 DELIVERY

A. Do not deliver products to the Owner.

B. Do not deliver products to project site until related shop drawings have been reviewed and approved by Owner.

C. Do not deliver products to the project site until required storage facilities as specified below have been reviewed by Owner.

D. Products shall be delivered to site in manufacturer's original, unopened, labeled containers.

E. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

1.03 STORAGE AND PROTECTION

A. General:

1. Store and protect products in accordance with the manufacturer's recommendations and the requirements specified herein. No on-site or existing storage facilities are available for use by the contractor. Furnish all on-site facilities if space is available in the area defined as the "Site Limits" for the Work.
2. When area for storage facilities is not available within the "Site Limits", provide, at no extra cost to Owner, acceptable, weatherproof storage facilities in accordance with the storage requirements for specific equipment as described in the Contract Documents.
3. Provide weatherproof storage for all spare parts, off site in a facility reviewed by Owner when area within the "Site Limits" for provision of such facilities does not exist. Provide for security of such spare parts and for the segregation of spare

parts from uninstalled products that will be used in the performance of the work.

4. Provide all equipment, spare parts and supplies that are to be delivered to the Owner in accordance with the Contract Documents in properly marked original packages that show the name of the item, the equipment, or system in which the item belongs, Owner's requisition number, the quantity and the Specification's Section number.
5. Do not store products in the structures being constructed unless approved in writing by the Owner.
6. Do not block or restrict the use of access roads with stored materials.
7. Do not store products where they will interfere with operations of Owner or other contractors or on Owner's property outside the "Site Limits" of the Work.
8. Protect stored materials from damage by vandals. Contractor is fully responsible for products.
9. Protect all products from damage or deterioration by weather.
10. Do not store any products directly on the ground.
11. Do not store any products in drainage ditches or areas where water may stand.
12. Label containers to identify materials inside using the terminology found in these Specifications.

B. Uncovered Storage:

1. The following types of materials may be stored out-of-doors without cover:
   a. Masonry units
   b. Reinforcing steel
   c. Structural Steel
   d. Piping
   e. Precast concrete items
   f. Castings
   g. Grating
   h. Hand Railing
2. Store the above materials on wood blocking.

C. Covered Storage:

1. The following types of materials may be stored out-of-doors if covered with material impervious to water:
   a. Rough Lumber
2. Tie down covers with rope and slope to prevent accumulation of water on covers.
3. Store materials on wood blocking.

D. Fully Protected Storage:

1. Store all products not named above in buildings or trailers which have a concrete or wooden floor, a roof and fully closed walls on all sides.
2. Provide heated storage space for materials which would be damaged by freezing.
3. Protect mechanical and electrical equipment from being contaminated by dust and dirt.
4. Maintain temperature and humidity at levels recommended by manufacturers for electrical and electronic equipment.
5. Temporarily connect equipment with built-in space heaters to a power source and keep heaters in operation.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01669

TESTING PROCESS SYSTEMS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Section 01657: Starting Process Systems.

B. Section 01340: Shop Drawings, Product Data, and Samples.

C. Section 01730: Operating and Maintenance Data.

1.02 MANUFACTURER'S RESPONSIBILITIES

A. Prepare equipment test procedure.

B. Provide field representative to assist with the performance test of the equipment and systems as specified.

C. Adjust or modify equipment during the performance test as necessary to achieve design performance.

D. Pay costs incurred because of the Manufacturer's equipment failure to operate at specified performance criteria.

E. Pay costs for installation and removal f rejected equipment.

F. Submit to Owner written verification of satisfactory completion of performance test.

1.03 OWNER'S RESPONSIBILITIES

A. Make available sufficient process media to conduct the performance test.

B. Pay costs of testing process media.

C. Operate equipment and systems which Owner has accepted that are necessary to support the system being tested.

1.04 SUBMITTALS

A. Submit the following in accord with Section 01340:

1. Equipment test procedure.

2. System test procedure and schedule a minimum of two weeks in advance of the performance test.

3. Copies of performance test data and test records.

B. Submit Operating and Maintenance Manual revisions according to Section 01730. Reflect actual operating conditions during the performance test.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 SYSTEM TEST PROCEDURE

A. Prepare system test procedure by coordinating the test procedures for the equipment in the system.

B. Incorporate procedures to test the full design performance range of the equipment and the system.

3.02 PREPARATION

A. Complete start-up according to Section 01657.

3.03 NONCONFORMING PROCESS MEDIA

A. If the process media, such as water, does not conform to design criteria to the extent that the equipment and system cannot meet the performance criteria, Owner may elect one of the following methods to complete the performance test:

1. Owner may modify the process media or obtain a new source until the media does conform to design criteria. Costs for modification or replacement of the media and additional testing to verify conformance to design criteria will be paid by Owner.

2. Owner may authorize modification of the performance criteria to a proportional equableness. Adjustments in the design criteria will be established by Owner and agreed upon in writing by Owner and manufacturer. The costs of modifications to the equipment or system required by adjusting the design criteria will be paid for by Owner.

3.04 PROCESS START-UP

A. Replace checkout media used to start the system with process media by one of the following methods:

1. Owner may modify the process media or obtain a new source until the media does conform to design criteria. Costs for modification or replacement of the media and additional testing to verify conformance to design criteria will be paid by the Owner.

2. Owner may authorize modification of the performance criteria to a proportional equableness. Adjustments in the design criteria will be established by the Owner and agreed upon in writing by the Owner and manufacturer. The costs of modifications to the equipment or system required by adjusting the design criteria will be paid for by the Owner.

3.04 PROCESS START-UP

A. Replace checkout media used to start the system with process media by one of the following methods:

1. Shut down, drain and refill the system.

2. Introduce process media to the influent stream. Add process media to replace the checkout media in the system; or add the process media at the design flow rate for a period of time equal to the longest retention time of any part of the system; whichever is the greater volume of process media.

B. Operate system under process conditions without interruption 2 consecutive days before making the performance test.

3.05 PERFORMANCE TEST

A. Conduct system performance test according to approved system test procedure.

B. Adjust system to operate at the performance criteria set by the Specifications and listed in Section 11001.

C. Operate system without interruption and maintain the performance criteria for a minimum of 2 consecutive days.

3.06 PERFORMANCE TEST FAILURE

A. If the system fails to meet the performance criteria, modify or replace the equipment or system components which are believed to be faulty.

B. Receive Owner's written authorization for modifications to the system or equipment before making changes.

C. Conduct another performance test.

D. Modifying or replacing equipment and the system retesting because of performance test failure will be at no cost to Owner.

3.07 EQUIPMENT REJECTION

A. If the equipment which causes the performance test failure is not corrected or if the system is again tested and fails to operate at the performance criteria, Owner may reject the faulty equipment.

B. Repay Owner all sums of money paid for the rejected equipment.

C. Repay Owner cost of installation of rejected equipment.

D. Owner will execute and deliver a bill of sale for the rejected equipment. Bill of sale does not abrogate Owner's right to recover damages for delays, losses or other conditions resulting from rejecting equipment.

E. Owner will obtain alternate equipment to replace the rejected equipment.

F. Provide use of rejected equipment at no cost to Owner until alternate equipment can be installed.

G. Remove rejected equipment at no cost to Owner.

H. Install alternate equipment according to the equipment specification.

3.08 SYSTEM ACCEPTANCE

A. After successful completion of the performance test, Owner will designate in writing that the system is accepted.

B. Owner will assume responsibility for the system operation and maintenance after acceptance is executed.

3.09 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 RELATED WORK

A. General Conditions:

B. Section 01027: Application for Payments

C. Section 01310: Construction Scheduling

D. Section 01370: Schedule of Values

E. Section 01710: Cleaning

F. Section 01720: Project Record Documents

G. Section 01730: Operation and Maintenance Data

1.02 GENERAL REQUIREMENTS

A. The Contractor shall prepare and provide all documentation required in this section, unless otherwise noted.

1.03 SUBSTANTIAL COMPLETION

A. Prepare and issue a Certificate of Substantial Completion for approval by the Owner containing:

1. Date of Substantial Completion.
2. Contractor's list of items to be completed or corrected as verified and amended by Owner.
3. The time required to complete or correct work of listed items.
4. Time and date Owner will assume possession of Work or designated portion thereof.
5. Responsibilities of Owner and Contractor for:
   a. Insurance.
   b. Utilities.
   c. Operation of mechanical, electrical and other systems.
   d. Maintenance and Cleaning.
   e. Security.
6. Signatures of:
   a. Contractor.

7. A place for signature of:
   a. Owner.

B. Owner Occupancy of the Work:

1. Owner will occupy Project, under provisions stated in Certificate of Substantial Completion.

C. Complete work listed for completion or correction, within designated time.

D. Owner will make an inspection after receipt of Certificate of Substantial Completion and should Owner consider that work is not substantially complete:

1. Contractor will be notified, in writing, stating reasons.
2. Contractor will then Complete Work, and send second written notices to Owner, certifying that Work or designated portion of Project, is substantially complete.
3. Owner will reinspect Work.

E. Where the Contractor desires to place part of the Work in operation before the entire project is substantially complete. This process may be performed on a unit by unit basis.

1.04 FINAL INSPECTION

A. Submit written certification that:

1. Contract Documents have been reviewed.
2. Project has been inspected for compliance with Contract Documents.
3. Work has been completed in accordance with Contract Documents.
4. Equipment and systems have been tested in presence of Owner and are operational.
5. Work is completed and ready for final inspection.

B. Owner will make final inspection after receipt of certification.

C. Should Owner consider that Work is complete in accordance with requirements of Contract Documents, Contractor will be requested to make Project Closeout submittals.

D. Should Owner consider that Work is not complete:

1. Contractor will be notified, in writing, stating reasons.
2. Contractor will take immediate steps to remedy the stated deficiencies and send second written notice to Owner certifying that Work is complete.

3. Owner will reinspect Work.

1.05 CLOSEOUT SUBMITTALS

A. Submit Record Drawings in accordance with Section 01720.

B. Deliver evidence of compliance with requirements of governing authorities:
   1. Certificates of Inspection:
      a. Mechanical.
      b. Electrical.
   2. Maintenance Bonds.
   3. Inventory lists and receipts for contractor furnished equipment that has been delivered to the Owner.

C. Deliver Certificate of Insurance for Products and Completed Operations.

1.06 EVIDENCE OF PAYMENTS, AND RELEASE OF LIENS

A. Contractor's Affidavit of Payment of Debts and Claims.

B. Contractor's Affidavit of Release of Liens:

   1. Consent Of Surety to Final Payment.
   2. Contractor's release or waiver of liens.
   3. Separate releases of waivers of liens for subcontractors, suppliers, and others with lien rights against property of Owner, together with list of those parties.

C. Duly executed all submittals before delivery to Owner's Representative.

1.07 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit final statement of accounting to Owner.

B. Reflect all adjustments for:
   1. Original Contract Sum.
   2. Additions and deductions resulting from:
      a. Previous Change Orders.
      b. Cash Allowances.
      c. Unit Prices.
      d. Other Adjustments.
      e. Deductions for uncorrected Work.
      f. Penalties.
      g. Deductions for liquidated damages
      h. Deductions for Reinspection Payments.
   3. Total contract Sum, as adjusted.
   4. Previous payments.

5. Sum remaining due.

C. Owner will prepare final Change Order, reflecting approved adjustments to Contract Sum not previously made by change Orders.

1.08 FINAL APPLICATION FOR PAYMENT

A. Submit final application in accordance with requirements of the General Conditions.

1.09 FINAL CERTIFICATE FOR PAYMENT

A. Owner's Representative will issue final certificate in accordance with provisions of the General Conditions.

B. Should final completion be materially delayed through no fault of Contractor, Owner's Representative may issue a Semi-Final Certificate for Payment, in accordance with provisions of General Conditions.

1.10 POST-CONSTRUCTION INSPECTION

A. Prior to expiration of one year from Date of Substantial Completion, Owner's Representative will make visual inspection of Project in company with Owner and Contractor to determine whether correction of Work is required, otherwise in accordance with provisions of the Contract Documents.

B. For Guarantees beyond one year, Owner will make inspections after notification to Contractor.

C. Owner will notify Contractor, in writing, of any observed deficiencies.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01710

CLEANING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. General Conditions:

B. Each Specification Section: Cleaning for specific Products or work.

1.02 DISPOSAL REQUIREMENTS

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning, every day, to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

D. Store volatile waste in covered metal containers and remove from premises as soon as possible.

E. Clean interior spaces prior to the start of finish work and continue cleaning on an as-needed basis until Work is completed.

F. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

G. Burning of debris on site is prohibited.

H. Disposal of volatile fluid wastes and other chemical wastes in storm or sanitary sewer systems is not permitted.

3.02 FINAL CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces.

B. Wash and shine glazing and mirrors.

C. Polish glossy surfaces to a clear shine.

D. Ventilating Systems:

1. Clean permanent filters and replace disposable filters if units were operated during construction.
2. Clean ducts, blowers and coils if units were operated without filters during construction.

E. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

F. Prior to final completion, or Owner occupancy, conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire Work is clean.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Maintain at the site for Owner one record copy of:

1. Drawings
2. Specifications
3. Addenda
4. Change Orders and other Modifications to the Contract.
5. Owner's Field Orders or written instructions.
6. Approved Shop Drawings, Product Data and Samples.
7. Field Test records.

1.02 RELATED REQUIREMENTS

A. Section 01340: Shop Drawings, Product Data and Samples.

1.03 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store documents and samples in Contractor's field office apart from documents used for construction.

1. Provide files and racks for storage of documents.
2. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with CSI/CSC format.

C. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by Owner.

1.04 MARKING DEVICES

A. Provide red pencils for recording information.

1.05 RECORDING

A. Label each document "PROJECT RECORD" in 2 inch high printed letters.

B. Record information concurrently with construction progress. Do not conceal any work until required information is recorded.

C. Legibly mark the following information on drawings to record actual construction:

1. Depths of various elements of foundation in relation to plan sheet datum.
2. Horizontal and vertical locations of underground and underslab utilities and appurtenances, referenced to permanent surface improvements.
3. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
4. Field changes of dimension and detail.
5. Changes made by Field Order or by Change Order.
6. Details not on original contract drawings.

D. Legibly mark each specification Section to record:

1. Manufacturer, trade name, catalog number, and Supplier of each Product and item of equipment actually installed.
2. Changes made by Field Order or by Change Order.
3. Other matters not originally specified.

1.06 SUBMITTAL

A. At Contract close-out, deliver Record Documents to Owner.

B. Place all letter-sized material in a three ring binder, neatly indexed.

C. Bind contract drawings and shop drawings in rolls of convenient size for ease of handling.

D. Accompany submittal with transmittal letter in duplicate, containing:

1. Date.
2. Project title and number.
3. Contractor's name and address.
4. Title and number of each Record Document.
5. Certification that each document as submitted is complete and accurate.
6. Signature of Contractor or his authorized representative.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide operation and maintenance data for the following

1. Valves, locks, gates and related accessories.
2. Instruments and control devices.
3. All mechanical and electrical equipment and devices.

1.02 RELATED WORK

A. Section 01310: Construction Scheduling

B. Section 01340: Shop Drawings, Product Data and Samples

C. Section 01700: Contract Closeout

D. Section 01720: Project Record Documents

1.03 DEFINITIONS

A. Operations and Maintenance Data: All product related information and documents which are required for preparation of the operation and maintenance manual.

B. Preventive Maintenance Instructions: All information and instructions required by personnel to keep a product or piece of equipment properly lubricated, adjusted and otherwise maintained so that the item functions economically throughout its full design life.

C. Corrective Maintenance: All information and instructions required by personnel to repair a product or piece of equipment in the field.

1.04 REQUIRED INFORMATION

A. Prepare the data specifically for this installation.

B. Include, as a minimum requirement, the following items.

1. Tracing, photocopy or other suitable reproduction of the equipment nameplates.

2. Equipment performance curves. (Copies of those submitted under Section 01340).
3. Start-up checklist.
4. Name, address and telephone number of the manufacturer.
5. Name, address and telephone number of source of replacement parts and service nearest to the Project site.
6. Complete, detailed operating instructions, written in the English language, for each product or piece of equipment listed in paragraph 1.01.A. of this Section.
7. Complete, detailed written preventive maintenance instructions as defined in paragraph 1.03.B. of this Section, including time required for each maintenance task.
8. Recommended spare parts lists and life expectancy of each part.
9. Written explanations of all safety considerations relating to operation or maintenance procedures.
10. Parts lists showing parts and catalog numbers with exploded view showing interrelationship of parts.
11. Step by step corrective procedures tied to exploded diagram.
12. A written explanation with illustrations as required for each preventive maintenance task, including finishes.
13. Recommended schedule for execution of preventive maintenance tasks.
14. Lubrication and other consumables charts, including rate of consumption.
15. Table of alternate lubricants.
16. Troubleshooting instructions and diagnostic procedures.
17. List of required maintenance tools and equipment.

1.05 SUBMITTAL REQUIREMENTS

A. Submit operations and maintenance data to Owner within one year after Award of Contract or 60 days after review of shop drawings, whichever occurs first.

B. Submit updated operation and maintenance data to the Owner as it becomes available.

C. Submit all revisions of manufacturer's literature and operation and maintenance data to the Owner within 60 days after such revision is made.

D. Submit 3 copies of each item.

E. Provide a letter of transmittal with each submittal and include the following in the letter:

1. Date of submittal.
2. Contract title and number.
3. Contractor's name and address.

4. A list of the attachments and the specification sections to which they relate.
5. Reference to or explanation of any related submittals previously submitted or to be submitted at a future date.

F. The Owner may withhold one hundred percent of progress payments until satisfactory operation and maintenance data has been submitted.

1.06 FORM OF SUBMITTALS

A. Prepare data for inclusion in an instructional manual for use by Owner's personnel.

B. Format:

1. Size: 8-1/2 in. x 11 in. or 11 in. x 17 in., folded.
2. Paper: Manufacturer's printed data, or neatly typewritten.
3. Drawings:
   a. Provide reinforced punched binder tab, bind in with text.
   b. Fold 11 in. x 17 in. drawings to size of text pages.
4. Provide fly-leaf for each separate product, or each piece of operating equipment.
   a. Provide typed description of product, and major component parts of equipment.
   b. Provide indexed tabs.
5. Provide left-hand binding margin of 1.25 inches.

C. Organization and Packaging

1. Submit data bound in looseleaf binders, arranged in logical sequence, neatly boxed in cardboard boxes.
2. Provide a table of contents for each box.
3. Label exterior of each box with typewritten labels indicating the titles of contents.
4. Use dividers between major categories of information such as "Operating Instructions", preventive maintenance instructions, etc. When necessary place each major category in a separate box.
5. Identify products by their functional names in the table of contents and at least once in each chapter or section. Thereafter, abbreviations and acronyms may be used if their meaning is explained in a table in the back of each box. Exclusive use of model or catalog numbers or letters for identification is not acceptable.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 02050

ROADWAY PREPARATION

PART 1 GENERAL

1.10 DESCRIPTION

Work included in this section is the construction of a gravel roadway at the plant site from the entrance at the main road to the treatment buildings.

1.02 RELATED WORK

A. Section 02110: Clearing and Stripping

B. Section 02200: Earthwork

1.03 SEQUENCING AND SCHEDULING

A. Notify Owner of intent to proceed with removal at least 10 days prior to start of work.

B. Schedule and coordinate removal work with new construction to expedite completion of new treatment facility.

1.04 PROTECTION

A. Locate, mark and protect all existing utilities, structures, landscape features, etc., as required in Section 02200.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

A. Establish extent of removal by area and elevation; designate and identify datum elevation.

B. Maintain bench marks, monuments and other reference points.

3.02 REMOVAL OF ABANDONED FACILITIES

A. Plug all incoming and outgoing pipes.
B. Drain water from structure and discharge in an approved manner.
C. Remove handrail, etc.

D. Cut or break off piping, concrete, reinforcing steel and masonry a minimum of two feet below existing grade.
E. Backfill structure per specification Section 02200 Earthwork.
F. Damage to existing facilities are to be repaired at no cost to Owner.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 02110

CLEARING AND STRIPPING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Clear areas of plant life and grass as necessary for construction and only with prior approval of Engineer.

B. Remove trees and shrubs.

C. Remove surface debris and rubbish.

D. Strip and stockpile topsoil.

1.02 RELATED WORK

Section 02200: Earthwork

1.03 REGULATORY REQUIREMENTS

A. Conform to applicable ordinances and codes for disposal of debris. Burning of debris on site is prohibited.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 CLEARING

A. Clear areas required for access to site and execution of work.

3.02 PROTECTION

A. Protect plant growth and features remaining as final landscaping.

B. Protect bench marks and existing work from damage or displacement.

C. Maintain designated site access for vehicle and pedestrian traffic.

3.03 DISPOSAL

A. Properly dispose of all excess scrap material, rubbish or debris from site or as directed by the Engineer.

3.04 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.01 WORK INCLUDED

A. General excavation and fill operations.

B. Rough grading and contouring of site.

C. Finish grading.

D. Drainage ditches.

1.02 RELATED WORK

A. Section 02220: Excavation, Backfilling and Compaction for Pipelines

B. Section 02221: Structural Excavation, Backfilling and Compaction

1.03 QUALITY ASSURANCE

A. Test material to be used as compacted fill, whether excavated on site or imported as off-site borrow, for compliance with the requirements of this Section prior to placement.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Stockpile excavated materials and/or borrow as instructed by the Engineer.

B. Lightly compact and slope top of stockpiles to prevent excessive erosion and ponding of water.

1.05 WORK AFFECTING EXISTING FACILITIES

A. Utilities

1. Protect above or below grade utilities which are to remain.
2. Do not take existing utilities out of service without specific authorization by the utility owner and Engineer.
3. Notify the utility owner and Engineer at least five working days prior to taking existing utilities out of service to make connections or for removal of utility.

1.06 PROTECTION

A. Protect trees, shrubs, lawns, and other features remaining as portion of final landscaping.

B. Protect bench marks, existing structures, fences, roads, sidewalks and paving.

C. Protect above or below grade utilities which are to remain.

D. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods, as required to prevent cave-ins or loose dirt from falling into excavations.

E. Underpin adjacent structures which may be damaged by excavation work, including service lines and pipe chases.

F. Notify the Engineer of unexpected sub-surface conditions and discontinue work in area until the Engineer provides notification to resume work.

G. Protect bottom of excavations and soil around and beneath foundations from frost and freezing.

H. Grade around excavations to prevent surface water run-off into excavated areas.

I. Repair damage, promptly, at no cost to Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Type A: Clean gravel-sand mixture free from organic matter and when tested in accordance with ASTM D422, conforming to following Illinois Department of Transportation gradation classification CA-18 requirements:

Sieve Size	% Passing
3 inches	100
1 inch	90 to 100
No. 4	50 to 100
No. 16	30 to 80
No. 50	10 to 30
No. 200	0 to 5

B. Type B: Unclassified material obtained from excavation or any other source; free from peat, wood, roots, bark, debris, garbage, rubbish, or other extraneous material; maximum size of stone not to exceed 6 inches.

C. Drain Rock: Clean, washed, sound and durable well-graded crushed rock, crushed gravel or gravel; when tested in accordance with ASTM D422, conforming to following Illinois Department of Transportation gradation classification CA-7 requirements:

Sieve Size	% Passing
1-1/2 inches	100
1 inch	90 to 100
1/2 inch	30 to 60
No. 4	0 to 10

D. Filter Sand: Select, granular material, free from organic matter; when tested in accordance with ASTM D422, conforming to following Illinois Department of Transportation gradation classification CA-18 requirements:

Sieve Size	% Passing
3 inches	100
1 inch	90 to 100
No. 4	50 to 100
No. 16	30 to 80
No. 50	0 to 20
No. 200	0 to 4

E. Riprap: Durable field or quarry stone of Illinois DOT approved quality; sound and relatively free of seams, laminations, cracks and other structural defects.

1. Maximum weight per piece of 150 pounds and not more than 5 percent weighs less than 3 pounds per piece; graded evenly, 30 to 70 percent of material to weigh 60 pounds or more per piece.
2. Riprap Bedding: Well graded; 100 percent passes 3-inch sieve with no more than 5 percent passing No. 4 sieve; Illinois DOT approved quality.

F. Granular Cradle: Stone screening, crushed stone, pit run gravel, washed gravel, or other granular material as approved with types and gradations of Illinois Department of Transportation classifications as follows:

GRANULAR CRADLE GRADATIONS

SIEVE SIZE					PERCENT PASSING				
IDOT CLASS	1-1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#200
CA-13			100	94-100	70-90	20-50		0-6	5-15

G. Selected Granular Backfill: Sand, stone sand, crushed stone, pit run or crushed gravel, with types and gradations of Illinois Department of Transportation classification as follows:

SELECTED GRANULAR BACKFILL

SIEVE SIZE				PERCENT PASSING				
TYPE	1-1/2"	1"	1/2"	#4	#8	#16	#100	#200
FA-6				84-100			0-40	0-12
A	100	90-100	60-100	40-80	25-60	20-45		0-15
B		100	60-95	40-60		15-45		5-15

1. Granular materials from local deposits, graded reasonable close to limits specified in A and B above may be used if approved by Engineer.
2. At time of use, Select Granular Backfill free of frozen lumps and foreign material.

H. Fill under landscaped areas:
1. Free from alkali, salt, and petroleum products.
2. Use sub-soil excavated from site only if conforming to specified requirements.

PART 3 EXECUTION

3.01 PREPARATION AND LAYOUT

A. Establish extent of site grading by area and elevation; designate and identify datum elevation.

B. Set required lines and levels.

C. Maintain bench marks, monuments and other reference points.

3.02 UTILITIES

A. Known underground utilities are indicated on the PLANS.

B. Before starting excavation, establish location and extent of underground utilities occurring in work area.

C. Notify the Engineer for direction of removal and/or relocation of lines which are in the way of excavation.

D. Maintain, re-route or extend as required, existing utility lines to remain which pass through work area with the approval of the Owner.

E. Support and protect utility services uncovered by excavation.

F. Remove abandoned service lines from areas of excavation; cap, plug or seal such lines and identify at grade.

G. Accurately locate and record abandoned and active lines rerouted or extended, on Project Record Documents.

H. As excavation approaches utilities, hand excavate to uncover utilities.

3.03 EXCAVATION

A. Before starting excavation, clear work area in accordance with Section 02110.

B. Excavate in accordance with lines and levels required for construction of the work.

C. When excavation is through paved areas, cut pavement to provide a square, uniform edge with minimum disturbance of remaining pavement.

D. Machine slope banks.

E. Hand trim excavations and leave free from loose or organic matter.

F. Keep excavations dry until backfilling is completed.

G. Do additional excavation only by written authorization of Engineer.

H. Correct unauthorized excavation as directed, at no cost to Owner.

I. Excavations are not to interfere with normal 45 degree bearing splay of any foundation.

J. Stockpile excavated material in areas designated by Owner according to classifications given under MATERIALS portion of this section.

K. Do not disturb soil within branch spread of existing trees or shrubs that are to remain.

L. If necessary to excavate through roots, perform work by hand and cut roots with a sharp ax.

3.04 BACKFILLING

A. Fill Placement

1. Do not start backfilling operations until structures have been inspected and backfilling authorized by Owner.
2. Ensure areas to be filled are free from debris, snow, ice and water, and that ground surfaces are not in a frozen condition.
3. Do not place fill over existing sub-grade surfaces which are porous, wet or spongy.
4. Compact existing sub-grade surfaces if densities are not equal to that required for materials.
5. Cut out soft areas of existing sub-grade. Backfill with select fill and compact to required density.
6. Place compacted fill to grades, contours, levels and elevations shown on PLANS.
7. Place fill systematically and as early as possible to allow maximum time for natural settlement and compaction.
8. Place and compact fill materials in continuous layers not exceeding 8 inches loose depth. Use a method so as not to disturb or damage completed work constructed in the excavations.
9. Maintain optimum moisture content of fill materials to attain required compaction density.

B. Compaction

1. Compact fill materials listed below to required percentages of maximum dry density as determined by ASTM D-698.
   a. Compact granular backfill under structures and roads to 95 percent.
   b. Compact bedding to 70 percent relative density or as approved by the Engineer.
   c. Minimum frequency of density tests.
      1) Granular backfill: 1 test/500 cubic yards.
      2) Initial backfill: 1 test/200 cubic yards.
      3) Bedding: 1 test/200 cubic yards.

3.05 FINISH GRADING

A. Subgrade Preparation

1. Rough grade compacted fill systematically to allow for a maximum amount of natural settlement and compaction. Eliminate uneven areas and low spots. Remove debris, roots, branches, stones, etc. in excess of 3 inches in size. Remove fill material which has been contaminated with petroleum products.
2. Cut out areas, to sub-grade elevation, which are to receive sidewalks or stabilizing base for slabs.
3. Bring compacted fill to required levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
4. Slope grade away from structures minimum 6 inches in 6 feet unless otherwise indicated on PLANS.
5. Where fill to required subgrade elevation is less than 6 inches, scarify to a depth of 6 inches and compact.
6. Cultivate subgrade to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subgrade.

B. Placing Topsoil

1. Place in minimum 4 inches depth up to finished grade elevations.
2. Use topsoil in relatively dry state. Place during dry weather.
3. Fine grade topsoil eliminating rough and low areas to ensure positive drainage. Maintain levels, profiles and contours of sub-grades. Rake until surface is smooth.
4. Remove stone, roots, grass, weeds, debris and other foreign material while spreading.
5. Manually spread topsoil around trees, plants, and buildings, to prevent damage which may be caused by grading equipment.
6. Lightly compact topsoil after placing.
7. Seed topsoil in accordance with Section 02937.

3.06 TOLERANCES

A. Site grading to conform to PLANS within the following tolerances:

1. Drainage ditches: $\pm$ 0.10 feet.
2. Excavations: $\pm$ 0.20 feet.
3. Compacted Fill: $\pm$ 0.20 feet.

3.07 SURPLUS MATERIAL

A. Dispose of unclassified material, surplus fill materials and excess topsoil off site or as directed by the Engineer.

B. Leave stockpile areas and entire job site clean and raked, ready to receive seeding.

3.08 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM prices.

END OF SECTION

SECTION 02220

EXCAVATION, BACKFILLING AND COMPACTION FOR PIPELINES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Trenching for utilities and piping systems as well as subsequent backfill and compaction operations.

1.02 RELATED WORK

A. Section 02200: Earthwork

B. Section 03300: Cast-in-Place Concrete

C. Section 15001: General Requirements for Piping Systems

1.03 REFERENCE STANDARDS

A. ASTM D698: Moisture Density Relationship of Soils using a 5.5 lb. Hammer and a 12-inch Drop.

1.04 PROTECTION

A. Protect trees, shrubs and lawn, areas to receive planting, and other features remaining as part of final landscaping.

B. Protect bench marks and existing structures, roads, sidewalks, paving and curbs against damage from vehicular or foot traffic. Install and maintain bridging, planking and cants to provide access to buildings.

C. Protect excavations by shoring, bracing, sheet piling underpinning, or by other methods, as required to prevent cave-ins or loose dirt from falling into excavations.

D. Underpin or otherwise support adjacent structure(s) which may be damaged by excavation work. This includes service lines and pipe chases.

E. Notify Owner of any unexpected sub-surface conditions. Discontinue work in the area until Owner provides notification to resume work.

F. Protect bottom of excavations and soil around and beneath foundations from frost.

PART 2 PRODUCTS

2.01 BED AND FILL MATERIALS

A. Bedding and backfill to conform to Section 02200.

B. Concrete to conform to Section 03300.

PART 3 EXECUTION

3.01 PREPARATION AND LAYOUT

A. Establish extent of excavation by area and elevation. Designate and identify datum elevation.

B. Set required lines and levels.

C. Maintain bench marks, monuments and other reference points.

3.02 UTILITIES

A. Known underground utilities are indicated on the PLANS.

B. Before starting excavation, establish the location and extent of underground utilities occurring in the work area.

C. Notify the Owner for direction for removal and/or relocation of utility companies' lines which are in the way of excavation.

D. Maintain, reroute or extend as required, existing utility lines to remain which pass through the work area with the approval of the Owner. Pay costs for this work.

E. Protect active utility services uncovered by excavation.

F. As directed on the PLANS, remove abandoned service lines from areas of excavation. Cap, plug or seal such lines and identify at grade.

G. Accurately locate and record abandoned and active lines rerouted or extended, on Project Record Documents.

3.03 TRENCHING

A. Excavate for mechanical and electrical services. Ensure trenching does not interfere with normal 45 degree bearing splay of any foundation.

B. Excavate in accordance with lines and grades.

C. Trench depths are calculated to provide adequate cover over pipes. Notify Engineer if adequate cover is lacking and correct as directed by Engineer.

D. Cut trenches sufficiently wide to enable proper installation of services and to allow for inspection. Trim and shape trench bottoms and leave free of irregularities, lumps and projections.

E. Do not disturb soil within branch spread of existing trees or shrubs that are to remain. If it is necessary to excavate through roots, perform work by hand and cut roots with a sharp axe.

F. When complete, request the Engineer to inspect excavations. Correct unauthorized excavation as directed, at no cost to the Owner.

G. Make additional excavation to remove unsuitable foundation material as directed by Engineer. Backfill and compact over excavation as shown on PLANS.

H. Stockpile excavated sub-soil for re-use where directed. Remove excess or unsuitable excavated sub-soil from site.

3.04 DEWATERING

A. Keep trenches dry. Provide necessary equipment including pumps, piping and temporary drains.

B. Do not discharge drainage water lines into municipal sewers without municipal approval. Ensure water discharge does not contain silt held in suspension.

C. Direct surface drainage away from excavated areas.

D. Control the grading in and adjacent to excavations to prevent water running into excavated areas or onto adjacent properties or public thoroughfares.

E. Furnish and operate suitable pumps on a 24-hour basis to keep excavations free of water until services have been placed and backfilling is completed.

3.05 BEDDING

A. Manually place and compact bedding material in layers not exceeding 8 inches.

B. Use granular cradle of CA-13 gradation.

C. Bed PVC and HDPE pipeline in accordance with ASTM D2321.

3.06 BACKFILLING

A. Do not start backfilling until services have been inspected.

B. Ensure trenches are free of building debris, snow, ice, and water and that ground surfaces are not in a frozen condition.

C. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.

D. Place and compact fill materials in continuous layers not exceeding 8 inches loose depth. Use a method so as not to disturb or damage services.

E. Maintain optimum moisture content of fill materials so as to attain required compaction density.

3.07 BACKFILLING BELOW PIPE CENTERLINE

A. If select granular backfill is required above pipe centerline, also place below pipe centerline.

B. When granular or concrete cradle is indicated, extend to horizontal plane through pipe diameter.

C. When no cradle is indicated, backfill below horizontal plane through pipe diameter with selected trench-excavated materials, free from rocks or other materials capable of damaging pipe or its coating.

D. Place material evenly around pipe and hand tamp.

3.08 BACKFILLING ABOVE PIPE CENTERLINE

A. Non-Structural Locations:
   1. Backfill up to 6 inches above top of pipe with selected excavation material free from clods and stones.
   2. Backfill from 6 inches above top of pipe to surface with excavation material which will not dislodge or damage pipe or cause trench bridging.
   3. Watersoaking or other methods of trench settlement not required.
   4. Round excess material neatly over top of trench as directed to allow for trench settlement.
   5. Reshape surface to level out uneven settlement during final clean-up.

B. Structural Locations:
   1. Backfill above pipe centerline to point 12 inches above top of pipe 6 inch layers loose measure Selected Granular Fill, with each layer compacted in manner not disturbing or injuring pipe.

2. Backfill balance to bottom level of permanent type surface in 12 inch layers Select Granular Fill with each layer compacted.
3. Compaction: 95% modified proctor.

3.09 COMPACTION

A. From the bottom of the trench to a minimum height 8 inches above pipe crown compact backfill materials with hand operated devices.

B. Compact fill materials to uniform density of 95 percent of maximum density obtained by ASTM method of compaction testing.

C. Remove and replace improperly compacted backfill material at no cost to Owner.

3.10 CLEAN UP

A. Remove surplus fill materials from site.

B. Conform to the requirements of Section 01710.

3.11 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM prices.

END OF SECTION

SECTION 02221

STRUCTURAL EXCAVATION, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Excavation and backfill around structures.

B. Excavation support systems.

C. Groundwater and surface water control.

1.02 RELATED WORK

A. Section 02200: Earthwork.

B. Section 02220: Excavation, Backfilling and Compaction for Pipelines.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials, ASTM:
   1. D422.
   2. D1557.

B. Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation, adopted July 1, 1988.

PART 2 PRODUCTS

2.01 MATERIALS

A. Excavation Support System: Contractor's option, suited for purpose.

B. Fill Materials: In accordance with Section 02200.

PART 3 EXECUTION

3.01 PREPARATION AND LAYOUT

A. Establish extent of structural excavation by area and elevation; designate and identify datum elevation.

B. Set required lines and levels.

C. Maintain bench marks and other reference points.

3.02 PROTECTION

A. Protect, support and/or reroute existing utilities as described in Section 02200.

B. Protect adjacent work from damage by excavation and backfilling operations.

C. Protect adjacent structures from undermining.

D. Support sides of excavations to prevent soils movement which may diminish the excavation width below width required for work.

E. Support sides of excavation which interfere with normal 45 degree bearing splay of any foundation.

3.03 EXCAVATION SUPPORT SYSTEMS

A. Design, installation and maintenance of temporary excavation support systems is the responsibility of the Contractor. Provide support systems at no additional expense to Owner.

B. Design and construct excavation support systems in accordance with OSHA Standards and interpretations.

3.04 GROUNDWATER AND SURFACE WATER CONTROL

A. Contractor is responsible for designing, providing and maintaining a system for control of groundwater based on recommendations contained in geotechnical investigation report.

B. Lowering groundwater by pumping from open sumps within foundation limits is not permitted.

C. Provide adequate swales, dams, ditches and grading to prevent surface water from flowing into excavation.

D. Maintain water control until structure is complete and backfill is brought to final grade unless otherwise directed by Owner.

3.05 STRUCTURAL EXCAVATION

A. Excavate to lines and grades shown on the PLANS.

B. When excavation is essentially complete, verify depths and dimensions as well as soil classification and bearing capacity. Immediately notify Owner of significant variation from geotechnical investigation report.

C. Perform additional excavation only as approved by the Owner.

D. Correct unauthorized excavation as directed at no cost to Owner.

E. Fill over-excavated areas under structure bearing surfaces with concrete or compacted sand fill as required by the Owner.

F. Excavate to within one (1) foot of final grade, making final excavation immediately prior to placement of formwork and reinforcing steel. Limit area of final excavation to that which is being prepared for concrete placement. Limit exposure of final excavated surface to eight hours or over excavate two inches and provide a concrete seal slab. Keep excavations dry until concrete and backfill operations are complete.

3.06 STRUCTURAL BACKFILL

A. Backfill around structures as soon as possible after approval by the Owner.

B. Structural Backfill:
   1. Type A material, unless otherwise indicated
   2. Place in horizontal layers not exceeding 8 inches in loose depth.
   3. Compact by power-operated tampers, rollers, or other suitable equipment to dry density equal to 90 percent of maximum.
   4. When backfill is sub-grade for walks, roadways, foundations, or slabs, compact to dry density equal to 95 percent maximum.

C. Common Backfill:
   1. Type B material, unless otherwise indicated.
   2. Backfill away from structures, 5 feet or greater:
      a. Place in layers not exceeding 12 inches loose depths.
      b. Compact to achieve 85 percent of maximum density.
   3. Backfill Adjacent to Structures: Place and compact in accordance with structural backfill requirements.

D. Do not backfill against walls until concrete has been in place at least seven days.

E. Do not backfill against partially completed structures until main floor slabs have been in place at least seven days and placement is approved by the Owner.

F. Backfill simultaneously on each side of foundation walls and other structures to equalize soil pressures. Provide temporary bracing as required.

G. Take special care to prevent wedging action against structure. Bench or serrate slopes bounding excavation.

END OF SECTION

SECTION 02227

WASTE MATERIAL DISPOSAL

PART 1 GENERAL

1.1 DESCRIPTION

Waste material disposal consists of disposal of trees, stumps, logs, brush, roots, grass, vegetation, humus, rubbish, and other objectionable matter from operations such as clearing and grubbing, excavation and grading. Unless otherwise specified, the Contractor is responsible for the removal and disposal of the above described materials.

PART 2 PRODUCTS

Specific products are not required. Use equipment and materials necessary to properly complete disposal of waste materials. The Contractor shall notify the Engineer of the proposed disposal sites.

PART 3 EXECUTION

3.1 DISPOSAL AREA

A. Waste material shall be removed from the work site and disposed of in manner not to damage the Owner or other persons.

B. Strip the disposal area of vegetation, humus, or other debris. Strippings become the property of the Contractor, to be disposed of with other waste materials.

C. Protect trees shown on the PLANS. Take special care not to damage trees which are outside limits of waste disposal areas.

D. The Contractor shall not dispose of any excavated materials within an area designated as being within the 100-Year Flood Hazard Area.

E. If excess soil is deposited on private property, the Contractor must secure written permission from the property owner to do so. Written permission must include a description of the property on which the soil is deposited and a copy of furnished to the Engineer.

3.2 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 02511

ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Prepare sub-grade to receive base course.

B. Place stabilizing base courses, work and compact.

C. Prime base course, place asphalt pavement.

1.02 RELATED WORK

A. Section 01410: Testing Laboratory Services

B. Section 02211: Backfilling and Rough Grading

1.03 REFERENCES

A. State of Illinois, Dept. of Transportation:
   1. Standard Specification for Road and Bridge Construction

PART 2 - PRODUCTS

2.01 STABILIZING BASE COURSE MATERIALS

A. Granular Sub-Base: Pit run gravel or crushed rock screenings; free from shale, clay, organic matter and debris; graded within limits of Illinois DOT CA-1 gradation.

B. Granular Base: Angular crushed natural stone; free from shale, organic matter and debris; graded within limits of Illinois DOT, Aggregate Base Coarse Type B, Gradation CA-9 or CA-10.

C. Primer: Homogeneous medium curing liquid asphalt; of type recommended for asphaltic paving; bituminous materials prime coat, MC-30.

2.02 ASPHALT PAVEMENT MATERIALS AND MIX

A. Bituminous Surface Plant Mix: IDOT, Class B.

B. Maintain thorough and uniform mixture.

C. Bring asphalt cement and mineral constituents to specified temperatures before mixing.

D. Ensure aggregates are sufficiently dry so as not to cause forming in mixture.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure grading of sub-grade to specified elevation.

B. Scarify sub-grade, where asphalt pavement is to be placed, to minimum depth of 5 inches.
   1. Windrow loosened soil to one side.
   2. Thoroughly scarify exposed surface to depth of 5 inches and compact.
   3. Rework windrowed soil to finely divided condition as possible, spreading over compacted surfaces.

C. Shaping:
   1. Before final rolling, shape entire section, add additional sub-soil and compact sub-grade to provide grades, elevation and cross-section indicated.
   2. Points of finished sub-grade surface within 1 inch of elevations indicated.

3.02 PLACEMENT OF STABILIZING BASE COURSE

A. Bring sub-base course to depth(s) and profiles indicated.
   1. Extend sub-base course minimum 12 inches beyond asphalt pavement width.
   2. Place in layers maximum depth of 4 inches.
   3. Compact each layer.
   4. Properly compact areas adjacent to curbs, catch basins, manholes and other areas not accessible to rollers with mechanical or hand tamping devices.
   5. Ensure granular sub-base course materials are not contaminated with deleterious materials.
   6. Ensure top surface of base course is true to lines and grades indicated, with all points within 1/2 inch of elevations indicated.

B. Optimum Moisture:
   1. Add water during compaction to bring stabilizing base course materials to optimum moisture content.
   2. When excess moisture exists, rework stabilizing base course materials until optimum moisture content is obtained.

3.03 PRIMING PREPARED STABILIZED BASE COURSE

A. Ensure stabilized base course is dry and free of loose or foreign material before priming.

B. Primer Application Rate:
   1. Apply primer over prepared stabilizing base course at uniform rate of 1/2 gallon per square yard.
   2. Ensure primer is at temperature recommended by manufacturer.
   3. Use clean natural sand to blot excess primer.

C. Similarly prime surfaces of curbs and gutters which will be in contact with asphalt pavements.

D. Coat surfaces of manoles and catchbasins which are to remain free of asphalt with oil to prevent asphalt adhesion.

3.04 PLACEMENT OF ASPHALT PAVEMENT

A. Placement Sequence:
   1. Place asphalt pavement within 24 hours of priming stabilizing base course.

B. Placement Depth:
   1. Place asphalt pavement to compacted depth of 3 inches in two lifts.

C. Temperature:
   1. Do no place asphalt pavement when surface temperature is 40°F or lower.
   2. Ensure asphalt pavement is minimum 225°F immediately after placing and prior to initial rolling.

D. Compaction:
   1. Compact each asphalt paving course as specified by IDOT Standard Specifications for Bituminous Surface Plant Mix (Class B), with approved rolling equipment.
   2. Start compaction as soon as pavement will bear equipment without checking or undue displacement.
   3. Carry out compaction in three operations in pass sequence.
   4. Ensure each pass of roller overlaps previous passes to ensure smooth surface free of roller marks.
   5. Keep roller wheel sufficiently moist so as not to pick up material.
   6. Perform hand tamping in areas not accessible to rolling equipment.

E. Joints:
   1. Ensure joints during paving operations are straight, clean, vertical and free of broken or loose material.

2. Prime vertical surfaces of joints to ensure tight bond.

F. Tolerances:

1. Ensure surface of completed asphalt pavement is true to lines, profiles and elevations indicated.
2. Free from depressions exceeding 1/4 inch when measured with 10-foot straightedge.

B. Do not allow vehicular traffic on newly paved areas until surface has cooled to atmospheric temperatures.

END OF SECTION

SECTION 02710

EXTRACTION WELL

PART I GENERAL

1.01 SECTION INCLUDES

A. Site Conditions.

B. Health and Safety.

C. Permits/notification requirements.

D. Location of buried pipelines and utilities.

E. Contaminated waste disposal requirements.

F. Submittals.

1.02 SITE CONDITIONS

A. It is the contractor's responsibility to acquaint and satisfy himself as to the nature and location of the work, the general and local conditions, the availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, the conformation and conditions of the ground, the character of equipment and facilities needed prior to and during the execution of the work, and all other matters which can in any way affect the work or the cost thereof under this contract.

B. It is also the contractor's responsibility to acquaint and satisfy himself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information provided by the Owner. Any failure by the contractor to acquaint himself with all the available information shall not relieve him the responsibility for properly estimating the difficulty or cost of successfully performing the work.

1.03 HEALTH AND SAFETY

A. The contractor shall develop and implement a site-specific Health and Safety Plan (HASP) to be reviewed by the owner and/or its representative, in accordance with Section 01390.

1.04 PERMITS/NOTIFICATION REQUIREMENTS

A. The contractor shall apply for and acquire permits from authorized agencies, if required. No field operations shall begin until these approvals have been obtained.

1.05 LOCATION OF BURIED PIPELINES AND UTILITIES

A. The approximate locations of buried pipelines and other utilities are shown on the accompanying drawings. The contractor shall coordinate with all applicable utility owners prior to drilling in areas where it is reasonable to expect the presence of existing utilities, whether shown on the drawings or not. The contractor shall be responsible for any and all damage to existing utilities caused by the work and if damage to utilities occurs, the contractor shall contact the affected utility immediately. The utility shall then make the determination as to who shall make the necessary repairs.

1.06 CONTAMINATED WASTE DISPOSAL REQUIREMENTS

A. All drill cuttings shall be placed in a roll-off box,or drums, or in an approved staging area. Cuttings shall be covered to prevent wind erosion and being washed away by the rain. The contractor shall collect a composite sample of the staged material to submit to a disposal facility for analyses and approval. The cuttings shall be analyzed by U. S. Environmental Protection Agency (EPA) method number 8240 which is the GC/MS method of analysis for volatile organic compounds.

B. If contamination is confirmed, arrangements for disposal of contaminated cuttings shall be made by the contractor. The contractor shall provide, to the owner and/or its representative, copies of all pre-disposal analytical results and post-disposal documentation including, but not limited to, manifests, bills of lading, and disposal certifications.

C. If contamination is not detected from laboratory analysis the contractor will spread the drill cuttings over the project site.

D. All other waste disposal shall be performed in accordance with Section 02227.

1.07 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Sections 01300 and 01340.

B. At a minimum, provide manufacturer's information on:
   1. Well casings.
   2. Well screens.
   3. Grout.

4. Filter pack.

C. Provide results of grainsize analysis and well screen selection criteria.

D. Provide results of laboratory analysis of drill cuttings.

PART 2 MATERIALS

2.01 WELL CASINGS

A. All well casings shall be new. They shall be manufactured of carbon steel conforming to appropriate standards such as those developed by the ASTM or API. The casings shall be joined by either (1) welding in accordance with the standards of the American Welding Society or (2) threaded and coupled joints.

2.02 GROUT

A. Grout shall consist of a cement-bentonite-water mixture in the ratio of 6.5 gallons potable water / 3 to 5 pounds bentonite / 94 pounds Type B cement.

2.03 WELL SCREEN

A. The well screen shall be of the continuous slot, wire-wound design to provide maximum inlet area consistent with strength requirements.

1. The well screen shall be fabricated from Type 304 stainless steel.
2. End fittings provided with the screen shall be fabricated from Type 304 stainless steel and selected on the basis of the well design parameters. The bottom of the screen shall be fitted with a flat plate of the same material as the screen body.
3. Intermediate screen sections shall be joined by welding or by threaded and coupled connections. If welded, the welding rod shall be suitable for joining material so as not to reduce corrosion resistance. The rod selected must be approved by the engineer.
4. The screen slot size shall be selected on the basis of a grain size analysis of either the natural water-bearing sediments or the filter pack material.
5. The screen diameter, length, and wire shape shall be chosen so that the less than or equal to maximum average velocity of the water entering the screen is 0.1 foot per second at the desired yield.
6. The contractor shall maintain well logs.

2.04 FILTER PACK

A. The filter pack material shall consist of clean, well-rounded grains that are smooth and uniform. The material should be mostly siliceous with not more

than 5 percent calcerous material by weight. The specific gravity of the filter pack material shall be 2.5 or greater.

B. The grading of the filter pack shall be determined by the screen manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Identify known underground, aboveground, and aerial utilities. Stake and flag locations.

B. Notify utility company to locate utilities.

C. Protect above- and below-grade utilities which are to remain.

D. Protect plant life, lawns, ad other features remaining as a portion of final landscaping.

E. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from drilling equipment and vehicular traffic.

3.02 WELL CONSTRUCTION

A. Test Holes and Formation Samples

1. A test hole shall be drilled adjacent to the proposed well. The test hole shall be advanced with 3.25-inch or 4.25-inch hollow stem augers to the depth of the proposed well. The boreholes will be sampled continuously through the aquifer of interest with a standard split-spoon sampler per ASTM D-1586.
2. An accurate log of the materials penetrated shall be recorded by the driller to determine the depths and thicknesses of the various underlying formations.
3. Formation samples from the test holes shall be collected for grain size analysis (ASTM D4322-63 [1990]) to determine the proper screen length and slot size.
4. Payment for this item will be based on the contract prices. If the depth is adjusted because of underground conditions at the site, payment will be based on the unit price per linear foot of the hole drilled.
5. Following completion of the test hole, the contractor shall demobilize from the site for the period necessary to obtain results from the grain size analyses and determine the correct filter pack and slot sizes. The recommended filter pack size and slot size, along with the grain size curves and supporting calculations, will be submitted to Owner for review.

B. Borehole Construction

1. The well shall be drilled at the exact location designated by the engineer and as shown on the site drawings. The finished well shall conform to the general design illustrated on the PLANS and to any applicable standards established by local, state, or federal regulatory agencies.

C. Setting the Screen and Inner Casing

1. The screen and inner casing assembly shall be joined properly and lowered into the well. The screen shall be centered in the hole by using a minimum of three, stainless steel centralizers. The assembly shall be installed so that the screen bottom is slightly above the bottom of the hole.
2. Payment for the screen shall be based on the linear feet of screen actually used and the cost of the end fittings. Payment for the inner casing will be based on the number of feet actually used.

D. Filter Packing

1. The filter pack shall be placed to a height of 5 feet above the top of the screen. The top 2 to 3 feet of filter pack material shall consist of an appropriately sized buffer sand so as to prevent penetration of the bentonite into the filter pack.
2. The filter pack shall be placed so that the actual volume used can be calculated to within ten percent.
3. Payment for the filter pack shall be made at the unit price per cubic foot for the amount of filter pack actually used to fill the hole.

E. Bentonite slurry seal - Bentonite shall be installed as shown on the PLANS. The bentonite slurry seal shall possess a mud weight as close to 12 pounds per gallon as can be attained. The bentonite seal shall be placed to a minimum thickness of 5 feet.

F. Grout - The grouting shall be done continuously and in such a manner as will insure the entire filling of the annular space.

3.03 WELL DEVELOPMENT

A. The development process shall be accomplished by high velocity, horizontal jetting and simultaneous air-lift pumping. The outside diameter of the jetting tool shall be 1/2 to 1 inch less than the inside diameter of the screen.

B. Development shall continue until the engineer or contractor decides that further development is unnecessary. Payment for development will be based

on the unit prices per hour as shown in the bid schedule. It shall cover only those hours the development tools and equipment are actually being operated.

C. Development water shall be stored in a portable tank in the vicinity of the new wells. The tank shall be sized large enough to hold the volume of extracted well water necessary to clear the filter pack of fine particles. The contractor shall dispose of the water off site. Off-site disposal will include sampling and analysis of the water as well as the approval of Owner.

3.04 CAPPING THE WELL

A. Upon completion of the well, the contractor shall install a suitable screwed, flanged, or welded cap to prevent any pollutants from entering the well.

B. Payment will be based on the lump sum price shown in the bid schedule.

3.05 ABANDONED WELLS

A. If the well fails to conform to these specifications and the contractor is unable to correct the condition or negotiate a mutually acceptable cost reduction for specification deviations, it shall be considered an abandoned hole, and the contractor shall immediately start a new well at a nearby location designated by the engineer.

B. The well shall be abandoned in accordance with Illinois regulations.

3.06 RECORDS

A. Two copies of the drillers's log, signed and dated by the well driller or drilling machine operator will be given to the engineer. The log will record the materials penetrated to the nearest foot.

B. If geophysical logs were made, a copy of each shall be given to the engineer.

C. A record of all static water level measurements, and times at which they were taken, will be given to the engineer.

D. A complete casing and screen location record will be made by the driller and given to the engineer. This will show the lengths of each casing and screen section and the location of packers, plugs, and seal.

E. Pumping test data shall be supplied to the engineer from all pumping tests conducted on the well and test well. These will show dates, water levels, discharge rates, times of starting and stopping the pump, and other conditions that could affect the test data.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 03200: Concrete Reinforcement.

B. Section 03300: Cast-In-Place Concrete.

1.02 QUALITY ASSURANCE

A. Design Criteria: Formwork shall be designed and constructed in accordance with ACI 347 and with controlling local building code.

B. Allowable Tolerances: Formwork shall be constructed to produce concrete surfaces conforming to tolerances specified in ACI 301, Table 4.3.1.

C. Reference Standards:

1. American Concrete Institute (ACI)
   a. ACI 301 Specifications for Structural Concrete for Buildings.
   b. ACI 347 - Recommended Practice for Concrete Formwork.
2. American Institute of Steel Construction (AISC) Manual of Steel Construction
3. American Iron and Steel Institute (AISI) Cold-Formed Steel Design Manual.
4. National Forest Products Association (NFPA) National Design Specification for Stress Grade Lumber and Its fastenings.
5. U.S. Department of Commerce
   a. PS 1 Construction and Industrial Plywood
   b. PS 20 American Softwood Lumber

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wood

1. Solid lumber: Use stress-graded lumber having adequate strength and properties to safely support anticipated loads, and conforming to NFPA Specifications and PS 20. Use dressed and matched boards of uniform thickness and width for exposed concrete surfaces.

2. Plywood: Use Plyform Class 11, 5.8-inch BB-Exterior Type, mill-oiled and edge sealed. Use HDO Plyform Class I where rubbed finish is indicated. Plywood shall conform to PS 1.

B. Metal: Steel for panel framing and bracing, panel systems, and falsework shall conform to AISC and AISI Specification.

2.02 ACCESSORIES

A. Form Ties

1. Form ties for liquid containment structures shall have waterstops and shall be non-removable.
2. Design form ties to provide adequate strength for holding forms. Ties shall be fixed or adjustable in length, and shall contain no devices capable of leaving holes larger than 7/8 inch in diameter in concrete surface.
3. Non-removable ties shall be supplied with conditions for positive breakoff or for internal disconnection. Metal remaining after removal of external tie parts shall not be left closer than 1-1/2 inches to finished concrete surface. Flat ties providing no positive breakoff will not be permitted.

B. Chamfers: Use PVC, rubber, or wood chamfers to produce uniform smooth external corners and tight edged joints. Use 3/4" x 3/4" chamfers unless noted otherwise on PLANS.

C. Form Coating: Use bond breaking, non-staining form coating agent conforming to ACI 347. Form coating agent shall be non-toxic after 30 days for liquid containment structures. Form coating agent shall not soften concrete and shall be compatible with paint, waterproofing material, or dampproofing material to be applied to finished surface.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to form construction, clean mortar and grout remaining from previous concreting operations from form surfaces.

3.02 FORM CONSTRUCTION

A. Forms shall be constructed to conform to required shape, form, line, and grade, and shall have sufficient rigidity to maintain specified tolerances.

B. Form joints shall be leakproof and arranged vertically and horizontally to

conform to design pattern, if any. Forms placed on successive units for continuous service shall be fitted to accurate alignment to assure a smooth, completed surface free from irregularities.

C. In long spans where intermediate supports are not possible, form deflection due to weight of fresh concrete shall be computed. Design forms to account for deflection in order to produce finished concrete members having true surfaces conforming accurately to desired lines, planes and elevations.

D. Provide positive means for shore and strut adjustments. Settlement shall be taken up during concrete placing operation. Brace forms securely against lateral deflections.

E. Provide temporary openings in wall and column forms to facilitate cleaning and inspection. Wall sleeves, inserts, wall pipes, anchor bolts, dovetail anchor slots, and openings required in concrete work shall be accurately set in formwork.

F. Form exposed external concrete corners with chamfers. Chamfers shall be accurately placed and secured to form uniformly straight lines, and shall be metered at changes in direction. Do not install chamfers where masonry wall units abut and are flush with concrete.

G. Coat wood and steel forms with form coating agent prior to placing reinforcement. Do not allow excess form coating agent to stand inside forms or to come into contact with fresh concrete. Use form coating agent in strict accordance with manufacturer's recommendations. Form ties to be completely withdrawn shall be coated with grease.

3.03 FORM AND SHORE REMOVAL

A. Form and shore removal shall be in accordance with ACI 301.

B. Formwork that does not support weight of concrete, such as sides of beams, walls, columns, and similar vertical parts of the work, may be removed 24 hours after placing concrete, provided concrete is sufficiently hard not to be damaged from form removal operations.

C. Formwork that supports weight of concrete, such as beam soffits, slabs, and similar horizontal parts of the work, shall remain in-place at least until concrete has attained design minimum laboratory compressive strength at 28 days for applicable concrete class specified.

D. Form facing material may be removed before concrete has attained its required 28-day compressive strength, but in no case less than six days after placing concrete, provided shores and other vertical supports have been arranged to permit removal of form facing material without loosening or

disturbing shores and supports. Shores and other vertical supports shall remain in-place until concrete has attained its required 28-day compressive strength.

E. Remove forms in a manner to assure complete structure safety. Do not remove shoring until supported member has acquired sufficient strength to support its weight and superimposed loads. Superimposed loads shall not exceed design live load unless members are adequately shored to support both the members and construction loads in a manner to protect members from damage. Formwork may be removed after expiration of time periods listed in ACI 347, provided concrete will not be injured, damaged, or overstressed.

F. Clamps for tie-rods to be entirely removed from wall shall be loosened 24 hours after concrete is placed and form ties, except for sufficient number to hold forms in place, may be removed at that time. Remove standard snap ties when forms are stripped. Ties wholly withdrawn from wall shall be pulled toward inside face.

G. The Contractor shall ensure that newly unsupported portions of the structures are not subjected to heavy construction or material loading.

3.04 ADJUSTMENT AND CLEANING

A. Forms to be reused shall be maintained clean and in good condition as to accuracy, shape, strength, rigidity, tightness, and surface smoothness. Do not use damaged forms or forms producing work not equal to work resulting from using new materials.

3.05 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 RELATED WORK

A. Section 03100: Concrete Formwork.

B. Section 03300: Cast-In-Place Concrete.

1.02 QUALITY ASSURANCE

A. Allowable Tolerances: Fabricating and placing tolerances shall comply with ACI 301.

B. Reference Standards:

1. American Concrete Institute (ACI)
   a. ACI 301 Specifications for Structural Concrete for Buildings.
   b. ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   c. ACI 318-89 Building Code Requirements for Reinforced Concrete.
2. American Society for Testing and Materials (ASTM)
   a. A185 Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
   b. A615 Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.
3. Concrete Reinforcing Steel Institute (CRSI).

1.03 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data in accordance with the requirements of Sections 01300 and 01340 and the supplemental requirements below.

1. Mill Reports: Certified mill reports shall accompany reinforcing steel deliveries.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Products shall be handled in accordance with the requirements of Section 01620. Ship reinforcing steel to job site properly bundled and tagged to facilitate identification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Deformed bars shall conform to ASTM A615, Grade 60.

B. Welded wire fabric shall conform to ASTM A185. Welded wire fabric shall be supplied as flat sheets or mats.

C. Tie wire shall be 16 gauge or heavier black annealed wire.

D. Bar supports shall comply with CRSI Manual and ACI 315, Chapter 7, Detailing Manual.

1. Use Class C bar supports at exposed surfaces and in water containment and treatment structures and Class D at other locations.
2. Precast concrete blocks may be used to support bottom bars in footings and slabs on ground.

E. Mechanical connectors shall comply with the requirements of ACI std. 318-89 for a full mechanical connection and as follows:

1. Develop in tension and compression, as required, at least 125 percent of the specified yield strength of the bar.
2. Connectors shall be threaded using an easy to duplicate thread, common to all connectors in this contract.
3. Connectors shall each be provided with a protective cover and coating capable of maintaining the threads in like new condition for at least 10 years of moist soil contact.

2.02 FABRICATION

A. Reinforcing steel shall be accurately cut and cold bent in shop to dimensions indicated on PLANS. Bar bends shall comply with CRSI Manual and ACI 315, Detailing Manual.

PART 3 EXECUTION

3.01 CLEANING

A. Metal reinforcement at time concrete is placed shall be free from mortar, mud, ice, oil, or other nonmetallic coatings adversely affecting bonding capacity. Reinforcement with rust or mill scale shall be considered satisfactory, provided minimum dimensions, including deformation height and weight of hand wire brushed test specimen, are not less than applicable ASTM specification requirements.

3.02 PLACING

A. Place reinforcement in positions and with spacings shown on Plans. Reinforcement placing shall conform to recommended practices in CRSI "Placing Reinforcing Bars" and Chapter 7 of ACI 318-89. Do not place bars with kinks or bends not shown on Plans. Do not heat reinforcement for bending or straightening, and do not bend reinforcement embedded in hardened concrete.

B. Use precast concrete blocks to support horizontal reinforcing bars in footings and slabs on ground. Use chairs, spacers, and bolsters to support horizontal reinforcing bars over formwork.

C. Accurately tie reinforcement at intersections with 16 gauge black annealed wire. Do not tack weld reinforcing bars at their intersections. Use two ties minimum per splice. Point tie wire ends away from forms and concrete surfaces.

D. Except where noted on Plans, lap splices shall be Class "B" conforming to ACI 318. Splices for horizontal reinforcement in circular tanks shall be 40 bar diameters minimum and splice locations shall be staggered. Splices not shown on PLANS shall be approved by Engineer. Vertical reinforcing bars in columns shall be offset one bar diameter at lapped splices.

E. Reinforcing bar embedment (Development) length and bar hook radius length shall be as indicated on the Plans and conform to ACI 318-89, Chapter 12. The bar hook radius length for bar size #3 through #8 shall be 8 bar diameters and the hook radius length for bar size #9 through #11 shall be 10 bar diameters.

F. Reinforcing bars may be moved one bar diameter maximum to avoid interference with other reinforcing steel, conduits, or embedded items. Engineer shall approve moving reinforcing bars more than one bar diameter to avoid interferences.

G. Place and secure welded wire fabric to prevent displacement during concrete placement. Support fabric in structural slabs in accordance with requirements for supporting reinforcing bars. Support fabric in slabs on ground in accordance with requirements for supporting reinforcing bars or by laying fabric on correct depth of fresh concrete prior to placing upper layer of slab concrete. Extend fabric across supporting beams and walls and to within 2 inches of concrete edges.

H. Welded wire fabric shall be overlapped wherever successive mats are continuous. Overlap measured between outermost cross wires of each fabric sheet shall not be less than spacing of cross wires plus 2 inches.

3.03 CONCRETE PROTECTION FOR REINFORCEMENT

A. Reinforcing steel shall be protected by concrete covering shown on Plans or specified herein. Where covering thickness is not shown, following values shall be used.

1. Footings and other principal structural members cast against ground: 3 inches.
2. Concrete surfaces exposed to weather or in contact with ground or water after form removal: 2 inches.
3. Slabs not exposed to weather but over water: 1-1/2 inches.
4. Slabs, walls, and joints not exposed to ground, water, or weather: 1 inch.
5. Principal reinforcement, ties, stirrups, or spirals for beams, girders, and columns: 1-1/2 inches.
6. Concrete in contact or exposed to sewage or sewage gases: 4 inches.

3.04 MEASUREMENT AND PAYMENTS

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02561: Manholes
B. Section 03100: Concrete Formwork
C. Section 03200: Concrete Reinforcement

1.02 QUALITY ASSURANCE

A. Specimen preparation and testing shall be performed by independent testing agency employed by the Owner. Additional testing required due to concrete not meeting specification requirements shall be at Contractor's expense.

B. Allowable Tolerances

1. Finishing Tolerances for Slabs:
   a. Finishes with Class A tolerances shall be true planes within 1/8 inch in 10 feet as determined by 10 foot straightedge placed anywhere on slab in any direction.
   b. Finishes with Class B tolerances shall be true planes within 1/4 inch in 10 feet, as determined by 10 foot straightedge placed anywhere on slab in any direction.
   c. Finishes with Class C tolerances shall be true planes with 1/4 inch in 2 feet, as determined by 2 foot straightedge placed anywhere on slab in any direction.
2. Compression test results shall be evaluated separately for each specified concrete mix design in accordance with ACI 214. Strength level of concrete will be considered satisfactory if the average of all sets of three (3) consecutive strength test results for laboratory-cured specimens equal or exceed the specified compressive strength and no individual strength test result falls below the specified compressive strength by more than 500 psi.

C. Chapter 18 of ACI 301 shall provide requirements for Engineer's acceptance of concrete structures and appurtenances.

D. Reference Standards

1. American Concrete Institute (ACI)

ACI 211.1	Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete.
ACI 214	Recommended Practice for Evaluation of Compression Test Results of Field Concrete.
ACI 301	Specifications for Structural Concrete for Buildings.
ACI 304	Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
ACI 305	Recommended Practice for Hot Weather Concreting.
ACI 306	Recommended Practice for Cold Weather Concreting.
ACI 309	Recommended Practice for Consolidation of Concrete.
ACI 318	Building Code Requirements for Reinforced Concrete.
ACI 350R	Concrete Sanitary Engineering Structures.

2. American Society for Testing and Material (ASTM)

C31	Standard Method of Making and Curing concrete Test Specimens in the Field.
C33	Standard Specification for Concrete Aggregates.
C39	Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens.
C42	Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
C94	Standard Specification for Ready-Mixed Concrete.
C143	Standard Method of Test for Slump of Portland Cement Concrete.
C150	Standard Specification for Portland Cement.
C171	Standard Specification for Sheet Materials for Curing Concrete.

C172	Standard Method of Sampling Fresh Concrete.
C231	Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
C260	Standard Specification for Air-Entraining Admixtures for Concrete.
C309	Standard Specification for Liquid Membrane-Forming compounds for Curing Concrete.
C618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete.
C881	Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
D1752	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
E96	Standard Test Methods for Water Vapor Transmission of Materials in Sheet form.
E329	Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction.

3. U.S. Army Corps of Engineers Handbook for Concrete and Cement. CRD-C572 Polyvinylchloride Waterstops.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Sections 01300 and 01340 and the supplemental requirements below.

1. Contractor shall furnish one cubic foot standard sample of coarse aggregate and one cubic foot standard sample of fine aggregate upon Owner's request.

2. Submit concrete mix design for each class of concrete to Owner for approval prior to construction.

3. Concrete test results shall be furnished by independent testing laboratory directly to Owner and Contractor.

4. Furnish delivery ticket with each concrete load delivered to job site. Ticket shall show class and strength of concrete, number of pounds of cement, size of coarse aggregate, batching time, slump ordered, and amount and types of admixture.

5. Submit manufacturer's product data sheets for all proposed admixtures.

6. Submit Drawings indicating construction joint locations not indicated on PLANS to Engineer for review prior to placing concrete.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Products shall be handled in accordance with the requirements of Section 01620 and the supplemental requirements below.

1. Immediately upon receipt at central batch plant, store cement in dry, weathertight, properly ventilated structure. Prevent cement from absorbing moisture.

2. Aggregate storage piles shall afford good drainage, preclude inclusion of foreign matter, and preserve gradation.

3. Store admixtures to avoid contamination, evaporation, or damage. Protect liquid admixtures from freezing and from temperature changes adversely affecting admixture characteristics.

4. Store fly ash in dry, weathertight, properly ventilated structure. Prevent fly ash from absorbing moisture. Clearly mark structures containing fly ash.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Hot weather concrete placement shall be in strict accordance with ACI 305. Maintain subgrades moist or lay waterproof sheathing paper on subgrade to prevent water extraction from concrete. At time of placement, mix temperature shall not exceed 90 degrees F.

B. Cold weather concrete placement shall be in strict accordance with ACI 306. When ambient temperature is below 40 degrees F, mix temperature shall not be less than 50 degrees F or more than 70 degrees F at time of placement.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Use Portland cement conforming to ASTM C150. Use one cement brand for exposed concrete in any individual structure. Do not use cement reclaimed from leaking containers. Use cement in sequence of shipment receipt.

1. Use Type II cement for structures containing water or liquid.

B. Coarse Aggregate: Use crushed limestone, granite or washed natural river rock conforming to ASTM C33 except that clay and shale particles shall not exceed one percent. Use largest aggregate size possible but not greater than 1/5 the narrowest dimension between sides of forms, 1/3 slab depth, 3/4 minimum clear spacing between individual reinforcing bars, nor 3/4 clear spacing between reinforcing bars and forms.

C. Fine Aggregate shall be well graded natural sand conforming to ASTM C33, except that clay and shale particles shall not exceed one percent. In addition to grading requirements of ASTM C33, fine aggregate shall be graded such that 15-30 percent passes No. 50 sieve and 3-7 percent passes No. 100 sieve.

D. Water shall be clean, potable, and free from deleterious amounts of oils, acids, alkalies, salts, and organic materials.

E. Admixtures

1. Air-entraining agents shall conform to ASTM C260 and shall contain no chlorides.

2. Fly ash shall conform to ASTM C618.

3. Do not use calcium chloride in concrete containing aluminum items.

4. Water reducer and super water reducer admixtures shall conform to ASTM C494.

F. Curing Materials

1. Absorptive cover shall be burlap, cotton mats or clean sand. Burlap shall not contain sizing or other substances injurious to portland cement or causing discoloration.

2. Moisture retaining cover shall be polyethylene film or waterproof paper conforming to ASTM C171. Color shall be white.

3. Membrane curing compound shall conform to ASTM C309, Type 1-D.

G. Premolded joint filler shall conform to ASTM D994 for asphalt joint filler and to ASTM D1752, Type I for sponge rubber and Type III for self-expanding cork.

H. Vapor Barrier Sheet shall include two (2) sheets of kraft paper laminated with asphalt and reinforced with glass fibers in two (2) directions. Top and bottom shall be extrusion-coated with black polyethylene. Sheet shall have 0.10 perm rating when tested in accordance with ASTM E96.

I. Epoxy Bonding System shall conform to ASTM Specification C881, Type II.

J. Rigid insulating board shall be polystyrene rigid insulation conforming to Federal Specification HH-1-5246, Type II, Class B. Compressive strength of insulation shall not be less than 20 psi.

2.02 MIX DESIGN

A. Design concrete mix in accordance with these Specifications and ACI 211.1.

B. Various concrete classes required shall be proportioned to give the following tabulated minimum strengths and shall not exceed listed maximum water-cement ratio.

MINIMUM STRENGTH			
Class of Concrete	Max Water-Cement Ratio lb/lb	28 Day Cyl., psi	
		Field Cured	Lab Cured
A	0.45	2,800	4,000
B	0.50	2,400	3,400
C	0.50	2,000	2,800
D	0.50	1,250	1,800

1. Class "A" concrete shall be used for general concrete work including steel reinforced structural building elements, tanks, appurtenant structures, slabs on ground, and equipment foundation pads.

2. Class B" concrete shall be used for concrete paving, curb and gutter, sidewalks, and where specifically indicated on Plans.

3. Class "C" concrete shall be used for unreinforced concrete work, including fill concrete in hydraulic structures.

4. Class "D" concrete shall be used for foundation seal slabs, and work mats.

C. Slumps shall not exceed maximum or be less than minimum tabulated values for corresponding type of construction.

SLUMP		
Type of Construction	Maximum	Minimum
Walls, Columns	4 inch	1 inch
Formed Slabs, Beams, Girders	4 inch	1 inch
Fittings & Slabs on Ground	3 inch	1 inch
Sidewalks & Curb & Gutter	3 inch	1 inch
Mass Concrete Sections	3 inch	1 inch
Fill Concrete	3 inch	1 inch

For Class "A" through "D" concrete artificial, chemically induced, slump up to a maximum of 8 inches may be produced by the addition of high range water reducer admixture in all types of construction. High range water reducer must maintain cohesiveness and be able to maintain the slump without free water for at least 1½ hours.

D. Class "A" and "B" concrete shall be air-entrained. Total air content by volume shall be as tabulated for indicated maximum aggregate sizes. Air-entraining agent shall be dispensed separately into concrete mix in an amount required to attain the specified quantity of entrained air. Use admixture in strict accordance with manufacturer's recommendations.

Maximum Agg. Size	Air Content (+1 Percent)
3/8"	6.5
1/2"	6.0
3/4"	5.0
1-1/2"	4.5
3"	3.5

E. Fly ash may be used at Contractor's option.

1. Maximum water-cement ratios listed in Paragraph B above for various concrete classes shall apply to maximum water-cement plus fly ash ratios.

2. Fly ash shall replace part of the cement but shall not exceed 25 percent by weight of cement plus fly ash (3 parts cement, 1 part fly ash).

2.03 READY-MIXED CONCRETE

A. Ready-mix concrete delivered to the job site shall comply with these Specifications and to ASTM C94. Engineer shall have free access at all times to the batching and mixing plant for material sampling and inspection.

2.04 SITE-MIXED CONCRETE

A. Batching plant and mixing equipment for Concrete mixed at job site shall comply with ASTM C94. Concrete shall comply with these Specifications. Concrete production shall comply with ACI 301.

PART 3 EXECUTION

3.01 PREPARATION

A. Place vapor barrier sheet under slabs and where indicated on Plans. Lap joints 6 inches minimum and seal.

B. Remove water from excavation prior to placing concrete. Divert flowing water through side drains to prevent water from flowing over freshly deposited concrete. Remove hardened concrete, debris, ice, and other foreign materials from inside forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position and inspected. Provide runways for wheeled concrete handling equipment. Do not place concrete on frozen ground. Subgrade shall be moist at time concrete is deposited.

C. Foundation Perimeter

1. Install boards on foundation walls vertically from base of foundation to top of insulation.

2. Stagger joints.

3. Butt edges and ends tight to adjacent boards and protrusions.

4. Install in accordance with manufacturers recommendations.

3.02 INSTALLATION

A. Notify Engineer 24 hours minimum prior to placing concrete. Concrete shall be transported and placed in accordance with ACI 304.

B. Concrete shall be handled from mixer to final place of deposit in continuous manner, as rapidly as practicable, and without segregation or loss of ingredient until unit of operation is completed. Each concrete layer shall closely follow preceding layer placement to prevent formation of seams and planes of weakness within the section. Concrete reaching initial set or containing water for more than 1-1/2 hours shall not be deposited in the work.

C. Place concrete into forms in uniform layers as nearly to final position as practicable. Consolidate concrete immediately after placing by thoroughly agitating mass with mechanical, internal vibrating equipment to force out air pockets, to work mixture into corners and around reinforcement and inserts, and to prevent void formation. Do not use vibrators to move concrete horizontally. Internal vibrator shall maintain speed of 8,000 impulses per minute when submerged in concrete. Maintain one (1) Spare vibrator minimum at job site. Limit vibration time to produce satisfactory consolidation without causing objectionable segregation. Concrete consolidation shall comply with ACI 309.

D. Do not allow concrete to drop freely more than five (5) feet. Use elephant trunks or tremies where greater drops are required. This may be increased in thick (>2'-0") wall placements only if it is clearly demonstrated to the Engineer that segregation is not occurring due to concrete bouncing off of rebar, etc. At least the first two feet of each wall placement shall always be placed with a tremie. Control tremie discharge to allow concrete to be effectively compacted into horizontal layers not exceeding 12 inches in thickness with minimum lateral movement. Do not use aluminum chutes, tremies, or pipes.

3.03 REPAIR OF SURFACE DEFECTS

A. Surface defects, including tie holes, shall be repaired immediately after form removal.

B. Honeycombed and defective concrete shall be removed down to sound concrete. Edges of chipped areas shall be perpendicular to surface or slightly undercut. No featheredges will be permitted.

C. Area to be patched and area at least 6 inches wide surrounding area to be patched shall be dampened to prevent water absorption from patching mortar. After surface water has evaporated from area to be patched, bond coat shall be well brushed into the surface. When bond coat begins to lose water sheen, premixed patching mortar shall be applied. Mortar shall be thoroughly consolidated into place and struck off to leave patch slightly higher than surrounding surface. Patch shall be left undisturbed for one (1) hour minimum before being finally finished. Patched area shall be maintained

damp for seven (7) days minimum. Metal tools shall not be used in finishing patch in formed wall exposed to view in final structure.

D. After being cleaned and thoroughly dampened, tie holes shall be filled solid with patching mortar.

E. Bond coat shall consist of approximately one (1) part cement to one (1) part fine sand passing No. 30 mesh sieve, mixed to consistency of thick cream.

F. Patching mortar shall be made from same materials and in approximately same proportions as used for concrete, except coarse aggregate shall be omitted and mortar shall contain not more than one (1) part cement to two and one- half (2-1/2) parts sand by damp loose volume and also include a non-metallic, non-shrink additive. Substitute white Portland cement for portion of gray cement on exposed concrete in order to produce color matching surrounding concrete, as determined by trial patch. Use no more water than necessary for mortar handling and placement. Mix mortar in advance and allow mortar to stand. Frequently manipulate mortar with a trowel, without adding water, until mortar has reached stiffest consistency that will permit placing.

3.04 CONCRETE FINISHES - FORMED SURFACES

A. After form removal, hardened concrete surfaces shall receive one or more finishes specified below. Unless noted otherwise on Plans or specifications, exterior below grade surfaces shall receive rough form finish, and all other surfaces shall receive a smooth rubbed finish.

B. Rough Form Finish: Remove fins, burrs, and other projections exceeding 1/4 inch in height left after form removal. Patch tie holes and defects.

C. Smooth Form Finish: Form facing material shall produce smooth, hard, uniform texture on concrete. Facing material shall be arranged in orderly and symmetrical manner, with number of seams kept to practical minimum. Forms shall be supported to prevent excessive deflection. Tie holes and defects shall be patched. Fins shall be completely removed.

D. Smooth Rubbed Finish: Finish shall be applied to concrete with smooth form finish. Rub wetted surfaces with carborundum stone to eliminate irregularities and to produce uniform, even-textured surface. Bulging or protruding areas resulting from slipping or deflecting forms shall be ground flush with adjacent surfaces. Do not apply cement grout to surfaces to be rubbed. Forms shall be removed and necessary patching completed as soon after concrete placement as possible without jeopardizing structure. Apply rubbed finish no later than one (1) day following form removal. Unless noted otherwise, use finish for concrete exposed in finished work and for concrete surfaces in contact with water or liquid.

E. Tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to texture reasonably consistent with that of formed surfaces. Final treatment on formed surfaces shall continue uniformly across unformed surfaces.

3.05 CONCRETE FINISHES - SLABS

A. Scratched Finish: After concrete has been placed, consolidated, struck off, and leveled to Class C tolerance, roughen surface with stiff brushes or rakes prior to final set. Unless noted otherwise, use finish on slabs to receive mortar setting beds for quarry tile, ceramic tile, terrazzo, or similar type wearing surfaces and on slabs to receive Portland cement grout swept in by process mechanical equipment.

B. Floated Finish: After concrete has been placed, consolidated, struck off, and leveled, concrete shall not be worked further until ready for floating. Begin floating when water sheen has disappeared and concrete has sufficiently hardened to bear man's weight without deep imprint. Prevent formation of laitance and excess water on finished surface. During first floating, cut down high spots and fill low spots to produce surface with Class B tolerance throughout. Slab shall be refloated immediately to uniform sandy texture. Unless noted otherwise, use finish for curbs and gutters, interim steps, and surfaces to receive roofing or waterproofing materials.

C. Troweled Finish: After applying floated finish to floor slab and when concrete has hardened sufficiently to prevent excess fine material from working to surface, apply first trowel finish with power driven trowel. Additional trowelings shall be done by hand. Final troweling shall be done when ringing sound is produced as trowel is moved over concrete surface. Surface shall be thoroughly consolidated by hand troweling operations. Finished surface shall be free of trowel marks, uniform in texture and appearance, and plane to Class A tolerance. Defects of sufficient magnitude to show through floor covering shall be removed by grinding. Unless noted otherwise, use finish on slab surfaces to be exposed to view, surfaces to be covered with resilient flooring, paint, or other thin film finish coating system, and surfaces in contact with process water or liquid.

D. Broom Finish: Give concrete surface transverse scored texture by drawing metal tinned broom across surface immediately after applying floated finish. Unless noted otherwise, use finish on exterior ramps, platforms, sidewalks, and steps.

3.06 CURING

A. Curing shall be accomplished by preventing loss of moisture, rapid temperature change, and mechanical injury for seven (7) days minimum following concrete placement. Protect fresh concrete from heavy rains, flowing water, and freezing temperatures. Begin curing as soon after placing and finishing as free water has disappeared from concrete surface. The Contractor may select one of the approved curing methods unless a specific method has been specified. Curing methods shall be in accordance with ACI 308.

1. Saturation Curing: Curing of concrete shall be by water saturation using methods which will keep the concrete surfaces adequately wet during the specified curing period. Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

   The use of membrane curing compound or moisture retaining cover in lieu of water curing will not be acceptable except for roadway and walkway surfaces.

2. Moist Curing: Cover unformed surfaces with absorptive cover and maintain surface continuously wet.

3. Moisture Retaining Cover: Cover surfaces with waterproof paper or polyethylene sheet. Lap sheet edges and ends 4 inches minimum and seal with mastic or pressure-sensitive tape. Sheets shall be weighted to prevent displacement. Patch holes and tears immediately.

4. Membrane Curing: Apply membrane curing compound, which complies with ASTM-C 309-81, with power spraying equipment using spray nozzle equipped with wind guard to flat surfaces. Use a roller to apply compound to walls and overhead surfaces. Apply compound in two-coat continuous operation. Apply second coat in direction approximately at right angles to first coat direction. Compound shall form uniform, continuous, adherent film. Film shall not check, crack, or peel and shall be free from pinholes and other imperfections. Surfaces subjected to heavy rainfall within three (3) hours after compound has been applied or surfaces damaged by subsequent construction operations within curing period shall be reapplied. Protect surfaces coated with curing compound from foot and vehicular traffic and other sources of abrasion during curing period. Do not use membrane curing compounds on surfaces to receive deferred toppings,

additional concrete placement, quarry tile grouts, liquid membrane waterproofing compounds or resilient floor tile, or on surfaces to be painted. Apply membrane curing compound in strict accordance with manufacturer's recommendations.

5. Forms Left in Place: Where curing is accomplished by leaving forms in place, the top exposed concrete surfaces and the forms shall be maintained continuously wet. After form removal, concrete shall be cured by other approved methods for remainder of required curing period.

   Form removal shall be in strict accordance with ACI 318, Chapter 6 and Section 03100 of these specifications.

3.07 JOINTS

A. Construction joints shall be keyed with keyways at least 1-1/2" deep and located as shown on PLANS unless otherwise approved by the Engineer. All walls and slabs continuous in one direction more than 60 feet shall be placed in alternating patterns such that construction joints are at no more than 60-foot intervals and at least 3 days elapse between placement of adjacent sections. Joints not shown on PLANS shall be located as not to significantly impair the strength of the structure and shall be approved by Engineer. Joints shall be located as follows:

1. In walls at not more than 60 feet in any horizontal direction; at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into wall.

2. In columns or piers, at top of footings; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.

3. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder shall offset a distance to twice the width of the beam. Transfer of shear through construction joint shall be made by use of inclined reinforcement.

4. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet.

Reinforcement shall be continued across construction joints. Joints shall be perpendicular to main reinforcement.

B. Expansion joints shall be constructed and located as shown on PLANS. Reinforcing bars or other fixed metal items embedded or bonded in concrete shall not be run continuous through expansion joints.

C. Place concrete continuously between construction and expansion joints to produce a unit monolithic in construction. Allow 72 hours minimum to elapse between casting of adjoining units.

D. Install flexible polyvinylchloride (PVC) waterstops in construction and expansion joints where shown on PLANS and where water integrity is required. Support water stop during concrete placement to maintain its proper position in the joint. Make splices with thermostatically controlled electric splicer. Spliced joints shall develop effective watertightness equal to watertightness of continuous waterstop material, shall permanently develop not less than 50 percent of the parent section mechanical strength, and shall permanently retain their flexibility. Waterstops protruding from joints shall be protected from damages.

E. Form transverse contraction joints in sidewalks with tool designed to form groove 3/4 inch deep. Joint spacing shall be equal to sidewalk width. Round joint edges with 1/4 inch edger. Provide transverse 1/2 inch wide expansion joints 20 feet on center. Fill expansion joints with asphalt premolded joint filler.

3.08 BONDING

A. Bonding to New Concrete: Prior to placing new concrete on or against recently set concrete work, thoroughly clean existing surface of laitance, foreign matter, and loose particles. Place or tighten forms, dampen concrete, and slush existing surfaces with neat cement grout. Place new concrete before neat cement grout has attained its initial set. For horizontal construction joints, place a 1-1/2 inch thick layer of mortar before placing new concrete. Mortar shall be standard concrete mix without coarse aggregate and shall have a 6 inch minimum slump. Neat cement grout shall consist of one (1) part cement to two (2) parts sand and sufficient water to produce a workable mix.

B. Bonding to Old Concrete: Apply epoxy bonding compound to existing concrete surfaces , where shown on the plans, prior to placing new concrete. Epoxy bonding compound shall be tacky at time new concrete is placed. Apply epoxy bonding compound in strict accordance with manufacturer's recommendations.

3.09 INSERTS AND APPURTENANCES

A. Set necessary anchor bolts, pipe anchors, pipe sleeves, wall pipes, conduits, inserts, and other appurtenances in forms accurately, true, plumb, and securely

to prevent dislocation during concrete placement. Coat aluminum items with two coats of heavy asphalt or bitumastic paint prior to placing in concrete.

B. Conduits and pipes embedded in concrete shall comply with ACI 318, Section 6.3 and the following:

1. Beams and joints having pipes or sleeves passing through them where not shown on PLANS shall have their width increased adjacent to the sleeve or pipe or over its entire length to obtain the same cross-sectional area of concrete called for, and to provide specified cover and clearance between reinforcing bars.

2. Concrete cover over pipes or sleeves shall be not less than 1 inch.

3. Conduits or pipes shall be placed at mid-height of beams and in the center of columns.

3.10 FIELD QUALITY CONTROL

A. Secure concrete samples for testing in accordance with ASTM C172.

B. Laboratory-Cured Compression Test Specimens: Four (4) test cylinders for each concrete class placed each day shall be taken not less than once per day, nor less than once for each 100 cubic yards, nor less than once for each 5,000 square feet of surface area for slabs or walls. Additional cylinders shall be made and tested when deemed necessary by Owner. Make and laboratory-cure compression test specimens in accordance with ASTM C31. Two (2) specimens shall be tested at 28 days for acceptance and two (2) at seven (7) days for information. Compression tests shall be made in accordance with ASTM C39. Test results shall be average of two (2) specimens tested. Do not remove shoring or apply appreciable loads to any concrete structure unless strength tests have been completed and results and equal to or greater than minimum required values. When the seven- (7) day test results do not exceed the minimum requirements, saturation curing shall be used on the related structural component for the remainder of the 28-day period. Procedures for protecting and curing concrete shall be improved when test results do not exceed minimum requirements. The Engineer shall have the right to alter mix design as needed to secure defined compression strengths.

C. If one specimen in a compression test manifests evidence of improper sampling, molding, or testing, specimen shall be discarded and remaining cylinder strength shall be considered test result. If both specimens in a compression test manifest evidence of improper sampling, molding, or testing, entire test shall be discarded.

D. Where question arises as to concrete quality in the structure, Engineer shall have right to require load or core tests. Load tests shall be performed in accordance with ACI 318. Core tests shall be performed in accordance with ASTM C42. Openings resulting from core extractions shall be coated with epoxy bonding compound and filled with non-shrink grout. If tests on hardened concrete fail to meet specified strengths for class of concrete in question, Engineer has the right to order affected portion removed and replaced with concrete meeting specified requirements at Contractor's expense.

E. Air content shall be determined at the same time as the preparation of test cylinders for compression tests and when directed by Engineer to confirm required air content. Perform tests at job site in accordance with ASTM C231.

F. Mix consistency shall be controlled by slump tests at job site in accordance with ASTM C143. Slump tests shall be performed at same time as preparation of test cylinders for compression tests and when directed by Engineer to confirm required slump.

G. Contractor shall furnish necessary labor to assist testing agency in obtaining and handling samples.

3.11 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SCOPE

A. Work related to construction of stairway and other carpentry where required.

B. Minimum Compliance Standards: The following National Bureau Standards and Commercial Standards govern the Work except where more restrictive items are specified.

1. PS-20-70 American Softwood Lumber Standard.
2. PS-1-83 Softwood Plywood.
3. PS-58-73 Basic Hardboard.

1.02 MINIMUM GRADING STANDARDS

A. The following Grading Associations and Inspection Bureaus govern the grades specified for each type of lumber used.

1. Southern Forest Products Association (SFPA).
2. Southern Pine Inspection Bureau (SPIB).
3. Western Wood Products Association (WWPA).
4. West Coast Lumber Inspection Bureau (WCLIB).
5. American Plywood Association (APA).
6. American Wood Preservative Association (AWPA) Standard C-2.

B. Marking: Stamp each piece with the Grade Association or Inspection Bureau Grade and species.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR LUMBER

A. Species: In general, use any common species except low strength woods such as redwood, cedar, or submontane fir.

B. Finish: Provide S4S finish unless specifically noted otherwise.

C. Seasoning Requirements: Kiln-dry or air-dry to a 15% maximum moisture content. Mark each piece "KD" or "MC"-15.

D. Grades:

1. Comply with the recommended minimum grades for each specific use as specified by the specific grading association such as the Western Wood Products Association.

2. Wood framing shall be Douglas Fir, meeting the following minimum grades.

a. Studs: Stud Grade 10 feet and shorter. Structural Light Framing, No. 2 for lengths greater than 10 feet.
b. Trusses, Joists And Rafters: Structural Light Framing, No. 2.
c. Exposed Exterior Beams: Structural Joists and Planks, No. 1/Appearance.
d. Plates, Sills, And Blocking: Light Framing Construction, No. 2.

E. Plywood: Provide PS-1-83 softwood plywood marked with APA stamp indicating quality and finish as recommended for each use by the American Plywood Association. Only plywood with an APA stamp indicating "Exterior" or "Exposure 1" grades will be acceptable.

2.02 WOOD TREATMENT FOR ABOVE GROUND LOCATIONS

A. Marking: Stamp each piece of lumber with the type of treatment and amount of retention. Redry waterborne type treatment to 19% and stamp "S-DRY".

B. Application: Apply pressure or vacuum treatment. Comply with AWPB Treating Standards LP-2 or LP-3 typically.

C. Locations: Provide treated wood at the following locations:

1. Where shown on the Drawings.
2. Sill plates resting on concrete or masonry.
3. Grounds embedded in concrete, plaster, or masonry.
4. Blocking or grounds embedded in construction in such a manner as to prevent exposure to circulating air.
5. Roofing grounds.

D. Cut Treatment: Treat cuts by dipping or brushing with preservative.

2.03 FIRE RETARDANT TREATMENT

A. Marking: Stamp each interior piece with UL FR-S label, and each exterior

piece with NCX label.

B. Application: Pressure impregnate to produce a flamespread of 25 or less tested to ASTM E 84. Kiln-dry to 19% maximum and 12% minimum moisture content.

C. Locations: All rough carpentry.

2.04 FASTENERS AND ACCESSORIES

A. Screws: Provide wood screws complying with F.S. FF-S-111D.

B. Nails: Provide necessary nail types as defined in ASTM F 547.

C. Connectors: Provide Simpson "Strong-Tie" connectors, sized and installed; in accordance with the manufacturer's recommendations.

D. Accessories: Provide metal accessories, including anchors, bolts, nuts, washers, plates, and shims complying with the Metal Fabrication Section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Selection And Use Of Lumber: Examine each piece of lumber separately. Select members for strength, lack of warp, and appearance. Use the best pieces for the most demanding purposes. Use poor pieces by cutting away objectionable portions.

B. Use washers on bolts use to attach wood. Use galvanized bolts and washers on treated wood.

C. Paint fireproofed wood with one coat of alkyd primer or sealer immediately after installation.

3.02 MEASUREMENT AND PAYMENT

A. No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes all flashing and sheet metal not specifically described in other sections of these specifications but require to prevent penetration of water through exterior shell of the building.

B. Porcelain enamel copings and scuppers.

C. Roofing, membrane flashing.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300 and Section 01340.

1.03 QUALITY ASSURANCE

A. Comply with standards specified in this section. Products used in the work of this section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to the engineer. Use adequate numbers of skilled workmen who are thoroughly trained and experience in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

1.04 PRODUCT DELIVER, STORAGE AND HANDLING

A. Products shall be handled in accordance with the requirements of Section 01620.

PART 2 PRODUCTS

2.01 DESIGN

Standard commercial items may be used for flashing, trim, and reglets, provided all such items meet or exceed the quality standards specified herein. in addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations contained in "Architectural Sheet Metal Manual", current edition, of the Sheet Metal and Air Conditioning Contractor's National Association.

2.02 MATERIALS

Sheet metal shall be 0.15 inch fully annealed Type 304 stainless steel, conforming to ASTM A167, coated with 40 pound terne (TCS) and as manufactured for building construction. The coating shall be 80 percent lead and 20 percent tin.

Anchors shall be fiber plugs with lead cores.

Screws, anchor bolts, washers, and the like shall be of stainless steel and of approved size to suit securement conditions.

Nails shall be flathead common stainless steel nails of approved size, length and gauge for the intended securement conditions.

Cleats, or clips shall be of 26-gauge (.018 inch) terne coated stainless steel.

Solder shall be top quality with 50 percent tin. Flux for soldering shall be rosin.

2.03 OTHER MATERIALS

All other materials, not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first quality of their respective kinds, and selected by the Contractor subject to the approval of Owner.

PART 3 EXECUTION

3.01 INSPECTION

Examine the areas and conditions under which work of this Section will be installed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected. Clean receiving surfaces of dirt, rubbish, and other foreign material.

3.02 WORKMANSHIP

A. General

Form all sheet metal accurately and to the dimensions and shapes required, finishing all molded and broken surfaces with true, sharp, and straight lines and angles and, where intercepting other members, coping to an accurate fit, soldering securely. Unless otherwise specifically permitted by the Engineer, turn all exposed edges back 1/2".

B. Expansion

Form, fabricate, and install all sheet metal so as to adequately provide for expansion and contraction in the finished work.

C. Weatherproofing

Finish watertight and weathertight where so required. Make all lock seam work flat and true to line, sweating full of solder. Make all lock seams and lap seams, when soldered, at least 1/2" wide. Where lap seams are not soldered, lap according to pitch but in no case less than 3". Make all flat and lap seams in direction of flow.

D. Joints

Joints parts with rivets or sheet metal screws where necessary for strength or stiffness. Provide suitable watertight expansion joints for all runs of more than 40', except where closer spacing is indicated on the drawings or required for proper installation.

E. Nailings

Whenever possible, secure metal by means of clips or cleats without nailing through the metal. In general, space all nails, rivets, and screws not more than 8" apart.

3.03 EMBEDMENT

Embed all metal in connection with roofs in a solid bed of sealant, using materials and methods described in these specifications or other materials and methods approved in advance by the Engineer.

3.04 SOLDERING

A. General

Thoroughly clean and tin all joint materials prior to soldering. Perform all soldering slowly with a well heated copper in order to heat the seams thoroughly and to completely fill them with solder. Perform all soldering with a heavy soldering copper of blunt design, properly tinned for use. Make all exposed soldering on finished surfaces neat, full flowing, and smooth.

B. Cleaning

After soldering, thoroughly wash acid flux with a soda solution.

3.05 TEST

Upon request of the Engineer, demonstrate by hose or standing water that all flashing and sheet metal is completely watertight.

3.06 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 07920

SEALANTS AND CAULKING

PART 1 GENERAL

1.01 DESCRIPTION

A. It is the intent of this Specification to provide a sealant system which, together with other specified materials, will render the joints in the structures watertight at all times. Contractor shall comply with this intent and guarantee in writing that his work will remain absolutely watertight for a period of two (2) years from date of final acceptance of building.

1.02 REFERENCE STANDARDS

A. FS: Federal Specification TT-S-00227E Sealing Compound, Elastomeric Type, Multi Component (for Caulking, Sealing and Glazing in Buildings)

1.03 SUBMITTALS

A. Submit manufacturer's brand name and product literature in accordance with Sections 01300 and 01340.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Do not apply caulking or sealant when compound, air, or substrate temperature is below 40 degrees F.

PART 2 PRODUCTS

2.01 MATERIALS

A. Caulking, and sealing compounds shall be elastic, nonstaining, gray, resistant to attach by chemicals, solvents, and water; remain resilient through temperatures ranging from -2 degrees to 200 degrees F; and consist of silicone or polysulfide compounds conforming to Federal Specification TT-S-00227E, Type II. Color samples(s) shall be submitted to Owner for approval.

B. Subcaulking shall be glass mat, untreated jute, expanded polyethylene, or polyvinylchloride.

C. Structural joint sealant. Non-sag applications shall be two (2) component polysulfide conforming to Federal Specification TT-S-00227E, Type II. Sealant shall remain resilient through temperatures ranging from -20 degrees to 200 degrees F; be resistant to chemicals, solvents, and water; and develop

a 20-35 Shore A hardness. Self-leveling applications shall be polyurethane conforming to Federal Specifications TT-S-00227E, Type I. Sealant shall remain resilient through temperatures ranging from -40 degrees to 180 degrees F; be resistant to chemicals, solvents, and water; and develop 20-35 Shore A hardness. Back rod shall be expanded closed-cell polyethylene. Primer shall be as recommended by manufacturer. Sealant color shall be gray to match concrete surfaces. Sealant color in expansion joints in tile floors shall match color of grout.

PART 3 EXECUTION

3.01 PREPARATION

A. Joint surfaces shall be clean, sound, and dry.

B. Joints deeper than 1/2 inch shall be filled to within 1/4 inch to 3/8 inch of joint face with subcaulking prior to caulking. Joints less than 1.4 inch wide need to not be packed with subcaulking. Joints to be filled with structural joint sealant shall be prepared as detailed on Drawings.

C. Mask areas adjacent to joint with waterproof, pressure sensitive making tape.

D. Apply primer to joints in strict accordance with manufacturer's recommendations.

3.02 INSTALLATION

A. Neatly apply caulking and sealant compounds with cartridge type ratchet hand gun in accordance with manufacturer's recommendations. Immediately tool caulk bead after application to ensure proper contact with inner joint surfaces. Remove masking tape within one hour after applying sealant or caulking.

B. Caulk around perimeters of window and door frames and other openings in walls and under exterior metal thresholds and metal sills. Caulk and seal joints as noted on Drawings.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1 GENERAL

1.01 DESCRIPTION

A. Hardware required, but not specified, shall conform in size, quality and finish to an opening of comparable usage.

1.02 RELATED WORK

A. Section 13600: Pre-Engineered Metal Buildings

B. Section 13601: Wood-Framed Building

1.03 DESIGN CRITERIA

A. Hardware for exterior doors shall be designed to resist a 90 mph maximum wind velocity.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with Sections 01300 and 01340.

B. Furnish hardware setting template to door and frame manufacturers.

1.05 STANDARD OF QUALITY

A. Manufacturers and model numbers shown are to establish a standard of quality. Similar items of manufacturers equal in design, function and quality will be acceptable. The Owner reserves the right to reject any material which, in his opinion, is not equal in quality, design, or function to the specified standard.

1.06 DELIVERY

A. Each hardware piece shall be separately packed, complete with screws, templates, instructions, keying, and markings corresponding to finish hardware schedule.

PART 2 PRODUCTS

2.01 Butt hinges shall be button-tip, ball bearing design, heavy duty template type, and stainless steel with US32D finish. Non-rising, non-removable, vandal-proof

pins shall be used for exterior doors. Use 1-1/2 pairs per leaf. Use hinges manufactured by Stanley, Hager, McKinney, or approved equal.

2.02 EXIT DEVICES

A. Horizontal push bar of extruded aluminum with steel channel reinforcement, chassis of heavy duty extruded aluminum, front and rear cover. Plates of cast aluminum, stainless spring U.L. Fire Rated by Russwin No. U572 or approved equal.

2.03 LOCKS AND LATCHES

A. Locks and latches shall be heavy duty cylindrical type, U.L. listed, 6 pin, stainless with US32D finish and manufactured by Sargent, Russwin, Corbin, or approved equal.

2.04 OVERHEAD TYPE CLOSERS

A. Use surface mounted liquid door closer equipped with key controlled checking adjustment screws. Units for exterior doors shall be sized for 4 foot wide door.

B. Units shall be of type and size normally furnished by steel door manufacturer. Finish shall be painted to match door.

2.05 DOOR STOPS AND BUMPERS

A. Floor stops shall be used where conditions prevent use of wall type stops. Wall stops shall be 3404 or 3405 by Sargent; 355-1/2 or 356-1/2 by Russwin; or approved equal. Floor stops shall be 3380 or 3381 by Sargent; 209-1/2 or 210-1/2 by Russwin; or approved equal.

2.06 DOOR SILENCERS

A. Rubber door silencers shall be provided on door jambs. Use three silencers per door. Silencers shall be Glynn-Johnson No. 6J64; Russwin No. 33; or approved equal.

2.07 WEATHERSTRIPPING

A. Exterior doors shall be weatherstripped at head and jambs with surface applied, vinyl-backed wool piling.

2.08 THRESHOLDS

A. Thresholds shall be extruded aluminum, not more than 1/2 inch thick. Saddle shall extend full opening width, be neatly coped to frame, and be

secured in place with countersunk stainless steel screws and expansion shields. Exterior saddles shall have surface applied extruded steel stop strips with integral vinyl bulb, No. 290AV as manufactured by Pemko.

2.09 KICKPLATES

A. Kickplates shall be 16 gauge stainless steel, 8 inches high, and full door width less 1-1/2 inch on push side and 1 inch on pull side. Fasteners shall be stainless steel screws.

2.10 KEYS

A. Provide three (3) change keys for each lock and six (6) masterkeys for each system. Provide key cabinet to hold present keys plus 20 percent expansion.

2.11 SCREWS AND BOLTS

A. Furnish proper quantity and size of screws and bolts required to apply finish hardware. Screw and bolt finish hardware. Screw and bolt finish shall correspond to hardware finish.

2.12 FINISHES

A. Butt hinges, locks and latches, US32D. Door Closers, Enamel (steel enamel). Stops, holders and all other hardware, US26D.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each hardware piece shall be packed separately in the manufacturer's original package, complete with screws, keying, instructions and templates, marked to correspond with the approved hardware schedule.

B. Hardware shall be delivered sufficiently in advance of its setting for proper inspection.

C. Hardware which is blemished or defective will be rejected even though set in place before defects are discovered. It shall be removed and replaced with new hardware and any resultant damage to other work shall be repaired.

D. Unless otherwise shown or directed, install hardware in accordance with "Recommended Locations for Builders Hardware" published by the National Builders Hardware Association.

E. All lock keying shall be set to a removable construction core Master Key. The construction core Master Key shall be utilized to operate all cylinders until the permanent cores are installed in the cylinders. This change shall require the cores, but not the cylinders, to be changed after installation.

F. Install kickplates as indicated in Hardware Schedule.

G. Weatherstripping shall be accurately cut and fitted, carefully aligned for full contact and tight seal, and firmly secured. Corners and intersecting members shall be coped or closely fitted. Install weatherstripping on exterior doors to maintain weatherproof and waterproof seal without preventing smooth and easy door operation.

H. Notch thresholds at stops. Set interior toe in full bed of caulking compound, and securely screw in place with lead shields and expansion bolts.

3.02 HARDWARE SETS

A. The following hardware sets are a general guide for hardware required for each opening. Where "UL" rating is required, hardware types shall be modified to comply with Underwriter's Laboratories, Inc., requirements and all components shall bear the U.L. label. Keying information will be based on a grand master key system with final keying information furnished by the Owner.

B. Where the function, finish, shape or size of a member receiving hardware is such as to prevent the use of, or make unsuitable the types specified, furnish similar types having as nearly as practicable the same operation.

C. If hardware for any location is not specified furnish hardware equal in design and quality to hardware of comparable function.

HARDWARE SCHEDULE

(EXTERIOR DOOR) (Quantity 2- Total)
1 1/2 PAIR 4-1/2" X 4-1/2" hinges
1 panic exit device
1 tubular lock set
1 door closer
1 threshold

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 09900

PAINTING AND COATINGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. This Section includes requirements for field painting. Refer to appropriate product specifications for shop applied painting and protective coating requirements of equipment and furnishings, except as noted.

B. Surfaces to Receive Surface Preparation, Priming and Painting:

1. All above ground vent piping.

1.02 WORK NOT INCLUDED

A. Field painting or coating will not be required on the following items:

1. Plastics including FRP, polypropylene, etc.
2. All galvanized surfaces, except as noted.
3. Products with approved factory coating system.

1.03 QUALITY ASSURANCE

A. WORKMANSHIP

1. The Painting Contractor shall furnish workers who perform quality work and who are experienced and knowledgeable in the surface preparation and application of high-performance industrial coatings. The painting Contractor shall list five (5) projects blasted and coated by the personnel which the Contractor proposes to employ for this project.
2. Paint application procedures shall conform to the standards of craftsmanship discussed in the Steel Structures Painting Council's Painting Manual, Volume 1, Good Painting Practice. These techniques include, but are not limited to, multiple passes of the spray gun, with each pass overlapped 50%, and "Cross Hatching" successive coats of paint.

B. EQUIPMENT: The Paint Contractor shall use properly functioning equipment capable of performing the tasks required herein. That is, compressors shall be capable of providing a minimum of 90 psi at the blast nozzle(s) and shall provide clean air that is free of moisture and oil through the required oil and moisture traps. Paint spray rigs shall have properly

functioning regulators and pressure gauges, and clean fluid lines which have not previously been used to spray zinc rich products or water base coating materials.

C. Application and surface preparation standards shall comply with the requirements of the Steel Structures Painting Council's Paining Manual, Column 1, Good Painting Practices. The Engineer shall be consulted regarding any situations not covered by the reference standards of this specification.

D. TEST EQUIPMENT: The Contractor shall furnish for the use of the Engineer:

1. One (1) non-destructive paint film thickness gauge, such as a Mikrotest thickness gauge;
2. One (1) set of certified coating thickness calibration standards produced by the U.S. Department of Commerce;
3. One (1) "wet sponge" low voltage DC type holiday detector, such as the Tinker-Rasor Electrical holiday detector.
4. Replica tape such as Tes-Tex Coarse and Extra-Coarse.
5. One (1) spring-loaded dialtype micrometer such as Mitutoyo No. 2804-10 for replica tape measuring.

1.04 SUBMITTALS

A. Shop Drawings and Product Data

1. Comply with Section 01340 and the supplemental requirements below.
2. Submit the following information for each item to be coated:
   a. Quantities and types of paint.
   b. Color chart.
   c. Surface preparation method.
   d. Coating system.

1.05 REFERENCE STANDARDS

A. Surface preparation standards of the Steel Structures Painting Council (SSPC).

B. Surface preparation standards of the National Association of Corrosion Engineers (NACE).

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Products shall be handled in accordance with the requirements of Section 01620.

PART 2 PRODUCTS

2.01 MANUFACTURER REQUIREMENTS

A. Use paints, sealers and coatings manufactured by firms listed in Table 1.

B. Comply with the requirements of Section 01630 if substituting products other than those listed in Table 1.

C. For each product required in Table 1, select only one manufacturer to provide all materials necessary to provide the complete painting or coating required.

2.02 EQUIPMENT

A. Use equipment for surface preparation and application in spraying operations to produce the minimum amount of air pressure required by SSPC or NACE and paint manufacturer's recommendations.

2.03 COLORS

A. Color selections are to be by the Owner unless otherwise specified.

B. Color charts for each item to be coated shall be submitted for Owner review and selection.

2.04 THINNERS AND SOLVENTS

A. Use only those thinners and solvents specified in paint formulas of paint being used. Mix in proportions recommended by paint manufacturer.

PART 3 EXECUTION

3.01 COORDINATION AND INSPECTION

A. Cooperate with all trades whose work comes in contact with work to be done under this Section, providing such information or applications as may be required by other trades to assure proper project continuity.

B. Examine all surfaces scheduled or specified to be finished under this Section, and if any defects or discrepancies are discovered, notify the Engineer in writing of the specific conditions. Verify that all such defects have been corrected.

C. Coordinate work so that shop primed items are primed and painted with compatible coatings from the same manufacturer. Shop painted items shall be coated with paint suitable for the items' working environment.

TABLE 1

Paint, Sealer, and Coating Schedule

Symbol	Used/ Not Used[1]	Coverage Sq. Ft./ Gal.	Min. Dry Mils Per Coat	Service	Generic Type	Brand and Manufacturer[2]
1.	X	Varies	NA	Primary Sealer	Chemical Penetrant	1154 Silicone Sealer-Acro Silicone Penetrant-Koppers 46-V-6 Silikote Water Repellent-Valspar 50-60 Silicone Water Repellent-Tnemec
2.	X	75 to 100	NA	Weather proof Primary Sealer	Chemical Penetrant	1153 Latex Block Filter-Acro 600 Emulsion-Koppers 46-V-6 Silikote Water Repellent-Valspar 54-562 Mod. Epoxy Masonry Filler-Tnemec
3.	X	Varies	NA	Primary Sealer	Vinyl-Acrylic Emulsion with epoxy esters	1153 Latex Block Filer-Acro Concrete & Masonry Filler-Koppers 79-W8 Block Filler-Valspar LVWC-Armstrong 54-560 Latex Masonry Filler-Tnemec
3a.	X	290 to 350	1.5 - 2.0	Finish Coat	Acrylic Emulsion	2288 Exterior Latex - Acro Koppers600--Koppers LVWC-Armstrong 79 Series Exterior Latex-Valspar Series 6 TnemeCryl - Tnemec
4.	X	425	1.5 - 2.0	Metal Primer	Alkyd, Lead-Chromate	1104 Heavy Duty Primer-Acro 622 LCF Primer-Koppers Armstrong Metalex Primer 69-430 13-R29 Sovalex Metal Primer-Valspar Series 37 ChemPrime - Tnemec
5.	X	385	1.5	Metal Primer	Polyamide Cured Epoxy Resin	4422 Epoxy Primer-Acro 294-Epoxy-Primer-Koppers 13-R-62R Val-Chem Epoxy Enamel-Valspar Series 65 PoxiPrime - Tnemec
6.	X	500	1.5 - 2.0	Finish Coats	Alkyd, Straight Long-Oil	2214 Heavy Duty Enamel - Acro Rustarmor 500 Enamel--Koppers 12 Series Panorama Coatings-Valspar Vitraguard-Armstrong Series 2H HiBuild TnemeGloss - Tnemec
7.	*	385	1.5 - 2.0	Metal Primer	Polyamide Cured Epoxy Lead, Chromate, Two Component	4422 Epoxy Primer-Acro 654 Epoxy Primer-Koppers Co. 13-R-62R Val-Chem Epoxy Enamel-Valspar 66-1211 HiBuild Epoxoline Primer - Tnemec

TABLE 1 (Cont.)

Paint, Sealer, and Coating Schedule

Symbol	Used/ Not Used[1]	Coverage Sq. Ft./ Gal.	Min. Dry Mils Per Coat	Service	Generic Type	Brand and Manufacturer[2]
7a.	X	300	2.0	Finish Coat	Polyamide Cured Epoxy Two Component	4460 Chemical Resistant Epoxy-Acro 84 Series Val-Chem Epoxy Enamel-Valspar Glamorglaze 200 Epoxy-Koppers Co. Series 66 HiBuild Epoxoline - Tnemec
8.	X	400	1.2 - 1.7	Wood Primer	Oil Base	2284 Wood Primer-Acro Thin Rustarmor 500 Enamel (15%-20%) - Koppers 531 Primer-Armstrong 17-W-4 Exterior First Coater-Valspar 36-603 Undercoater - Tnemec
9.	X	500	1.4 - 2.0	Finish Coat	Alkyd, Straight Long-oil	2214 Heavy Duty Enamel-Acro Rustamor 500 Enamel--Koppers Armstrong Vitraguard 20 Series M.F. Enamel-Valspar Series 23 Enduratone - Tnemec
10.	X	400	6.0 - 8.0	Submerged Steel or Iron	Polyamide-Cured Epoxy Resin	4460 Chemical Resistant Epoxy-Acro Hi-Gard Epoxy-Koppers 78-Series High Build Epoxy-Valspar Series 66 HiBuild Epoxoline - Tnemec
11.	X	100 to 200	10.0 - 12.0	Submerged Steel or Iron	Coal-tar Epoxy Two Component	4467 Coal Tar Epoxy-Acro 300-M-Koppers Co. 64-J3 Coal Tar Epoxy-Valspar 46H-413 HiBuild TnemeTar - Tnemec
12.	X	55 to 75	9.0 - 10.0	Buried Steel or Iron	Tar-base Pitch	8500 Coal Tar Coating-Acro Bitumastic No. 50--Koppers 35-J-10 High Build Bituminous Coating-Valspar 46-450 Heavy Tnemecol - Tnemec
13.	X	215	5.0 - 7.0	Interior Concrete Surface of Lift Station	Epoxy Polyamide	4460 Chemical Resistant Epoxy-Acro Hi-Build Epoxoline-Tnemec Hi-Gard Epoxy-Koppers 78 Series Hi-Build Epoxy-Valspar Series 66 HiBuild Epoxoline - Tnemec
14.	*	480 to 640	1.5 - 2.0	Finish Coat	Polyurethane	4426 Polyurethane-Acro 1122BRS-Koppers V40 Series Urethane Enamel-Valspar Series 70-1 Endura Shield - Tnemec

[1] (*) Denotes specific items relating to this project; contractor shall verify.
(X) Denotes items not used in this project.
[2] Brand and manufacturer specified to establish standard of quality and not to exclude any equal product.

3.02 SURFACE PREPARATION

A. Concrete and Masonry Surfaces

1. Clean surfaces of all latent matter, burrs and fins.
2. Wash concrete surfaces with 10 percent solution of muriatic acid, wash clean with fresh water and thoroughly dry.
3. Insure surfaces are clean and free of scale, dust, oil, grease, moisture and other foreign matter.

B. Metal Surfaces

1. Surface preparation of all surfaces to be painted shall be by abrasive blasting in the field. Degree of preparation shall be as outlined in Table 2.
2. Cleaning and painting shall be so programmed that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Surfaces not intended to be painted shall be suitably protected from the effects of cleaning and painting operations.
3. The surface to be painted shall have the specified surface preparation at the time of application of the paint. If the surface is degraded or contaminated subsequent to surface preparation and prior to painting, the surface shall be restored before paint application.
4. Cleaning - All surfaces to be coated shall be made free of grease, oil and dirt by steaming and/or detergent cleaning per SSPC-SP1.
5. Metal and Weld Preparation - All surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter, etc., shall be removed by the Paint Contractor by grinding. All rough welds shall be ground smooth and all sharp edges shall be radiuses 1/8th inch minimum, 1/4 inch preferred.
6. Abrasive Materials
   a. Blast only as much steel as can be coated the same day of blasting.
   b. The abrasive to be used shall be sharp, angular, properly graded and brought to the job site in moisture proof bags or airtight bulk containers, and shall be capable for producing the depth of profile specified herein. Copper slag abrasives are not suitable for immersion service, however.
   c. The profile thus obtained may be verified with replica taps such as Tes-Tex Coarse Press-O-Film Tape, with one (1) measurement for every 300 square feet or surface area. The tapes shall then be given to the Engineer for filing for future reference.
   d. Blasting shall not be performed if the surface may become wet before priming commences or when the surfaces are least then 5 degrees F above the dew point.

e. The standard of cleanliness for the surface preparation shall be evaluated with the use of SSPC Pictorial Surface preparation Standards for Painting Steel Surfaces, SSPC-Vol. 1, or Swedish Pictorial Standards.

f. Remove all dust and abrasives from freshly blasted surfaces by brushing, or blowing with clean dry air, paying special attention to corners and joints of connecting members.

7. Clean pumps and motors to be coated using power tools and/or hand tools, as necessary, to remove loose mill scale and rust as described in Table 2.

3.03 APPLICATION

A. Environmental Conditions

1. Use all material in accordance with the directions of the manufacturer. Use of thinners at any time must have the approval of the Engineer. Apply coatings in accordance with the manufacturer's application instructions by conventional or airless spray wherever possible. Leave no sags, brush marks, or other defects.
2. Coatings shall not be applied: When the metal temperature is less than 50°F; when the metal temperature is less than 5°F. above the dew point; when the expected weather conditions are such that the temperature will drop below 40°F within six (6) hours after the coating has been applied; or when the relative humidity is above 85%.
3. Do no interior painting until the building or other enclosed area has been enclosed, ventilated and thoroughly dried out as approved by the Engineer. Do no exterior painting in rainy, snowy, damp or frosty weather, not until surfaces are thoroughly dry.
4. Maintain interior temperature of rooms at 70 degrees F. or higher where varnish, lacquer or enamel is being applied and at 60 degrees F. or higher during other painting and finishing. Do exterior painting only when air temperature is 60 degrees F. or higher and only in dry weather.
5. Apply material under adequate illumination.
6. Provide fans where natural ventilation is insufficient. Do not use the building fans without the written consent of the Engineer.
7. Mix and store materials only in a designated space at the site. Keep fire extinguisher available in area.

B. Application Procedures

1. All coatings shall be applied in accordance with manufacturer's recommendations and the specifications as outlined herein, using the best state-of-the art techniques that will result in a finish containing uniformity and integrity, and a finish that is free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive overspray, or delaminations.

2. Insure conformance of all paint application to the following general conditions:
   a. Provide primer and coatings of the thickness specified in Table No. 2 for the appropriate surfaces.
   b. Maintain equipment in good working order. Thoroughly clean and inspect daily. Regularly replace worn spray nozzles, tips, etc. Use and properly service effective oil and water separators on all air lines.
3. Materials shall only be thinned with the manufacturer's recommended thinners and shall be thinned as required to adjust the viscosity for temperature variations, proper atomization and flow-out.
4. Any catalyzed material remaining at the end of the day shall be discarded.
5. The intermediate coat on a 3-coat exterior application shall not be the same color as the finish coat.
6. All edges and welds shall be striped by brush or spray prior to applying the first full coat to surrounding surfaces.
7. Remove all hardware, trim and other items as required for proper application of coatings.

C. In order to prevent the degradation or contamination of cleaned surfaces, the first coat of paint shall be applied immediately after the surface has been cleaned. Succeeding coats shall be applied before contamination of the under surface occurs. When this procedure is impossible or impractical, the Contractor and the Engineer shall agree on the procedure to be followed.

D. Curing

1. Each coat of paint shall be allowed to either dry or cure for the amount of time recommended by the coating manufacturers before successive coats of point shall be applied within the recoat threshold time as recommended by the coating manufacturer.
2. Adequate ventilation is essential to proper curing of any paint film, especially inside tanks, pipe and other enclosed areas. Solvent fumes are heavier than air and must be properly exhausted through adequate sized bottom outlets using heavy duty explosion-proof forced air fans. Safety factors notwithstanding, failure to do so will result in the paint tending to run, difficulty in film building, extended curing schedules and, in the worst case situation, complete failure to cure.
3. Forced ventilation of tanks shall continue for at least 24 hours after the last coat has been applied, after which the tank or other enclosed area shall be left open for an average of 5 to 7 days for complete cure prior to placing the tank or equipment in service. Consult manufacturer for specific curing schedule.
4. Color Scheme - The Owner shall select colors for the project. The Contractor shall submit a current chart of the manufacturer's available

colors to the Engineer and receive approval prior to the start of coating and painting operations.

3.04 SHOP - COATED METAL SURFACES AND EQUIPMENT

A. After delivery to work site, and prior to installation, keep all shop-coated metal work clean and free from corrosion. Clean and retouch or repaint damaged areas with additional coating system as directed by the Engineer.

B. After erection or installation of shop-coated metal work and equipment, clean and retouch all rust spots, all places where paint has been rubbed or scraped off and all bolts and nuts. After previously applied paint has hardened and when surfaces to receive succeeding coats of paint have been cleaned and dried, apply paint in accordance with Table No. 2. Allow 5 days for hardening of final coat for submerged surfaces.

3.05 INSPECTION

A. The Owner or Consulting Engineer, if unable to furnish an on-staff inspector who is fully knowledgeable of and qualified to inspect (both ground and elevated) surface preparations and application of high-performance coatings, may acquire the services of an independent third-party inspector who is a NACE (National Association of Corrosion Engineers) Certified Coatings Inspector, or equivalent (by virtue of experience and reputation), to inspect any or all phases of the work to be performed as outlined herein. The Engineer's decision shall be final as to interpretation and/or conflict between any of the reference specifications and standards contained herein.

B. The Engineer shall be sufficiently notified in advance of all work performed in order to perform the examination of and approval of the surface preparation and each coat prior to application of the next coat. Runs, overspray, roughness, and/or abrasives in the coating, or other indications of improper application, shall be recoated or repaired in accordance with the coating manufacturer's and the Engineer's instructions.

C. All repairs, surface preparation and painting will be subject to inspection by the Engineer. Particular attention will be paid to hard-to-reach areas, bolted connections, sway rods, anchor bolts, and thread joints. The guide lines as specified in the standards published by the Steel Structures Painting council will be used as a basis for acceptance or rejection of cleaning, painting, or coating application. The SSPC-Vol. 1 Pictorial Surface, along with single probe magnetic pull-off dry file thickness gauges, electrical holiday detectors, and standard wet film thickness gauges will be used by the Engineer to determine the acceptability of the paint application.

D. To facilitate adequate inspection to all surfaces, including roofs and other raised surfaces, the Paint Contractor shall provide scaffolding or riggings and

TABLE NO. 2

SYSTEM SCHEDULE

Symbol	Used/ Not Used[1]	Type of Surface	Exposure	Cleaning	Primer	1st Coat	2nd Coat	3rd Coat	Total Mil Thickness
A.	X	Clay or Brick Masonry	Exterior	Manufacturer's Spec.	-	1			
B.	X	Concrete Block Buildings	Exterior	Manufacturer's Spec.	-	3	3a	3a	
C.	X	Concrete Block Walls	Interior	Spec. 3.02 Para.A	1	3a	3a	-	3.0-4.0
D.	X	Concrete Walls and Ceilings	Interior	Spec. 3.02 Para.A	-	3	3a	3a	
E.	X	Wood	Exterior and Interior	Manufacturer's Spec.	8	9	9		4.0-5.5
F.	X	Steel tank	Interior	SSPC-10	7	10	10		4.5-6.0
G.	*	Structural and Misc. Steel, Piping and Valves, including Vent Piping	Exterior	SSPC-#10 or NACE-#2	7	14	14		5.5-6.5
H.	X	Structural and Misc. Steel	Interior	SSPC-#6 or NACE-#3	4	6	6		4.5-6.0
I.	X	Piping and Valves	Exterior	SSPC-#6 or NACE-#3	7	7a	7a		5.5-6.5
J.	X	Waste Treatment Plant Piping and Valves	Submerged and Steel Members of Digester Cover	SSPC-#10 or NACE-#2	7	11	11		20.0-22.0
K.	X	Valves and Bolting on D.I. Pipe	Buried	SSPC-#6 or NACE-#3		12	12	12	36.0-40.0
L.	X	Interior of Lift Station Including Roof and Valve Box	Submerged	Spec. 3.02 Para A.	-	5	10		9.0-11.0
M.	X	Sludge Collectors	Submerged	SSPC-#10 or NACE #2	Hot-Dipped Galvanized ASTM 123				

TABLE NO. 2 (Cont.)

SYSTEM SCHEDULE

Sym-bol	Used/ Not Used[1]	Type of Surface	Exposure	Cleaning	Primer	1st Coat	2nd Coat	3rd Coat	Total Mil Thickness
N.	X	Equipment	Varies	SSPC-#2,#3	Per Manufacturer's Recommendations				
O.	X	Trucks, Tractors, Trailers and Accessories	Exterior	Per Manuf.	Per Manufacturer's Recommendations				
P.	X	Electrical Panels	Exterior	SSPC #2,#3	Per Manufacturer's Recommendations				
Q.	X	Steel Grating	Exterior	SSPC #10 or NACE #2	Hot-Dipped Galvanized ASTM 123				

[1] (*) Denotes specific items relating to this project; contractor shall verify.
(X) Denotes items not used in this project.

adequate illumination that the Inspector may require to perform the dry film thickness readings and holiday test inspections as required by the specifications and referenced standards. The Paint Contractor shall also provide personnel to move the scaffolding or rigging at the instructions of the Engineer or Inspector.

E. Film thickness shall be checked with a nondestructive, magnetic pull-off gauge such as the Mikrotest Model DFG-100, or electronic thickness gauge. The Paint Contractor shall furnish U.S. Department of Commerce, National Bureau of Standards calibration plates (or calibration shims, depending upon the type of thickness gauge used) to verify accuracy of the thickness gauge. The number of film thickness readings taken will be in accordance with SSPC PA-2.

F. Holiday Test

1. All interior surfaces, both immersed and non-immersed shall be holiday free.
2. Inspection shall commence only after the coating has sufficiently cured, usually 1 to 5 days. (Consult coating manufacturer for specific curing schedule.)
3. Inspection device to be used shall be a 67 1/2 volt DC, 80,000 ohm Thiner-Rasor wet sponge holiday detector Model M-1, or equal.
4. The holiday detector shall be properly grounded, and the sponge probe shall be saturated and lightly wrung out, using clear tap water only. Sponge shall be moved at a slow to moderate pace over all surfaces. Any defects detected shall be marked with chalk, repaired, and reinspected.

3.06 COATING REPAIRS

A. If it is necessary to touch-up or recoat damaged areas after the coatings have cured beyond the maximum recoat time, the surfaces shall be specifically prepared prior to touch-up painting.

1. Surface Preparation - Damaged and surrounding areas for a distance of 6" into satisfactorily painted areas shall be cleaned of dust, dirt, oil and grease. Surfaces to be coated shall be brush blasted under low pressure to uniformly abrade and surface. Abrasive blast residue shall be removed from the blast area with particular attention paid to the surfaces which have been "feathered" where abrasive particles may be imbedded in the intact coating. If agreed upon by the Engineer, Contractor and Paint Manufacturer, the areas to be repaired may be prepared in accordance with SSPC SP-3, Power Tool Cleaning. The cleaned areas shall be wiped with a proper bond solvent to increase the coating adhesion to the intact coating surfaces. Coatings shall be

applied to fulfill the requirements of the coatings systems outlined for interior and exterior surfaces.

2. Any areas containing abrasive materials in the cured coating shall be removed by blasting and recoated in accordance with the specified system.

3.07 CLEANUP

A. Upon completion of the work, all staging, scaffolding and containers shall be removed from the site by the Contractor. Coating or paint spots and oil or stains upon adjacent surfaces shall be removed and the job site cleaned. All damage to surfaces resulting from the work of this section shall be cleaned, repaired, or refinished to the satisfaction of the Owner and/or the consulting Engineer at no additional cost to the Owner. The area around the tank shall be left in substantially the same condition as when the work began. The Contractor shall be responsible for removal of all debris and blast abrasive residue to an approved disposal site.

3.08 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11001

AIR STRIPPING TOWER ASSEMBLY

PART 1 GENERAL

1.01 Furnish and install a complete volatile organics contaminant air stripping tower. The air stripper shall be free-standing, vertical and be of the countercurrent design. Vessel construction shall provide for a water flow rate of 350 gpm through the vessel. Influent VOC concentrations existing in the groundwater and the maximum effluent concentration allowable when sampled at the effluent of the air stripping tower are listed below.

Volatile Organic Contaminant	Maximum Expected Influent VOC Concentration (ppb)	Maximum Allowable Effluent VOC Concentration (ppb)
Trichloroethene (TCE)	150	5
Tetrachloroethene (PCE)	110	5
1,1,1-Trichloroethane (1,1,1-TCA)	3000	200

1.02 RELATED WORK

A. Section 11215: Process Pumps

B. Division 16: Electrical

1.03 SUBMITTALS

A. Submit in accordance with Section 01340 and the supplemental requirements below.

1. Vessel capacity
2. Vessel diameter
3. Overall vessel height
4. Top, bottom, and shell wall thickness
5. Influent and effluent connections
6. Moisture eliminator details
7. Surface preparation description
   a. Painting method
   b. Number of coats and dry film thickness
8. Water redistributor details
9. Packing support tray details
10. Air seal details
11. Control system details, wiring diagrams, and electrical requirements
12. Packing type, size, and pressure drop at design point

13. Blower information including manufacturer, performance characteristics, and electrical requirements
14. A list of air stripping towers of similar type and size currently in operation with customer contacts.
15. Evidence of technical capability to design, install, and check out the complete system.

1.04 WARRANTY

Material and workmanship of all mechanical equipment described in this section shall be warranted for 1-year from date of Owner issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

A. Each unit body shall be a minimum of 4-foot diameter and a minimum height of 29 feet as necessary to achieve the specified performance. If a diameter different from that specified is used, all costs associated with the new vessel size (design, building, foundation, etc.) will be the responsibility of the contractor. Materials of construction shall be carbon steel plate. Under no circumstances shall vessel plate thickness be less than 3/16 inch.

B. The body, top, and bottom plates shall be appropriately reinforced with structural steel members. Each vessel shall be continuously fillet or butt welded throughout on both the interior and exterior of the unit. All welds shall be of the same size as the thickness of the plate specified. Each vessel shall be tested at the factory to ensure all welds are water tight. Gusset type anchor legs shall be provided for anchorage of each tower to the concrete base provided by the installing contractor. Lifting lugs shall be provided to enable unloading of the tower when delivered and lifting of the vessels during installation.

C. Each vessel side shell shall be equipped with a minimum of two 24-inch manways to be used for media loading, unloading and periodic inspection purposes. The manways are to be gasketed to prevent leakage. Manways are to be attached to the vessel with all stainless steel mounting hardware.

D. The influent connection to the tower is to be a 6-inch flanged pipe size. The effluent connection from the tower shall be 8-inch flanged end pipe size. Threaded and plugged connections shall be provided at three locations within reach of the ladder assembly to permit sampling of the towers at various depths of the packing. A sampling probe shall be provided by the tower manufacturer which penetrates the tower and collects water on 12-inch centers across the centerline of the vessel. The sampling probe shall be removable and fitted with a test cock at one end.

E. Each vessel shall be equipped with necessary structural supports for the packing support trays. The structural supports shall be of structural steel and of adequate design to support the media support tray, the wetted media, and solids which may accumulate on the media over time.

2.02 INFLUENT WATER DISTRIBUTOR

The raw water shall enter the air stripping tower chamber and be distributed through the influent water distributor to accomplish the mass transfer of water volume to droplet size. The distributor header shall be of corrosion resistant Schedule 80 PVC pipe, with cone pattern, self cleaning orifice reactors, attached to the header by means of Schedule 80 PVC pipe laterals and fittings.

2.03 AIR STRIPPING TOWER MEDIA

A sufficient amount of tower packing media (minimum 20 feet) shall be provided to achieve the effluent VOC concentrations specified. The surface area of the media shall no be less than 45 square feet/cubic feet. The media shall be capable of being dilute acid washed periodically to permit solids removal without adverse effects to the media.

2.04 MEDIA SUPPORT TRAY

Media support tray(s) shall be provided to support the air stripping tower media. Additional support trays shall be supplied if the tower packing height is 26 feet. The design of the media support tray shall be adequate to support the wetted media and the anticipated solids encrustation which may be encountered prior to media removal and cleaning.

2.05 AIR STRIPPING TOWER SUMP

A. The vessel will have a sump (tank) as an integral part of its assembly. The sump shall have a diameter equal to that of the packing section of the vessel and a height of at least four (4) feet. The sump shall be equipped with following features at a minimum:

1. 16" inspection manway
2. 2" drain coupling
3. Level sensor(s) access
4. 2" overflow
5. 8" outlet
6. Level gage:
   a. Straight tubular glass type
   b. Length- 6" from top to 6" from bottom of sump
   c. Integral bonnet
   d. Stuffing box gage connection
   e. [redacted] check shutoff

f. Integral drain cock
g. Guard rods
h. Minimum pressure rating- 500 psi

2.06 BLOWER

Each air stripping tower shall be equipped with one forced draft pressure blower assembly. The blower shall be rated to produce 1400 cfm at pressure drop of air stripper during normal operation. The fan shall be belt driven and arranged such that air is discharged horizontally or vertically. The blower assembly shall be equipped with a weatherproof enclosure. The supporting platform and blower pedestal for aligning the blower to the tower air inlet apron shall be provided by the contractor.

Guards shall be provided to protect all moving parts from general traffic conditions. All equipment, guards, and protective devices shall meet or exceed OSHA safety regulations. The fan shall be equipped with a flexible connection and transition duct for connecting the blowers to the tower. The blowers shall be equipped with a permanent oil-wetted, flange mounted filter. The blowers shall be equipped with silencers of heavy welded steel construction filled with high density acoustical absorption material.

The blower motor electrical characteristics shall be a minimum of 1.0 HP, 230/460 volts, 3 phase, 60 Hz service. Motor and fan bearings shall be rated for 100,000 hours severe duty (B-10) and shall be either grease or oil lubricated.

2.07 ACCESS LADDER

The air stripping tower shall be equipped with an access ladder, cage and platform assembly. The access ladder, cage and platform shall comply with OSHA requirements. The platform assembly shall be equipped with 3/16-inch thick steel deck plate, 4-inch kick plate, and 1 1/2-inch Schedule 40 steel pipe two row handrail. Additional platforms shall be provided as needed if more than one media support tray is required.

2.08 MOISTURE ELIMINATOR

A moisture eliminator assembly shall be provided to effectively eliminate 99 percent of all droplets greater than 40 microns in diameter. The moisture eliminator shall be mounted in a structural framework, mounted to the plenum located directly above the inlet water distribution assembly.

2.09 TOWER EXHAUST ASSEMBLY

The air stripping tower shall be equipped with an air exhaust housing that provides for exhausting of air from the tower.

2.10 CONTROLS

1. Control Panel

NEMA 4 enclosure suitable for wall mounting. Pilot lights, controls and nameplates shall be mounted on deadfront panel. Audible alarm to be mounted on panel exterior.

a. Control panel shall include a deadfront interior panel with all operating controls mounted on panel.
b. Hinged outer door with padlocking provisions.
c. Provide engraved legend plates for all devices mounted in door of control panel.

2. Contents

a. HAND/ON/OFF/AUTOMATIC selector switches for each pump (effluent, air stripper feed, and extraction well pump).
b. Running time meters, 6-digit, with last digit indicating tenths of an hour for each pump.
c. Control voltage: 120VAC.
d. Heater, thermostat, and appurtenances.
e. Terminal board.
f. Alarm circuits:
   1) Relay contacts close for alarm conditions.
   2) Signals by contact closure for remote audible alarm.
g. Pilot lighting:
   1) Visual indication by means of pilot lights of the following conditions as required:
      a) Each pump running.
      b) Each alarm condition.
      c) High level alarm.
   2) 120VAC lamps with push to test features.
   3) Fault conditions indicated by red lens on pilot light.
   4) Operating conditions indicated by green lens on pilot light.
   5) Each pilot light operated by relay contact.
   6) Provide contact at high level alarm conditions to sound alarm in control panel.
h. Audible alarm:
   1) Audible indication of fault condition. Audible alarm equipped with silencing switch which silences alarm but keeps fault indicating pilot light illuminated until fault is corrected. Subsequent faults cause audible alarm to resound.
i. Alarm conditions:
   1) Surge Tank - high level
   2) Surge Tank - low level
   3) Leak Detection Alarm

4) Floor Sump - high level

j. Lightening protection.

B. Level Sensors

1. Floats: Mercury switch in chemical-resistant, polypropylene casing, complete with 3 conductor waterproof cables.
2. One float for each function as described in 2.01 (C) of this Section.
3. The exact levels at which the sensors operate are as follows:

Tank Type	Level	Setting Height (From Tank Bottom)
Surge	1	2 ft.
	2	8 ft.
	3	16 ft.
Air Stripper Sump	1	1 ft.
	2	2 ft.
	3	3.5 ft.

Table 1
Equipment Control Plan

RISING SURGE TANK LEVEL		EQUIPMENT TURNED ON	EQUIPMENT TURNED OFF
LEVEL 1		Well pump Blower	–
LEVEL 2		Air Stripper Feed Pump	–
LEVEL 3		–	Well Pump
	RISING AIR STRIPPER SUMP LEVEL		
	LEVEL 1	–	–
	LEVEL 2	Effluent Pump	–
	LEVEL 3	–	Air Stripper Feed Pump
FALLING SURGE TANK LEVEL			
LEVEL 3		–	–
LEVEL 2		Well Pump	–
LEVEL 1			Air Stripper Feed Pump
	FALLING AIR STRIPPER SUMP LEVEL		
	LEVEL 3	–	–
	LEVEL 2	Air Stripper Feed Pump	–
	LEVEL 1	–	Effluent Pump

C. Function/Operation

1. Level sensors (floats) in the surge tank and air stripper sump control the respective pumps according to Table 1.
2. Control panel shall visually indicate pump-on-line and visually and audibly indicate high water level and low water level conditions.
3. Provide adjustable time delay (0-5 minutes) for all pumps.

D. Acceptable Manufacturers

1. Flygt
2. Healy
3. Or Equal

2.11 PRESSURE CONTROL SYSTEM

A. Differential Pressure Gauge

1. Differential pressure switch shall incorporate gages and switch set point indicators for continuous indication of applied pressure and switch settings. Unit shall be diaphragm operated with switching accomplished by phototransistor controlled internal relays. Set point shall be controlled by knobs on front of unit.
2. Switch/gages shall operate within a range of 0-15 inches of water and read in 0.5" divisions.

B. Function/Operation

1. Differential pressure gauge shall be located on the blower exhaust pipeline between the air stripper tower and the blower.
2. At the high pressure set point the blower shall turn off.

C. Acceptable Manufacturers

1. Dwyer
2. Or Equal

2.12 WATER FLOW METER

A. Water meter shall be 4" Turbo Meters with 125 pound flanged end connections. Pressure at 400 gallons per minute shall not exceed 2.0 psi. Flow meter shall be compatible with water from ground water extraction well. Register shall read in 1000 gallons. Accuracy over the range of the meter (25-1000 gpm) shall be $\pm 1.5\%$. Meter shall be equipped with local mechanical readout and remote readout.

B. Acceptable manufacturers

1. Badger Meters, Inc.
2. Kent Meters, Inc.
3. Or Equal

2.13 PAINTING

Surface preparation:

Interior - sandblast to a near white blast cleaning (SSPC-SP10).
Exterior - sandblast to commercial blast cleaning (SSPC-SP6).

Coating:

Interior - coated with Tnemec #20-1255 Pota-Pox primer to a dry mil thickness of 3.0 mils before any rust can form. Followed by 2 coats of Tnemec #20-2000 Pota-Pox finish to a dry mil thickness of 3 to 4 mils per coat.

Exterior - coated with Tnemec #66-1211 epoxoline primer to a dry mil thickness of 3.0 mils before any rust can form. Exterior finish painting is by others.

Finish field paint must be compatible with manufacturer's primer paint. Finish field paint must be applied before rust forms beneath the primer coat and in any event no more than 60 days after the primer coat has been applied.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Inspect equipment as received. Note all shipping damage immediately in writing and notify engineer.

3.02 INSTALLATION

A. All equipment shall be installed in strict compliance with the equipment manufacturer's written instructions. All anchor bolts and other items shall be located according to certified prints furnished by the manufacturer, as approved by the Engineer.

B. Field erection requirements shall include, but not be limited to, the following:

1. Set equipment on foundation, level, and anchor.
2. Grout beneath equipment skid.
3. Assemble piping and other components disconnected for shipping.
4. Thoroughly clean the system including flushing of all debris, grease, and deleterious material from piping and vessels.

C. The air stripping tower manufacturer shall provide the services of a factory trained representative to instruct plant personnel in the proper operation and maintenance procedures necessary to maintain maximum equipment efficiency. Start-up services shall be provided for a minimum of one 8-hour day at such time that the system is ready for on-line service, not including travel time to and from the site.

D. Prior to system startup but no more than 30 days from completion of construction, tests shall be conducted to determine compliance of the air stripping equipment to the specified limits.

The system will be started and samples of the water shall be collected at the influent and effluent of the air stripping tower, at not less than 30-minute intervals, over a 2-hour period of time. During the 2-hour test period and until analytical confirmation of satisfactory performance, the contractor shall provide storage containers on site to hold the effluent water. Five sampling intervals are required. Sample collection shall be witnessed by a representative of the Owner or the Engineer. The samples shall be delivered to an independent test laboratory approved by the Engineer and analyzed for each chemical specified to be removed. The samples, once collected, shall be transported to the laboratory by a representative of the Owner.

The cost to analyze the initial samples shall be borne by the Owner.

If the equipment fails to meet the minimum removal requirements specified, the equipment shall be modified and additional sampling performed at the contractor's expense, until compliance with the specifications is obtained.

3.03 MEASUREMENTS AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11021

SUBMERSIBLE WELL PUMP

PART I GENERAL

1.01 DESCRIPTION

Furnish and install the well pump, drives, well level controls, and related accessories required for this project. The pump and motor shall be designed for continuous submerged operation. The pump shall be driven by a motor attached below the pump section.

1.02 SUBMITTALS

Submittals shall be made in accordance with Sections 01300 and 01340.

1.03 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of Owner issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pumps

1. There shall be a built-in integral check valve made of 300 Series stainless steel. The check valve seat shall be Teflon with a 300 Series stainless steel insert.
2. The pump bowls, impellers, guide vanes and filter screen shall be 300 Series stainless steel.
3. Each impeller shall have a Teflon seal ring around its eye or skirt to reduce hydraulic losses.
4. There shall be a Teflon shaft bearing located either above or below each impeller.
5. A 300 Series stainless steel filter screen shall be included as part of the suction inlet assembly.
6. A 300 Series stainless steel priming inducer shall be included to provide lubricating flow and to prime the pump should the fluid pumping level fall below the first impeller.
7. The stainless steel nameplate shall be affixed to the pump. The pump model shall be stamped into the nameplate. No inks or dyes shall be used.

B. Motors

1. The motor shall be a squirrel-cage induction motor designed for submersible operation in conformance with NEMA standards.
2. All materials in contact with the pumped fluids shall be 300 Series stainless steel or Viton.
3. The motor shall not use any oils or greases for lubrication of bearings.
4. A flexible Viton diaphragm shall be provided to permit expansion and contraction of the internal motor lubricating and cooling fluid.
5. The motor shaft seal shall be constructed of Viton.
6. A sand slinger made of Viton shall be included.

C. Well Level Control

1. A level control system in each well to prevent pump from running dry.
2. Two level probes and a ground connection in each well and a level relay located in main control panel.
3. Use dedicated conduit for level control wires.
4. Acceptable manufacturers include Magnetek, B/W Controls, Clawson, MI, Model No. 5200-HF2 or approved equal.
5. Provide connection to plant status system described in Section 13610.

D. Cables

1. The cable shall be continuous with no splices.
2. The connector boot shall be constructed of Viton. The connector shall be constructed of 300 Series stainless steel. The motor wire shall be AWG12 with Teflon insulation.

E. Suction Strainers

1. The pump shall have a suction strainer to restrict gravel and other debris from entering the pump.

F. Operations and Maintenance Manual

1. Provide manufacturer's operation and maintenance manual as specified in Section 01730.

2.02 PUMP SCHEDULE

A. Pump for Use in 8-Inch Well

1. Discharge pipe size (NPT): 4 inches
2. Motor type: Submersible
3. Flow range: 230 to 500 GPM
4. Average operating conditions: 250 gpm at 50 feet of head

5. Nominal speed: 3450 RPM
6. Minimum motor rating: 15 horsepower
7. Power: 480 volts, 3 phase

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which work of the Section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Inspect equipment as received. Note all shipping damage immediately in writing and notify engineer.

3.02 INSTALLATION

All equipment shall be installed in strict compliance with the equipment manufacturer's written instructions. All items shall be located according to certified prints furnished by the manufacturer, as approved by the Owner.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11024

FIBERGLASS TANKS

PART I GENERAL

1.01 DESCRIPTION

A. Furnish and install a 5,500 gallon, vertical storage tank in accordance with the specifications and contract drawings.

1.02 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D 638: Test for Tensile Properties of Plastics.

2. ASTM D 790: Test for Flexural Properties of Plastics and Electrical Insulating Materials.

3. ASTM D 3299: Standard Specification for Filament Wound Glass-Fiber-Reinforced Polyester Chemical-Resistant Tanks.

4. ASTM E 84: Surface Burning Characteristics of Building Materials.

B. National Bureau of Standards (NBS), Voluntary Product Standards (VPS)

1. PS15: Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Sections 01300 and 01340.

1.04 WARRANTY

A. Material and workmanship of equipment described in this section shall be warranted for 1-year from date of Owner issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 GENERAL

A. All tanks shall be centrifugally cast, flat bottom.

B. All tank nozzles shall be hand molded and have 150# flat face flanges unless noted otherwise.

2.02 DESIGN CRITERIA

A. The tank body shall be fiberglass reinforced plastic (FRP).

B. All tanks will operate at atmospheric pressure and ambient temperature.

C. Inlet and outlet connections shall conform to the sizes and locations specified in the plans.

D. Tanks, supports and anchorage shall be designed for all anticipated dead and live loading.

2.03 SHOP TESTING

A. Test samples shall be full thickness of the item produced. Do not machine sample surfaces.

B. Test surface hardness of the resin-rich surface.

C. Test flexural strength with the resin-rich surface in compression.

D. Mechanical properties shall conform to the following standards for the respective tests.

1. Ultimate Tensile Strength: ASTM D 638
2. Flexural Strength: ASTM D 790
3. Flexural Modules of Elasticity: ASTM D 790

E. Perform fully hydrostatic test in shop for four (4) hours with no visible leakage. Provide certified reports of test results to the Engineer.

2.04 MATERIALS

A. Outer gel coat: 20 mil "C" Glass, resin rich surface.

B. Interior coat: 100 mil corrosion barrier.

C. Flame spread rating: maximum, 35 in accord with ASTM E 84 for materials and assembled tanks.

D. All other materials: manufacturer's standard fiber reinforced plastic.

2.05 ACCESSORIES

A. Provide a PVC sight tube assembly along the side of the tank to be used as a visual level gauge. Tube shall be a one (1) inch diameter and extend the entire height of the tank. The tube shall be marked in standard increments with every foot being labeled on the tank.

B. Provide fiberglass ladder from the upperlevel to top of tank.

2.06 FABRICATION

A. Make laminations without voids, dry spots, cracks, or crazes.

B. Do not allow glass fibers to remain exposed in finished surface.

C. Reinforce tank with steel shapes totally encapsulated with a minimum of 1/8 inch thick glass mat and resin.

D. Provide tank appurtenances including outlets, inlets, manways and other items as shown on the plans.

E. For removable or cover plates which weight in excess of 30 lbs, provide lifting handles totally encapsulated with glass mat and resin.

F. Remove mold and release agents prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Inspect equipment as received. Note all shipping damage immediately in writing and notify engineer.

3.02 INSTALLATION

A. The potable water tank shall be installed in strict compliance with the equipment manufacturer's written instructions. All anchor bolts and other

items shall be located according to certified prints furnished by the manufacturer, as approved by the Owner.

B. Field requirements shall include, but not be limited to, the following:

1. Set equipment level, and anchor.
2. Assemble components disconnected for shipping.
3. Thoroughly clean the system of all debris, grease, and deleterious material from piping and tanks.

C. Perform hydrostatic test on all tanks after installation and prior to connection of piping.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11120

LEAK DETECTION & LOCATION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

Furnish a complete leak detection and location system consisting of a monitoring unit, sensor cable, probes, system layout map and auxiliary equipment required to provide continuous monitoring of the sensing string(s) for leaks, faults and breaks. If any of these conditions should occur at any point along the cable, an alarm shall sound, type of condition shall be clearly identified and the location clearly displayed. The system shall be designed to monitor the interstitial space of the double contained piping and shall detect all liquids which may be present using a sensor cable for the pipe.

1.02 RELATED WORK

A. Division 16 of these specifications

B. Section 15001: General Requirements for Piping Systems

1.03 SUBMITTALS

A. Submittal shall be made in accordance with the requirements of Sections 01300 and 1340.

1.04 REGULATORY REQUIREMENTS

A. National Electrical Code, NEC (Latest Edition)

1. Comply with the applicable portions of NEC.

B. National Electrical Manufacturers Association, NEMA

1. Comply with the applicable portions of NEMA.

C. Underwriter's Laboratories, UL

1. Products tested and labeled by UL.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Products shall be handled in accordance with the requirements of Section 01620.

1.06 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of Owner issuance of certification of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 MONITORING UNIT

A. The monitoring unit shall be microprocessor based and capable of monitoring up to 5000 feet of sensing string per cable card, including sensor cable, probes and jumper cable. The monitoring unit shall indicate when any liquid comes in contact with the sensor cable by sounding an alarm, actuating the output relays, displaying a message that a leak has been detected and the location of that leak on the sensing string.

B. The monitoring unit shall have a green LED on the front panel to indicate that power is available to the unit. A two (2) line by forty (40) character LCD shall be visible from the front of the unit to provide system data.

C. The monitoring unit power requirements shall be 120/240 VAC, 100 VA, 50/60 Hz, single phase. Monitoring units shall be equipped with a RS232 communication port, one common alarm relay and one (1) relay per cable card. Relays to be SPDT output, rated for 240 VAC, 10 amp.

D. The monitoring unit shall be enclosed in a modified NEMA 12 enclosure. The unit shall be U.L. listed and FM approved to provide connections for intrinsically safe sensor circuits for the use in Class I, Division, I, Groups C and D hazardous locations. The system shall be tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules and so labeled.

The system shall be evaluated by an independent third party, according to the Third Party Procedures developed according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Liquid-Phase Out-of-Tank Product Detectors." The evaluation results shall verify the system manufacturer's claims regarding sensitivity, range and other performance data.

Ability to locate a leak shall not depend on battery backed up functions. In the event of power failure, system conditions and parameters shall be stored in nonvolatile memory allowing the unit to automatically resume monitoring, without resetting, upon restoration of power.

2.02 SENSOR CABLE

The sensor cables shall be suitable for use with the monitoring unit. The sensor cables shall be of coaxial construction consisting of an insulated copper center conductor, a suitable spacer material, an outer braid and special requirements which are cable specific.

AGW Detect water-based liquids and shall be capable of being flushed and dried in-place and will not require replacement after a leak event of any water-based liquid.

All cables must be capable of field installation of connectors by trained electricians. The sensor cable shall be available in lengths up to 1500 feet in bulk spools. All cables must be field repairable by trained electricians.

2.03 PERFORMANCE

A. LEAK DETECTION/LOCATION

The Leak Detection/Location System shall identify the presence of a liquid at any point along its sensing string and indicate its location within +/- 1% of the distance from the last calibration point or +/- five (5) feet, whichever is greater on the sensor cable and shall indicate a probe leak by the probe number. The system shall operate on the principle of pulsed energy reflection and be capable of mapping the entire length of the sensor cable and storing the digitized system map in nonvolatile memory. An analog system, using an alarm threshold value, fixed for the length of the cable, or a portion of the cable, will not be allowed, as it will not detect a second leak smaller than any acknowledged leak.

B. SENSING STRING LENGTH

The system shall be capable of monitoring up to 5000 feet of cable and probes from a single monitoring unit.

C. MULTIPLE LEAKS

After proper acknowledgement of a minor leak, the Leak Detection/Location System shall be capable of monitoring the entire sensing string for additional leaks, even if they are smaller than the leaks previously acknowledged. The system shall be capable of accounting for minor installation irregularities, static moisture and puddles (such as condensation) with no loss in accuracy or sensitivity.

D. BREAKS AND SHORTS

The system shall be capable of identifying the location of breaks and shorts on the cable. When either of these faults occur, an alarm shall sound and a

display visible from the front of the monitoring unit shall clearly indicate the type of fault, in plain English, i.e. BREAK or SHORT and display the exact location of the fault.

E. REMOTE ANNUNCIATION

The system shall provide relays for remote indication of an alarm condition. The relays shall provide indication that no alarm conditions exists; an alarm condition exists but not yet acknowledged; and an alarm condition exists and has been acknowledged.

F. ARCHIVES

The system shall record significant events (leak, break, fault, probe actuation, password entry, etc.) in nonvolatile memory. A minimum of 900 events shall be stored. When the memory becomes full, the recorded events shall be over written on a FIFO basis. Each recorded event shall include the time and date that the event occurred.

G. SYSTEM STATUS

The system shall continuously provide positive indication that it is monitoring the sensing string and the status of the sensing string.

H. SYSTEM CLOCK

The system clock shall provide the time and date display on the monitoring panel. The system clock shall be programmable by the user. A time and date indication shall be included for all events recorded in memory.

I. SECURITY

The system shall provide a password security scheme to limit unauthorized use. The passwords shall be assignable and provide for varying levels of system access. A minimum of 20 passwords shall be available within the system. All password entries will be recorded to the archives.

The system shall not permit unauthorized modifications to the sensing string (ie. shortening the cable length) without causing an alarm condition.

J. SENSOR TYPES

The system shall be capable of monitoring sensor cables, probe sensors and switch sensors (such as float switches, pressure switches, etc.) from the same Monitoring Panel. English language displays shall indicate the status of the sensors.

K. SENSITIVITY

The system shall not detect incidental liquid contact that is not at least equivalent to a small puddle, 3 inches in diameter. The sensitivity of the system shall be field adjustable to increase the amount of wetted cable needed to cause an alarm. The cable sensing principle shall provide for continuous monitoring while a short length of the cable is in contact with liquids, without altering the system's sensitivity and/or accuracy.

PART 3 EXECUTION

3.01 GENERAL

The system shall be installed per the manufacturer's recommended installation procedures. All local, state and federal codes and requirements shall be followed. The system shall be installed by properly trained personnel.

3.02 MAPS

A location map shall be provided with the system by the installing contractor indicating the "As Installed" system configuration and sensing string layout. Footage, along with the cable shall be provided as references to locate leaks. Footage shall be based upon Reference Points taken per Section 3.03.

3.03 REFERENCE POINTS

The installing contractor shall be responsible for taking and recording reference points along the sensing string per the manufacturer's recommended procedures.

3.04 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11215

PROCESS PUMPS

PART 1 PRODUCTS

1.01 WORK INCLUDED

A. Pumps

B. Motors

1.02 RELATED WORK

A. Section 07920: Sealants and Caulking.

B. Division 15: Pipings and valves.

C. Division 16: Field electrical work.

1.03 QUALITY ASSURANCE

A. Have pump manufacturer factory test the pumps to detect any defects and demonstrate that they will function satisfactorily under all conditions specified in the Pump Schedule. Conduct pump testing in accordance with the Standards of the Hydraulic Institute.

1.04 SUBMITTALS

A. Shop Drawings and Product Data

1. Comply with Section 01340 and the supplemental requirements below.
2. Submit the following information.
   a. Catalog bulletins describing pump construction. Mark out inapplicable information.
   b. Dimensional sketches of pumping unit including motor.
   c. List of materials used for construction of pump if not included in catalog bulletin.
   d. Weight of total pumping unit and weights of pump assembly and motor separately.
   e. Pump performance data as specified below.
   f. Motor data.
   g. Installation instructions.
3. Include the following items with the pump performance data.
   a. Head-capacity curve
   b. Efficiency curve
   c. NPSH curve

d. BHP curve
e. Shut off head
f. RPM

4. Mark the specified ratings on the pump performance curves.

B. Operation and Maintenance Data

1. Comply with the general requirements of Section 01730 and supplemental requirements below.
2. Submit complete instruction for operation and maintenance of pumps, motors and power transmission components.
3. Include the following data:
   a. Alignment, adjustment and repair instructions.
   b. Guide to troubleshooting.
   c. Lubrication instructions.
   d. Seal adjustment and replacement instructions.
   e. Recommend spare parts lists and predicted lift of parts subject to wear.

1.05 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 01620.

1.06 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 MANUFACTURER REQUIREMENTS

A. Acceptable manufacturers include Weil, Aurora, Fairbanks Morse or approved equal.

B. Comply with the requirements of Section 01630 when making substitution.

2.02 PUMPS

A. Type: Frame-mounted end suction centrifugal.

B. Performance Requirements:

1. Capable of pumping contaminated groundwater.

2. Capable of meeting the detailed performance requirements specified in the pump schedule at the end of this Section.
3. Continually decreasing head-capacity curve between shut-off and maximum capacity.
4. Capable of operating continuously at all points on the head-capacity curve between minimum and maximum capacity without vibration, noise, cavitation and overheating.

C. Materials of Construction

1. Casing: Cast iron
2. Impeller: Bronze
3. Wear Ring: Bronze
4. Shaft Sleeve: Bronze or Stainless Steel
5. Mechanical Seal - Double
6. Back Pull-out to permit removal of motor, seal and impeller without disturbing pipe connections.

2.03 MOTORS

A. Comply with the general requirements of Section 16151 and the supplemental requirements below.

B. Furnish totally enclosed fan cooled motors for pump service.

C. Motors ratings to be equal to or greater than maximum pump brake horsepower requirements at all points on the head capacity curve without taking advantage of the service factor.

2.04 FLEXIBLE CONNECTORS

A. Between equipment and piping 2-1/2 inches and larger: Plate steel flanged end fittings, 150 lb. drilled for bolting to piping flanges.

B. Use connectors suitable for minimum 125 psi WSP and 450° F. and 200 psi WOG and 250° F.

C. Construct spool pieces to exact sizes for insertion of flexible connection.

D. Manufacturers:

1. Anaconda Metal Hose.
2. Flexonics Division.
3. Keflex, Inc.
4. Mason Industries.
5. Metraflex Co.
6. Or equal.

2.05 FACTORY ASSEMBLY

A. Completely assemble each pumping unit at the factory.

2.06 SPARE PARTS

A. Furnish one spare mechanical seal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pumping units in accordance with the PLANS, approved shop drawings and the manufacturer's installation instructions.

B. Align, adjust and lubricate in accordance with the manufacturer's instructions and leave in proper working condition.

C. Touch up factory finish using kit furnished by manufacturer.

3.02 FIELD QUALITY CONTROL

A. Required Manufacturer Services

The services of a qualified representative of the manufacturer of the pump shall be provided to review the installation and field testing of the equipment, make any necessary adjustments and instruct and plant personnel in its operation and maintenance.

B. Field Testing

1. Demonstrate to the Owner's representative that each pumping unit will pump plant water satisfactorily.

C. Provide all test gear required at no extra cost to the Owner.

D. Follow testing procedures recommended by the manufacturer and approved by Engineer.

3.03 PUMP SCHEDULE

A. Air Stripper Feed Pump

1. Numbers of Units: 1
2. Rated Capacity Per Unit: 350 gpm
3. Total Dynamic Head: 100 ft.
4. NPSHR: 8 ft.

5. Minimum Efficiency: 70
6. Nominal Speed: 1750 RPM
7. Minimum Motor Rating: 15 HP
8. Power = 480V, 3 Phase

B. Effluent Pump

1. Numbers of Units: 1
2. Rated Capacity Per Unit: 350 gpm
3. Total Dynamic Head: 40 ft.
4. NPSHR: 8 ft.
5. Minimum Efficiency: 85
6. Nominal Speed: 1750 RPM
7. Minimum Motor Rating: 5HP
8. Power = 480V, 3 Phase

3.04 MEASUREMENT AND PAYMENT

A. No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11331

CARTRIDGE FILTERS

PART 1 GENERAL

1.01 DESCRIPTION

Supply a small pilot system to properly size the cartridge filters. Furnish and install 2 cartridge filter systems in accordance with the specifications and the contract drawings. The specifications for the cartridge filters will be finalized after the pilot study.

1.02 SUBMITTALS

Submittals shall be made in accordance with Sections 01300 and 01340.

1.03 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of Owner issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

A. Filter housing shall meet the following requirements:

1. Material of Construction

   304 stainless steel. The construction must have a ASME UM stamp.

2. Maximum Operating Pressure

   250 psig at 200 °F

3. Corrections

Inlet/Outlet :	4" flange
Drain:	1.5" NPT
Vent:	1" NPT
Gauge:	1/4" NPT

4. Shell O-Ring

   Buna N

5. Internals

Carbon steel or 316 stainless steel compression plat assemblies and tube guides

6. Size

The filter housing should be capable of housing cartridge filters required for handling 600 gpm of flow.

B. The cartridge filters shall meet the following performance requirements:

1. Flow Rate

Maximum flow of 600 gpm at a maximum headloss of 5 psi under normal operating conditions of extracted groundwater. This will allow for fewer filter changes since the design rate for the treatment system is 350 gpm.

2. Size

The length, diameter and micron size of the filters will be determined during the pilot study. The pilot study will be performed with 10 micron size filters. The cartridge filters must also be available in following sizes of 1, 2, 5, 10, 15, 20, 25, 30, 40, 50, 75, 100, 150 or 200 microns.

3. Material

The material of cartridge filter and center core must be compatible with water containing halogenated organics at ppm levels, and must not be a possible source of fiber migration. A core cover must be provided.

4. Maintenance

The filter cartridges must be washable. The manufacturer must provide the cleaning procedure. In addition, the replacement cartridges must be easily available and easy to replace.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely

completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Inspect equipment as received. Note all shipping damage immediately in writing and notify engineer.

3.02 INSTALLATION

A. All equipment shall be installed in strict compliance with the equipment manufacturer's written instructions. All anchor bolts and other items shall be located according to certified prints furnished by the manufacturer, as approved by the Engineer.

B. Field erection requirements shall include, but not be limited to, the following:

1. Set equipment on foundation, level, and anchor.
2. Assemble piping and other components disconnected for shipping.
3. Thoroughly clean the system including flushing of all debris, grease, and deleterious material from piping and vessels.

C. The filter system manufacturer shall provide the services of a factory trained representative to instruct plant personnel in the proper operation and maintenance procedures necessary to maintain maximum equipment efficiency. Start-up services shall be provided at such time that the system is ready for on-line service.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11332

SEPARATOR SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

Furnish and install a solids separator system in accordance with the specifications and the contract drawings.

1.02 SUBMITTALS

Submittals shall be made in accordance with Sections 01300 and 01340.

1.03 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of Owner issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

The separator shall meet the following requirements:

A. Flow Rate

The separator must be capable of handling a flow range of 250-350 pgm at a maximum headloss of 15 psi under normal operating conditions.

B. Maximum Operating Pressure

150 psig at 140°F.

C. Removal Efficiency

Solids removal up to 98%.

D. Connections

Pipe Size:	3" FNPT or 4" flange
Drain Size:	2"

E. Solids Removal

The separator must have a timer that activates the blowdown of the separator. The timing of the blowdown must be adjustable, as desired. An air operated solenoid must be provided for the blowdown. The manufacturer or vendor of the separator must also provide a bag filter system to remove the solids from the blowdown. The bag filters must be easily available and easy to replace.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Inspect equipment as received. Note all shipping damage immediately in writing and notify engineer.

3.02 INSTALLATION

A. All equipment shall be installed in strict compliance with the equipment manufacturer's written instructions. All anchor bolts and other items shall be located according to certified prints furnished by the manufacturer, as approved by the Engineer.

B. Field erection requirements shall include, but not be limited to, the following:

1. Erect equipment on the wall and floor, as required.
2. Assemble piping and other components disconnected for shipping.
3. Thoroughly clean the system including flushing of all debris, grease, and deleterious material from piping and vessels.

C. The separator manufacturer shall provide the services of a factory trained representative to instruct plant personnel in the proper operation and maintenance procedures necessary to maintain maximum equipment efficiency. Start-up services shall be provided at such time that the system is ready for on-line service.

D. Prior to system startup but no more than 30 days from completion of construction, tests shall be conducted to determine compliance of the separator system to the specified limits.

Samples of the water shall be collected at the influent and effluent of the separator during the same period of time that the cartridge filter is sampled.

Sample collection shall be witnessed by a representative of the owner or the engineer. The samples will be used to determine separator efficiency.

If the equipment fails to meet the minimum removal requirements specified, the equipment shall be modified, influent and effluent samples analyzed at the contractor's expense, until compliance with the specifications is obtained.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 11370

AIR COMPRESSOR

PART 1 GENERAL

1.01 WORK INCLUDED:

A. Compressor Unit
B. Air receiver
C. Pressure reducing valve
D. Controls

1.02 RELATED WORK

A. Section 15050: Basis Mechanical and Methods
B. Division 16: Electrical

1.03 SUBMITTALS

A. Shop Drawings and Product Data

1. Submit the following items for review in accordance with Sections 01300 and 01340.

a. Equipment layout and erection details; include mounting details and wiring diagrams.

b. Setting diagrams for positioning equipment.

2. Provide manufacturer's standard data sheets showing equipment.

B. Operation and maintenance data in accordance with the requirements of Section 01700.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver air compressors with factory-installed shipping skids with plastic end-cap protectors on each end of pipe and tube.

B. Package accessories in factory-fabricated containers.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide reciprocating compressor unit consisting of an air-cooled compressor air receiver, pressure reducing station, and operating controls.

B. Capacity: 50 scfm at 70 psig; unit capable of producing specified SCFM at following conditions:

1. Inlet air temperature: 110°F.
2. Elevation (mean sea level): 700 feet.

C. Compressor operates at specified air volume without oil creep, overloading, and within 10% of peak efficiency.

2.02 CONSTRUCTION

A. Cast-iron housing and head, disc type suction and discharge valves.

B. Statically and dynamically balanced rotating parts.

C. Removable connecting rod caps to facilitate piston ring replacement.

D. Mount motor and compressor on one-piece ribbed cast iron or welded steel base for mounting on air receiver.

D. Replaceable media style oil filter element.

E. Positive pressure lubrication through crankshaft with connecting rods to piston wrist pin.

2.03 AIR RECEIVER

A. Receiver built to ASME regulations for working pressure of 200 psi.

B. Screw inlet and outlet connections.

C. Fittings include adjustable pressure regulator, safety valve, pressure gauge, drawcock, and automatic condensate trap.

D. Tank finish: shop prime and factory finish coat.

2.04 PRESSURE REDUCING VALVE

A. Pressure reducing station complete with automatic reducing valve and bypass, and low pressure side relief valve and gauge.

B. Valve capacity suitable to reduce pressure from 100 psi to 5 psi; pressure reducing valve adjustable upwards from reduced pressure.

2.05 CONTROLS

A. Pressure switch cuts out at 100 psi with minimum differential of 20 psi.

PART 3 EXECUTION

3.01 Installation.

A. Install line size gate valve and anti-return valve on compressor discharge.

B. Install replaceable cartridge type filter silencer of adequate capacity for the compressor.

C. Assemble components and piping disconnected for shipping.

3.02 FIELD QUALITY CONTROL

A. Compressed air piping leak test

1. Prior to initial operation, clean and test compressed air piping in accordance with American National Standards Institute (ANSI) B31.1: Power Piping.

2. Provide services of factory representative to inspect installation of air compressor and make field adjustments to ensure proper mechanical operation. Submit letter from manufacturer's representative that equipment has been properly installed and is operating properly.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract Lump Sum Price.

SECTION 11501

SUMP PUMPS

PART 1 GENERAL

1.01 WORK INCLUDES

A. Sump pumps at locations indicated on Contract Drawings.

B. Pump controls where self-contained.

1.02 RELATED WORK

A. Section 15100: Valves.

B. Division 16 of these specifications.

1.03 SUBMITTALS

A. Submit in accordance with Section 01340.

B. Product Data:
   1. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted.

PART 2 PRODUCTS

2.01 PUMP CHARACTERISTICS

A. Statically and dynamically balanced rotating parts.
   1. Complete servicing without breaking piping or motor connections.
   2. Pumps operate at 1750 RPM unless specified or scheduled otherwise.
   3. Pump Connections:
      a. Suction 3/4 inch - 2 inches: Threaded or Non Threaded
      b. Suction 2-1/2 inches and larger: Flanged.

2.02 SUBMERSIBLE SUMP PUMP

A. Perimeter Drainage Sump Pump

Type: Completely submersible; rated at 50 gpm at 12 ft. TDH.
1. Casing: Heavy duty, one piece cast iron.
2. Impeller: Cast-iron, non-clog, on corrosion-resistant alloy steel shaft.
3. Bearings: Ball bearings.
4. Accessories: Oil-resistant power cord with 3-prong connector.

5. Controls (Simplex): Integral diaphragm type level control, separate liquid level control high level alarm.
6. Wiring: Factory-wired.
7. Discharge Check Valve: Provide check valve of suitable design and materials on pump discharge line.

B. Secondary Containment Sump Pump

Type: Completely submersible; rated at 75 gpm at 20 ft. TDH.
1. Casing: Heavy duty, one piece cast iron.
2. Impeller: Cast-iron, non-clog, on corrosion-resistant alloy steel shaft.
3. Bearings: Ball bearings.
4. Accessories: Oil-resistant power cord with 3-prong connector.
5. Controls (Simplex): Integral diaphragm type level control, separate liquid level control high level alarm.
6. Wiring: Factory-wired.
7. Discharge Check Valve: Provide check valve of suitable design and materials on pump discharge line.

C. Manufacturers:
1. Armstrong Pumps
2. Aurora Pumps
3. Well
4. Or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Access: Provide access space around plumbing pumps for service indicated, but in no case less than that recommended by manufacturer.

B. Electrical Wiring:
1. Install electrical devices furnished by manufacturer but not specified to be factory-mounted.
2. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
3. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 Sections.
4. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of pumps, and after motors have been energized with normal power source, bleed air from pump casings and test pumps to

demonstrate compliance with specifications.

B. Where possible, field correct malfunctioning unit, then retest to demonstrate compliance.

C. Replace units which cannot be satisfactorily corrected.

D. Alignment:
   1. Inspect alignment, and realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.

E. Start-Up:
   1. Lubricate pumps before start-up.
   2. Start-up in accordance with manufacturer's instructions.
   3. Provide pump start-up in presence of manufacturer's service representative.

F. Cleaning:
   1. Clean factory-finished surfaces.
   2. Repair all marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 13600

PRE-ENGINEERED METAL BUILDING

PART I GENERAL

1.01 DESCRIPTION

A. This Section applies to work associated with supplying a one-story, free-span building to house the groundwater treatment plant.

B. The building shall include all primary and secondary structural framing members, connection bolts, covering, door, flashing, fasteners, closures, sealant tape, caulking, pedestrian door, overhead door, louvers, vents, handrail, ladder, all equipment and column foundation work, drainage requirements, and other miscellaneous items as shown or called for in the PLANS or SPECIFICATIONS.

1.02 DRAWINGS, CALCULATIONS AND CERTIFICATION

A. The building manufacturer will furnish complete erection drawings showing anchor bolt settings, sidewall, endwall, and roof framing, transverse cross-sections, covering and flashing details, and accessory installation details to clearly indicate the proper assembly of all building parts.

B. The building manufacturer shall also furnish a certificate signed by a Registered Professional Engineer (P.E.) that the building design meets the requirements of the specifications and the 1991 Uniform Building Code, and is in accordance with generally accepted engineering practices.

1.03 DESIGN REQUIREMENTS

A. GENERAL

1. Building manufacturer shall provide the Engineer with a column layout drawing, column loads and design calculations.
2. All structural steel sections and welded plate members shall be designed in accordance with the AISC, "Specifications for the Design, Fabrication, and Erection of the Structural Steel of Buildings."
3. All light gauge cold-formed, structural members and exterior covering shall be designed in accordance with the AISI, "Specification for the Design of Cold-Formed Steel Structural Members."
4. Contractor shall be responsible for providing a pre-engineering metal building based upon the loading criteria given herein and the dimensions shown on the PLANS.

B. BUILDING PARAMETERS

1. Length: 32'
2. Width: 28'
3. Eave Height: 14'

C. BUILDING LAYOUT

1. See PLANS for location of doors, louvers, etc.

D. DESIGN LOAD - BUILDING AND FOUNDATION

1. Dead Load: Weight of all structural members plus flooring and roof.
2. Superimposed Dead Load: 2 psf on roof for electrical, plumbing and HVAC loads.
3. Wind Load: Per 1991 Uniform Building Code, latest edition (but not less than 100 mph).
4. Live Load: 30 psf (minimum).

E. FIRE RATING

1. Building shall be designed for a minimum 1 hour fire rating.

F. ANCHORAGE SYSTEM

1. Necessary anchoring system shall be provided to anchor the building to a concrete foundation. Anchorage at column bases shall be mechanical expansion type or chemically secured anchor bolts. Hook bolts are not permissible.
2. Provide literature with design calculations that assures that the anchorage provided will withstand design loads at the column base (including uplift).

1.04 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of Owner issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 STRUCTURAL MEMBERS AND FASTENERS

A. All rolled shapes, plates and bars shall conform to ASTM A36.

B. All structural framing members shall be cleaned in accordance with the AISC Code of Standard Practice and given a shop coat (1.0 mils) of red-oxide

primer designed for short-term field protection during the erection process. A final paint coat is to also be applied (by others).

C. Anchor bolts and standard threaded fasteners shall have a minimum Grade 5 specification and shall be galvanized or cadmium plated.

D. High strength bolts, nuts and washers shall conform to ASTM A325.

E. Welding electrodes shall conform to AWA A5.1, E70 Series.

2.02 ROOF AND WALL PANELS

A. Roof and wall panels shall be completely prefabricated in the factory. Panels shall be 26 gauge minimum, aluminum-zinc alloy coated steel, AC 50 coating class, conforming to ASTM A 792, Grade 50 and precoated with a 1 mil thick polyester finish. Provide all flashing, trim, fasteners, and sealants as required.

B. Color of roof and wall panels to be gray or white.

2.03 INSULATION

A. The entire building (excluding doors) shall be equipped with insulation with an R-13 value.

B. Provide necessary auxiliary clips, supports or other items necessary to fasten insulation to roof and wall panels.

C. An interior insulation covering shall be back-faced with vinyl reinforced polyester film (3 mil), moisture-resistant so that no exposed insulation shall be visible from the inside of the building.

2.04 HOLLOW METAL SWING DOORS

A. Provide a hollow metal door consisting of two flush faces of 16 gauge, one-piece quality rolled sheet steel with one-piece honeycomb core bonded to both faces, top and bottom channels, 16 gauge steel. Door leaves shall be 1-3/4" thick. Door jambs shall be 16 gauge steel with mitered, welded and ground corner joints. Attach jambs with three 14 gauge wall anchors and adjustable floor clips.

B. Provide hardware in accordance with the hardware schedule in SPECIFICATION Section 08710.

2.05 HANDRAIL

A. Provide handrail as described in this section and as shown on the plans.

B. Extruded rails, post and fittings are to be aluminum alloy 6063-T6 and 214.

C. All fasteners are to be stainless steel type 18-8.

D. Railings are to be shipped with factory pre-assembled posts and fittings.

PART 3 EXECUTION

3.01 ERECTION

A. Erect framing in accordance with AISC Specifications.

B. Wall and Roofing Systems

1. Install in accordance with Manufacturers recommendations.
2. Install sealant and gaskets to prevent weather penetration.

C. After erection , prime welds, abrasions, and surfaces not shop primed; use primer consistent with shop prime. Paint all primed steel in accordance with SPECIFICATION Section 09900.

D. Gutter and Downspout

1. Rigidly support and secure components.
2. Slope gutters minimum 1/8" inch per foot.
3. Install concrete splash pad below each downspout.

E. Provide Building unloading from the truck, erection and installation.

F. Building manufacturer to provide supervision and any specialized tools for the duration of the erection/installation process. These services shall be included in the bid quotation.

3.02 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 15001

GENERAL REQUIREMENTS FOR PIPING SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

A. All exposed, submerged and buried plant piping.

B. Influent ground water mains, effluent ground water mains.

1.02 RELATED WORK

A. Section 02220: Excavation, Backfilling and Compacting for Pipelines.

B. Section 09900: Paintings and Coatings.

C. Section 15400: Plumbing

1.03 DESCRIPTION OF PIPING SYSTEMS

A. The configuration and layout of piping systems are shown in the PLANS.

B. The type of pipe and joints to be used for each system is specified in the Piping Schedule at the end of this Section.

1.04 SHOP INSPECTION AND TESTING

A. The quality of all materials, the process of manufacturer and finished piping shall be subject to inspection and approval of the Engineer.

B. Pipe may be inspected at the place of manufacture, and on the Work site, and shall be subject to rejection, if defective, at any time even though submitted samples may have been approved.

C. The Engineer may have pipe or fittings inspected or tested, or both, by an independent inspection service at either the manufacturer's plant or elsewhere. Such inspections and/or test will be at the Owner's expense.

1.05 SUBMITTALS

A. Shop Drawings and Product Data

1. Comply with the provisions of Section 01340 and the supplemental requirements below.
2. Submit detailed layout drawings for all piping systems. Those drawings may be organized by system or by areas. Prepare drawings to scale and show the following information on them:
   a. Type of piping including material, weight, linings, and coatings. If desired, use code and key to product data sheet specified below.
   b. Location and type of joints, fittings, taps, supports, kickers and blocking.
3. Submit fabrication drawings for specials including fabricated fittings, wall pipes and wall sleeves. Show dimensions and materials of construction.
4. Submit manufacturer's standard drawings showing dimensions, configuration and materials of construction for the following items:
   a. Joints
   b. Flanges
   c. Couplings
   d. Expansion joints
   e. Hangers, brackets and other similar accessories.
5. Submit the following product data on all piping materials.
   a. Reference standard
   b. Type material
   c. Wall thickness, schedule or class as appropriate
   d. Outside diameter
   e. Type of lining
   f. Type of coating
   g. Pressure rating, if applicable.

B. Affidavits of Compliance

1. Submit affidavits of compliance with the reference standards.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling

1. Do not deliver piping materials to project site prior to Engineer's approval of required submittals.
2. Unload and handle piping materials using proper materials handling equipment.
3. Do not drop, roll, or skid piping materials.

4. Take such additional precautions as necessary to avoid damaging piping materials and coatings thereon.

B. Storage

1. Store piping materials in a manner which will reduce risk of damage.
2. Block piping materials to prevent rolling.

1.07 WORK AFFECTING EXISTING LINES

A. Notify Engineer at least five working days prior to taking existing lines out of service to make connections or for other reasons.

B. Do not take existing lines out of service without written authorization.

1.08 WARRANTY

Material and workmanship of equipment described in this section shall be warranted for 1 year from date of issuance of certificate of final payment to be free of defects in design or manufacture other than normal wear and tear.

PART 2 PRODUCTS

2.01 GENERAL

A. See other Sections in Division 15 for piping materials specifications.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install all piping systems in accordance with the PLANS and TECHNICAL SPECIFICATIONS and approved shop drawings and manufacturer's installation instructions.

B. Examine all piping materials prior to installation and replace items that are damaged or otherwise defective.

C. Thoroughly clean inside of all piping, valves, and accessories, and outside of all materials which will be exposed. Clean before installation and maintain in that condition until accepted by Engineer.

D. Provide temporary caps or plugs over all pipe openings at the end of each day to prevent foreign material from entering the piping systems. The foregoing requirement may be waived for large diameter exposed piping at the discretion of the Engineer when conditions are such that foreign material will not be inadvertently or maliciously placed in the pipe.

E. Do not modify structures, equipment, or piping for the purpose of installing piping unless specifically authorized in writing by the Engineer.

3.02 INSTALLATION OF BURIED PIPING SYSTEMS

A. Line and Grade

1. Install piping to lines and grades shown on PLANS.
2. Install pressure piping at centerline elevations shown.
3. If centerline and/or flowline elevations are not shown on PLANS, install piping so that there is at least five feet of cover over same.

B. Dewatering

1. Keep trenches free of water when performing any type of work in them.
2. Discharge water from construction pumps or dewatering wells to storm sewers or drainage ditches.

C. Bedding

1. Bedding material shall conform to the requirements of **Section 02200.**

D. Laying of Pipe

1. Do not drop or roll pipe into trench. Place carefully by hand or materials handling equipment.
2. Do not lay pipe in water.
3. Joint pipe as specified in piping material specifications.
4. Do not deflect pipe unless shown on PLANS or approved by Engineer.
5. When deflection of pipe is authorized, do not exceed 50 percent of pipe manufacturer's recommended maximum deflection.

E. Encasement of Piping and Valves

1. Provide sand encasement when called for on PLANS or ordered by Engineer.
2. Sand encasement to extend at least six inches from pipe in all directions.
3. Use Class C concrete when concrete encasement is called for on PLANS. Such encasement to extend at least six inches from pipe in all directions unless otherwise noted on PLANS.

F. Concrete Blocking

1. Provide concrete thrust blocking for all buried piping under pressure.
2. Locate thrust blocks at all bends, tees, and plugs.
3. Use Class C concrete.
4. Place concrete against undisturbed firm earth.
5. Area of concrete in contact with earth to be as required to withstand specified field test pressure.

G. Restrained joints

1. Use restrained joint piping and fittings when called for on PLANS.
2. Restrained joints may be used in lieu of concrete blocking if type of restraining system and number of restrained joints are approved by Engineer.

H. Backfilling

1. Comply with Section 02220 and the following supplemental requirements.
2. Backfill as soon as practicable after installation of piping, valves, encasement, and blocking.
3. Touch up damaged protective coatings prior to backfilling.
4. Exercise care to avoid damaging piping or protective coatings with tamping equipment.
5. When authorized by the Engineer, leave sheeting and bracing in trench. Cut off all members so that tops of same are at least 18 inches below ground.

I. Making Connections to Existing Lines

1. Verify location of existing line.
2. After exposing existing line, determine fittings and adapters required to make connection and have same delivered to job site before taking existing line out of service.

3.03 INSTALLATION OF EXPOSED PIPING SYSTEMS

A. Alignment and Elevation

1. Install straight runs true to line and elevation.
2. Install vertical pipe truly plumb in all directions.
3. Install piping parallel or perpendicular to building walls. Piping at odd angles and 45 degree runs across corners will not be accepted unless specifically shown on PLANS.

4. Install small diameter piping generally as shown on PLANS when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, etc.
5. Install piping so that pipe, flanges, valves, and associated appurtenances are at least eight feet above finished floors, stairs, and landings unless lesser clearances are specifically dimensioned on the PLANS.
6. Bring piping to alignment and elevation without forcing or springing pipe.

B. Joints

1. Joint pipe in accordance with piping material specifications and the supplemental requirements below.
2. Bring piping to proper alignment and elevation with permanent support system before tightening flange bolts and nuts.

C. Unions for Piping

1. Install unions near valves and equipment to facilitate assembly and disassembly of piping.
2. Install dielectric unions wherever dissimilar metals are joined.

D. Expansion joints

1. Install in accordance with specifications for expansion joints and approved shop drawings.
2. Use of additional couplings and adapters to be approved by Engineer prior to installation.

E. Flexible Couplings and Flanged Coupling Adapters

1. Install in accordance with specifications for couplings and adapters, and approved shop drawings.
2. Contractor may use couplings and adapters over and above those shown on PLANS to facilitate installation of piping. Use of additional couplings and adapters must be approved by Engineer prior to installation.

F. Piping Supports and Restraints

1. General
   a. Restrain, block, brace, support, or suspend pipe and fittings as shown on the Drawings and as specified herein to prevent displacement, vibration, sagging, warping, deformation, or failure of piping and fittings, and to allow for expansion and contraction.

b. Support and restrain piping so that no piping loads will be imparted to pumps or other equipment.

G. Supports for Horizontal Piping

1. Space supports and hangers for piping no farther apart than the distances shown below.

Pipe Size (in.)	Spacing (ft.)
1/8 & 1/4	2
1/2 & 3/4	4
1 through 3	6
4 and above	10

2. Space supports and hangers for plastic piping in accordance with specifications for said piping.
3. Locate hangers or supports immediately adjacent to any change in piping direction, and on both sides of valves, couplings, and heavy fittings.
4. Install all hangers and supports so as not to interfere with the free expansion and contraction of the pipe.
5. When hangers are used to support insulated piping, provide shields to protect insulation.
6. Provide concrete supports to comply with these specifications.

H. Supports for Vertical Piping

1. Support in accordance with approved shop drawings.
2. For piping 4 inches and smaller, install riser clamps to support piping at each floor sleeve.

I. Piping Restraints

1. Provide kickers and thrust blocking where required.
2. Use Class A concrete for thrust blocks.

J. Supports for Valves

1. Provide supports for valves 16 inches and larger. Contractor may select type, but must submit shop drawings for same to Engineer for approval before installation.
2. Install floor stands as recommended by the manufacturer.
3. Provide lateral restraints for extension bonnets and extension stems as recommended by the manufacturer.
4. Provide sleeves where operating stems pass through floor.

K. Pipe Sleeves

1. Install sleeves where pipes pass through walls, floors, or roof slabs.
2. Size sleeves as follows:

Nominal Pipe Size	Sleeve I.D. Less Pipe or Insulation O.D.
Less than 1-inch	1/2-inch to 3/4-inch
1-inch through 3 inches	3/4-inch to 1-inch
3 inches through 12 inches	1-inch to 2 inches
12 inches and over	2 inches to 3 inches

3. When mechanical seals are used, size sleeves to suit seals.
4. Install floor sleeves flush with underside of floor and 2 inches above top of floor.
5. Install roof sleeves per manufacturer's recommendations.
6. Install wall sleeves flush with each wall face.
7. Seal sleeves with sealant or mechanical seals with stainless steel hardware.
8. When using sealant, install jute packing to back up sealant and seal between pipe and sleeve on both sides of wall or floor.

3.04 PIPING SCHEDULE

A. Exposed Air Piping

1. Type of Pipe: Type Stainless Steel (Type 304L)
2. Weight: 8 Gauge
3. Type of Joint: Stainless Steel Flanged
4. Specification ASTM A312 or A778

B. Buried Influent Groundwater, Double Wall

1. Type of Pipe and Fittings: ASTM D3035 or F714, PPI Listed, Extra High Molecular Weight, High Density PE3408 (HDPE).
2. Pressure Class:
   a. Carrier Pipe: 100 psi
   b. Containment Pipe: 15 psi
3. Type of Joint: Thermal Fusion Weld
4. Double wall system shall be designed to allow for leak detection. Pipe supports shall have guides that facilitate cable pulling. Prevent cable damage during pulling operations. Pipe manufacture shall provide pull ports for access to cable.

C. Exposed Influent Groundwater, (Plant Piping)

1. Type of Pipe: PVC Pressure Pipe
2. Pressure Class: Schedule 80
3. Type of Joint: Couplings with twin gaskets or solvent weld

D. Exposed Treated Water (Plant Piping)

1. Type of Pipe: PVC Pressure Pipe
2. Pressure Class: Schedule 80
3. Type of Joint: Solvent Weld or Couplings with twin gaskets

E. ~~Buried, Treated Water, Single~~ Wall

1. Type of Pipe and Fittings: ASTM D3035 or F714, PPI Listed, Extra High Molecular Weight, High Density ~~PE3408 (HDPE)~~.
2. Pressure Class: 1~~00 psi~~ Driscopipe 1000
3. Type of Joint: Thermal Fusion Weld

F. Foundation Drain Pipe

1. Type of Pipe: Perforated PVC
2. Pressure Class: Schedule 40
3. Type of Joint: Solvent Weld or Couplings with Twin Gaskets

3.05 FINAL INSPECTION

A. Each section of buried piping will be inspected by the Engineer prior to backfilling and final pressure testing.

B. Correct, repair or replace any pipe which is not true to both line and grade and free of projections and debris.

3.06 FIELD TESTING

A. Repair or replace and retest any piping which does not conform to the test requirements.

B. Correct and retest until all piping conforms to test requirements.

C. Before pressure testing, remove or isolate all equipment that could be damaged by the test pressure or test medium from the pipe being tested.

D. Backfill buried pressure piping to a minimum depth of two feet above the top of the pipe before final testing. Temporarily brace piping to prevent damage or movement during testing. The Contractor may perform preliminary tests at his own expense prior to backfilling if desired.

E. Test pressure piping hydrostatically in accord with AWWA C600 at 1.5 time the maximum operating pressure or the pump shut-off pressure, whichever is greater, but in no case exceeding the allowable working pressure of the piping materials. The operating pressures shall be defined by the Engineer.

F. Pipe installation will not be accepted until the leakage for the section of line tested is less than the rate of leakage specified below:

1. Flanged, welded, screwed and soldered: No measurable leakage.
2. Push-on, mechanical joints or caulked bell and spigot piping: in accordance with AWWA C600.

G. Locate and repair the defective joints and/or pipe until the leakage is within the specified allowance, at no cost to Owner.

3.07 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work contract LUMP SUM price.

END OF SECTION

SECTION 15100

VALVES

PART 1 GENERAL

1.01 SCOPE

This section covers the valves to be furnished and installed in this Contract as indicated on the PLANS. The valves shall be complete with all accessories and appurtenances which are specified or required for proper installation and operation. For brevity, the term "valves" shall be construed to mean valves, cocks, and stops, and their associated operators and accessories throughout the remainder of this section.

1.02 RELATED WORK

A. Section 01340: Shop Drawings, Product Data and Samples

B. Section 01730: Operation and Maintenance Data

C. Section 09900: Paintings and Coatings

D. Section 15001: General Requirements for Piping Systems

E. Section 15400: Plumbing

1.03 QUALITY ASSURANCE

A. Manufacturer's Experience

1. The manufacturer shall have at least one installation of one or more valves of the type specified and comparable with the specified units in terms of size, flow characteristics and material.
2. The installation(s) described above shall have operated successfully for at least one year.
3. Manufacturers unable to meet the requirements of the two preceding paragraphs shall submit a performance bond valued at 250 percent of the total installed price of the units. Said bond shall remain in effect for one year after final acceptance and installation.

1.04 SUBMITTALS

A. Shop Drawings and Product Data

1. Comply with the requirements of Sections 01300 and 01340 and the supplemental requirements below.

2. Submit the following information for each valve:
   a. Specific valve number and contract drawing number where shown.
   b. Description, including type of valve, type of operator, and accessories included.
   c. Make, model, and size.
   d. Catalog bulletins describing the unit. Mark out inapplicable information.
   e. Dimensional sketches of the unit including fittings. Certify for construction.
   f. List of materials used for construction of the unit separate from the catalog.
   g. Weight of total unit.
   h. Maximum working pressure for which valve is designed.
   i. Complete and detailed installation instructions.
3. Submit the following information for geared operators:
   a. Type of gearing.
   b. Type of lubrication.
   c. Size of handwheel, lever, or crank.
   d. Input torque required to develop required output torque.

B. Operation and Maintenance Data

1. Comply with the general requirements of Section 01730.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the provisions of Section 01620 and the supplemental requirements below.

1. Provide temporary protective coating on cast iron and steel valves, and provide factory applied end caps on valves.

2. Maintain coatings and end caps through shipping, storage, and handling, in adequate condition to inhibit corrosion, prevent damage and eliminate dirt and moisture from inside of valves.

PART 2 PRODUCTS

2.01 GENERAL

A. Obtain all valves and operators of a given type from a single manufacturer.

B. Furnish valves made by one of the manufacturers listed for the specific valve type.

C. Furnish valves which meet the requirements specified for each valve type. The abbreviations for each valve type are listed below:

Valve	Abbreviation
Air release	ARV
Ball	BV
Butterfly	BFV
Check	CV
Eccentric plug	EPV
Gate	GV
Pinch	PV
Relief	RV

D. Furnish valves in the sizes specified in listings for each valve type below.

E. Furnish valves capable of withstanding the test pressures specified in Section 15001, unless a greater pressure is specified in this section.

F. Furnish valves that turn clockwise to close.

G. Furnish valves with end connections compatible with those specified for the pipe.

H. Factory finish exposed and submerged valves with primer coat that is compatible with the finished paint system as specified in Section 09900.

I. Furnish operators with the following criteria:

1. Chain-wheel operators to be furnished for valves six feet or more above floor unless otherwise specified.
2. Obtain all operators of a given type from a single manufacturer.
3. Furnish geared operators for all valves 8 inches and larger, unless otherwise specified.
4. Geared operators for quarter turn valves may be geared or travelling nut type.
5. Furnish geared operators with the following features unless otherwise specified.
   a. Weatherproof enclosure.
   b. Grease lubricated design.
   c. Closes valve when turned clockwise.
6. Factory finish valve operators as specified for valves.

2.02 VALVE SCHEDULE

A. Valves shall be as specified for the service as intended unless indicated otherwise on the drawings. Valve specification sheets are included in this section. Buried valves shall have valve boxes.

SERVICE	ISOLATING	THROTTLING	CHECK
AIR	BUTTERFLY	BUTTERFLY	DOUBLE LEAF
GROUNDWATER, TREATED WATER			
3" & SMALLER	BALL	BALL	SWING
4" & LARGER	ECCENTRIC PLUG	ECCENTRIC PLUG	SWING

B. Valve specification sheets for the following valves are included in this Section:

Valve No.	Valve Type
V0101	Eccentric Plug
V0103	Eccentric Plug
V0104	Eccentric Plug
V0105	Eccentric Plug
V1001	PVC Ball
V1002	PVC Ball
V2102	AWWA Butterfly
V2105	AWWA Butterfly
V2106	AWWA Butterfly
V3101	AWWA Gate
V3103	Bronze Gate
V3104	AWWA Gate
V6001	Drain Valve
V6002	Curb Stop
V7102	Swing Check
V7201	Silent Check
V7401	Double Leaf Check
V7501	PVC Ball Check
V8101	Pressure Reducing
V8201	By-Pass Relief
V9101	Air and Vacuum
V9102	Air and Vacuum
V9103	Air Release
V9104	Hose

VALVE SPECIFICATION V0101

1. Valve Type: Eccentric Plug
2. Size Range: 3" through 12"
3. Non-Shock Working Pressure @ 100 degrees F: 175 psig
4. End Connections: Flanged
5. Operator
   a. 2" Square nut
   b. Wrench to extend 4 ft. above operating level
6. Valve Construction
   a. Body: Cast iron
   b. Plug: Cast iron, neoprene faced
   c. Bearings: Oil impregnated stainless steel bushings
   d. Packing: Nitrile-butadiene chevron, repackable without removing the bonnet or actuator from the valve and repackable under pressure
   e. Seat: Nickel steel
7. Accessories: Over-sized extension stem, stem guides, floor box (where shown on PLANS) and cover
8. Manufacturers
   a. DeZURIK

VALVE SPECIFICATION V0103

1. Valve Type: Eccentric Plug
2. Size Range: 1/2" through 2 1/2"
3. Non-Shock Working Pressures @ 100 Degrees F: 175 psig
4. End Connections: Threaded
5. Operator: Removable lever
6. Valve Construction
   a. Body: Cast Iron
   b. Plug: Cast iron, neoprene faced
   c. Bushing: Oil impregnated stainless steel bushings
   d. Packing: Nitrile-butadiene chevron, repackable without removing the bonnet or actuator from the valve, and repackable under pressure
   e. Seat: Nickel steel
7. Manufacturers
   a. DeZURIK or equal

VALVE SPECIFICATION V0104

1. Valve Type: Eccentric Plug
2. Size Range: 3" through 12"
3. Non-Shock Working Pressures @ 100 Degrees F: 175 psig
4. End Connections: Mechanical joint
5. Operator

a. 2" Square nut
b. Wrench to extend 4 ft. above operating level

6. Valve Construction
   a. Body: Cast iron
   b. Plug: Cast iron, neoprene faced
   c. Bearings: Oil impregnated stainless steel bushings
   d. Packing: Nitrile-butadiene chevron, repackable without removing the bonnet or actuator from the valve, and repackable under pressure
   e. Seat: Nickel steel
7. Accessories: Extension stem, valve box, cover and wrench
8. Manufacturers
   a. DeZURIK or equal

VALVE SPECIFICATION V0105

1. Valve Type: Eccentric Plug
2. Size Range: 3" through 8"
3. Non-Shock Working Pressures @ 100 Degrees F: 175 psig
4. End Connections: Flanged
5. Operator: Removable lever
6. Valve Construction
   a. Body: Cast iron
   b. Plug: Cast iron, neoprene faced
   c. Bearings: Oil impregnated stainless steel bushings
   d. Packing: Nitrile-butadiene chevron, repackable without removing the bonnet or actuator from the valve, and repackable under pressure
   e. Seat: Nickel steel
7. Manufacturers
   a. DeZURIK or equal

VALVE SPECIFICATION V1001

1. Valve Type: PVC Ball
2. Size Range: 1/2" through 2"
3. Non-Shock Working Pressures @ 70 Degrees F: 100 psig
4. End Connections: Union, threaded
5. Operator: Lever
6. Valve Construction
   a. Body: PVC
   b. Ball: PVC
   c. Seat: TFE
   d. Seals: Viton
7. Manufacturers
   a. Asahi/America
   b. R & G Sloane

c. Hayward

VALVE SPECIFICATION V1002

1. Valve Type: PVC Ball
2. Size Range: 3"
3. Non-Shock Working Pressures @ 70 Degrees F: 100 psig
4. End Connections: Flanged
5. Operator: Lever
6. Valve Construction
   a. Body: PVC
   b. Ball: PVC
   c. Seat: TFE
   d. Seals: Viton
7. Manufacturers
   a. Asahi/America
   b. R & G Sloane
   c. Hayward

VALVE SPECIFICATION V2102

1. Valve Type: AWWA Butterfly
2. Size Range: 6" through 48"
3. Reference Standard: AWWA C504-80, Standard for Rubber-Seated Butterfly Valves
4. Non-Shock Working Pressure @ 200 degrees F: 150 psig
5. End Connections: Flanged
6. Operator
   a. Geared handwheel
   b. Comply with general requirements in Part 2
7. Valve Construction
   a. Body: Cast or ductile iron, short body
   b. Disc: Stainless steel or ductile iron with stainless steel seat ring
   c. Shaft: Wrought SS
   d. Bearings: Sleeve type, self-lubed
   e. Seals: EPDM ("NORDEL")
   f. Seat: EPDM ("NORDEL")
8. Manufacturers
   a. BIF, Model 652
   b. Allis-Chalmers Mfg. Co.
   c. Henry Pratt Co.

VALVE SPECIFICATION V2105

1. Valve Type: AWWA Butterfly
2. Size Range: 3" through 20"

3. Reference Standard: AWWA C504-80, Standard for Rubber-Seated Butterfly Valves
4. Non-Shock Working Pressure @ 200 degrees F: 150 psig
5. End Connections: Wafer style with tapped lugs
6. Operator
   a. Geared handwheel
   b. Comply with general requirements in Part 2
7. Valve Construction
   a. Body: Cast or ductile iron, short body
   b. Disc: Stainless steel or ductile iron with stainless steel seat ring
   c. Shaft: Wrought SS
   d. Bearings: Sleeve type, self-lubed
   e. Seals: EPDM ("NORDEL")
   f. Seat: EPDM ("NORDEL")
8. Manufacturers
   a. DeZURIK
   b. Henry Pratt Co.

VALVE SPECIFICATION V2106

1. Valve Type: AWWA Butterfly
2. Size Range: 6" through 24"
3. Reference Standard: AWWA C504-80, Standard for Rubber-Seater Butterfly Valves
4. Non-Shock Working Pressure @ 200 degrees F: 150 psig
5. End Connections: Flanged
6. Operator
   a. Electric Actuated
   b. Comply with general requirements in Part 2
7. Valve Construction
   a. Body: Cast or ductile iron, short body
   b. Disc: Stainless steel or ductile iron with stainless steel seat ring
   c. Shaft: Wrought SS
   d. Bearings: Sleeve type, self-lubed
   e. Seals: EPDM ("NORDEL")
   f. Seat: EPDM ("NORDEL")
8. Manufacturers
   a. DeZURIK
   b. Henry Pratt Co.

VALVE SPECIFICATION V3101

1. Valve Type: AWWA Gate
2. Size Range: 2" through 12"
3. Reference Standard: AWA C500-80, Standard for Gate Valves, 3 in. through 48 in. NPS, for Water and Sewer Systems
4. Non-Shock Working Pressure @ 100 degrees F: 200 psig

5. End Connections: Flanged
6. Operator: Handwheel
7. Valve Construction
   a. Body: Cast iron, bronze mounted
   b. Bonnet: Bolted
   c. Gates: Double disc cast with bronze rings
   d. Stem: OS&Y, bronze
   e. Seat Rings: Bronze
   f. Stem Seals: Packing or O-rings
8. Manufacturers
   a. M & H Style 68-02
   b. Clow Figure F-5070

VALVE SPECIFICATION V3103

1. Valve Type: Bronze Gate
2. Size Range: 1/4" through 2"
3. Reference Standard: MSS SP-80, Bronze Gate, Globe, Angle & Check Valves
4. Non-Shock Working Pressure @ 100 degrees F: 200 psig
5. End Connections: Threaded
6. Operator: Handwheel
7. Valve Construction
   a. Body: Bronze
   b. Bonnet: Union
   c. Gates: Solid wedge
   d. Stem: NRS, bronze
   e. Seat Packing: TFE impregnated asbestos
   f. Disc: Solid wedge
   g. Trim: Stainless Steel
8. Manufacturers
   a. Crane No. 428
   b. Nibco

VALVE SPECIFICATION V3104

1. Valve Type: AWWA Gate
2. Size Range: 2" through 10"
3. Reference Standard: AWA C500-80, Standard for Gate Valves, 3 in. through 48 in. NPS, for Water and Sewer Systems
4. Non-Shock Working Pressure @ 100 degrees F: 200 psig
5. End Connections: Push-on or mechanical joint
6. Operator
   a. 2" square nut
   b. Wrench to extend 4 ft. above grade
7. Valve Construction
   a. Body: Cast iron, bronze mounted

b. Gates: Double disc cast iron with bronze rings
c. Stem: NRS, bronze
d. Seat Rings: Bronze
e. Stem Seals: Packing or O-rings

8. Accessories: Valve box & cover
9. Manufacturers
   a. M & H Style 67-13
   b. Clow Figure F-5085

VALVE SPECIFICATION V6001

1. Valve Type: Drain Valve
2. Size Range: 1/8" through 1/2"
3. Non-shock Working Pressure @ 100 degrees F: 100 psig
4. End Connections: NPT x Bibb
5. Operator: Lever
6. Valve Construction
   a. Body: Bronze
   b. Plug: Brass
   c. Washer: Brass
   d. Screw: Brass
7. Manufacturers
   a. Crane
   b. Lunkenheimer

VALVE SPECIFICATION V6002

1. Valve Type: Curb stop
2. Size Range: 3/8" through 2"
3. Non-shock Working Pressure @ 100 degrees F: 70 psig
4. End Connections: Threaded
5. Operator: Tee head
6. Valve Construction: Bronze
7. Accessories
   a. Curb box
   b. Wrench; length adequate to place handle 4 ft. above grade
8. Manufacturers
   a. Mueller H-10204
   b. Nibco

VALVE SPECIFICATION V7102

1. Valve Type: Swing Check
2. Size Range: 3" through 12"
3. Non-Shock Working Pressure @ 100 degrees F: 200 psig
4. End Connections: Flanged
5. Valve Construction

a. Body: Cast Iron
b. Bonnet: Bolted
c. Disc: Bronze
d. Seat: Bronze
e. Trim: Bronze

6. Accessories: Outside lever and adjustable weights
7. Manufacturers
   a. Crane
   b. M & H Style 159-02

VALVE SPECIFICATION V7201

1. Valve Type: Silent Check, Center Guided
2. Size Range: 3" through 10"
3. Non-Shock Working Pressure @ 100 degree F: 125 psig
4. End Connections: Flanged
5. Valve Construction
   a. Body: Cast iron
   b. Plug: Center guided, bronze
   c. Seat: Bronze
   d. Spring: Stainless steel
   e. Trim: Bronze
6. Manufacturers
   a. APCO, Series 600
   b. G-A Industries, Model 280

VALVE SPECIFICATION V7401

1. Valve Type: Double Leaf Check
2. Size Range: 2" through 20"
3. Non-Shock Working Pressure @ 100 degrees F: 125 psig
4. End Connections: Wafer style with tapped lugs
5. Valve Construction
   a. Body: Cast iron
   b. Discs: Double, bronze
   c. Seat: EPDM ("NORDEL")
   d. Springs: Low Torque, stainless steel
   e. Shaft: Stainless steel
   f. Trim: Stainless steel
6. Manufacturers
   a. APCO, Series 9000L
   b. Mission Duo-Check II

VALVE SPECIFICATION V7501

1. Valve Type: PVC Ball Check
2. Size Range: 1/2" through 2"

3. Non-Shock Working Pressure @ 70 degrees F: 100 psig
4. End Connections: Threaded
5. Valve Construction
   a. Body: PVC
   b. Ball: PVC
   c. Seat: Viton O-ring
   d. Seals Viton O-ring
6. Manufacturers
   a. Asahi/American
   b. Hayward Mfg. Co., Inc.

VALVE SPECIFICATION V8101

1. Valve Type: Pressure Reducing
2. Size Range: 1/2" through 2"
3. Non-Shock Working Pressure @ 100 degrees F: 150 psig
4. End Connections: Threaded
5. Operator: Spring loaded diaphragm
6. Valve Construction
   a. Body: Bronze
   b. Seat: Renewable, nickel alloy
   c. Diaphragm: High temperature resistant
7. Supply Pressure: 40-60 psi
8. Regulated Pressure: 0-30 psig; set for 30 psi
9. Accessories: Strainer bronze body, with 20 mesh stainless steel screen
10. Manufacturers
    a. Watts No. 223S
    b. Cash-Acme Type B

VALVE SPECIFICATION V8201

1. Valve Type: By-pass Relief
2. Size Range: 1" through 2"
3. Non-Shock Working Pressure @ 100 degrees F: 150 psig
4. End Connections: Threaded
5. Operator: Spring loaded diaphragm
6. Valve Construction
   a. Body: Bronze
   b. Plug: Renewable
   c. Stem: Bronze or stainless steel
   d. Gaskets: Asbestos
   e. Spring: Stainless steel
   f. Trim: Bronze
7. Relief Pressure: 75-100 psig; set for 80 psi
8. Manufacturers
   a. Cash-Acme, Type K-5

VALVE SPECIFICATION V9101

1. Valve Type: Air and Vacuum Valve
2. Size: 2"
3. Non-Shock Working Pressure @ 100 degrees F: 150 psig
4. Connections: Threaded
5. Valve Construction
   a. Body: Cast iron
   b. Cover: Cast iron
   c. Baffle: Cast iron
   d. Float: Stainless steel
   e. Seat: Buna-N
   f. Screen: Brass
6. Manufacturers
   a. Val-matic, No. 302 BWA
   b. APCO, Model No. 402

VALVE SPECIFICATION V9102

1. Valve Type: Air and Vacuum Valve
2. Size: 1"
3. Non-Shock Working Pressure @ 100 degrees F: 150 psig
4. Connections: Threaded
5. Valve Construction
   a. Body: Cast iron
   b. Cover: Cast iron
   c. Baffle: Cast iron
   d. Float: Stainless steel
   e. Seat: Buna-N
   f. Screen: Brass
6. Manufacturers
   a. Val-matic, No. 101 DWS
   b. APCO, Model No. 142 WD

VALVE SPECIFICATION V9103

1. Valve Type: Air release, simple lever type
2. Size: 3/4"
3. Non-Shock Working Pressure @ 100 degrees F: 150 psig
4. Connections: Threaded
5. Valve Construction
   a. Body and Cover: Cast iron
   b. Float: Stainless steel
   c. Seat: Buna-N
   d. Linkage: Delrin and bronze
6. Manufacturers
   a. APCO, No. 75

b. Val-matic, No. 15

VALVE SPECIFICATION V9104

1. Valve Type: Hose
2. Size Range: 1/2" through 2 1/2"
3. Non-Shock Working Pressure @ 100 degrees F: 250 psi
4. Connections
   a. Inlet: Threaded, NPT
   b. Outlet: Threaded, Chicago standard hose thread
5. Operator: Handwheel
6. Valve Construction
   a. Bronze except as specified below
   b. Composition disc
   c. Brass disc holder
7. Manufacturers
   a. Crane
   b. Nibco

PART 3 EXECUTION

3.01 INSTALLATION

A. Each valve shall be factory assembled and tested before being shipped. Each valve shall be shipped completely assembled for installation by the contractor.

B. Installation shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the PLANS.

C. Install valves and valve operators to provide for ease of access and operation.

D. Install small valves with stems upright or horizontal.

E. Install butterfly valves with shafts horizontal.

F. Space stem guides at 8 feet center to center maximum or closer if recommended by manufacturer.

3.02 FIELD QUALITY CONTROL

A. Required Manufacturer Services

1. Retain a qualified representative of the manufacturer to assist in the following services.
   a. Provide assistance, as required, for installation of the valves specified herein.
   b. Furnish procedures for field testing.

c. Provide Contractor and Engineer written material for the operations and maintenance of the valves.

3.03 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 15311

COARSE BUBBLE DIFFUSER

PART 1 GENERAL

1.01 WORK INCLUDED

A. Coarse bubble diffusers for surge tank.
B. Air drop assemblies.
C. Structural supports for assemblies.

1.02 SUBMITTALS

A. Submit in accordance with Section 01340 and 01730.
B. Shop Drawings

1. Shop layout of all equipment. including construction and erection details for aeration equipment, including associated piping.

2. Manufacturer provides setting diagrams and templates for positioning equipment and anchoring details.

PART 2 PRODUCTS

2.01 SURGE TANK DIFFUSERS

A. Diffusers shall consist of an orifice body, ball check diaphragm, orifice adjustment bolt and a lockout. The body shall be molded one piece plastic construction with equally spaced air released orifices. The stem of body shall have NPT pipe threads for connection to air manifold. Plastic shall be high heat resistant compound combining high impact characteristics and retention of mechanical properties at elevated temperatures. The diffusers must be of proven structural design without inherent mechanical weaknesses.

1. Each diffuser shall operate at a maximum air flow rate of 12 cfm. The surge tank shall have four diffusers, equally spaced to provide 24 cfm air at average conditions.

B. Air drop assemblies each consisting of a 2-inch air drop pipe at the tank wall, 2-inch horizontal distribution pipe, with nonclogging air diffusers. All parts of the assembly except the diffuser shall be Schedule 80 PVC plastic pipe.

C. Structural supports for each air drop assembly with all nuts, bolts, washers, and expansion fasteners of stainless steel. Provide sufficient supports to adequately support assemblies. These supports will be attached to fiberglass

mounting lugs permanently mounted to the interior tank floor by the manufacturer.

PART 2 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.
   1. Install aeration equipment level, plumb, and at uniform spacing.
   2. Space supports on maximum 4-foot centers.

3.02 FIELD QUALITY CONTROL

A. Level Inspection:
   1. Inspect header with leveling instrument to ensure that all diffuser outlets are within plus or minus 1/4 inch of same elevations.

B. Uniformity and Leakage Test:
   1. Flood tank to depth of 1 foot (1') above diffusers.
   2. With compressor operating, check for leakage and visually check that air is evenly distributed through tank.

SECTION 15400

PLUMBING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Whenever the word "piping" is used herein, it shall be understood to refer to all pipe, fittings, valves, flanges, gasketing, hangers and supports comprising any given system.

B. The Contractor, at his own expense, shall do all work required by, and in accordance with local codes, shall arrange for all permits, inspections and tests required by those codes; and shall do everything necessary to provide complete systems which will be ready for use without further expense to the Owner.

C. The Drawings show the general arrangement, direction, and sizes of pipes, it is not intended to show every offset, valve, and fitting, or every structural difficulty that may be encountered. The piping and appurtenances shall be installed to suit, and to avoid interference with the installation, operation, and maintenance of fixtures, equipment, or other piping. All measurements shall be verified at the job site.

1.02 RELATED WORK

A. Section 02220: Excavation, Backfilling and Compacting for Pipelines.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 and 01340.

B. Operational and maintenance manuals shall be submitted in accordance with Section 01730.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES LIST

A. Drainage Piping:

1. Drainage piping (which includes soil, waste, roof drain, and vent piping) 3 inches and larger, shall be schedule 40 PVC pipe and fittings unless otherwise shown on the Drawings.

2. Soil and waste piping 2-1/2 inches and smaller, shall be schedule 40 PVC.
3. Vent piping, 2-1/2 inches and smaller shall be schedule 40 PVC.

B. Cleanouts:

1. In-Line Mounted - Josam 58490 (-20) series or approved equal coated cast iron cleanout ferrule with spigot connection and bronze threaded plug for installation.
2. On-Grade Mounted - Same as above except to be enclosed in a 6-inch high concrete pad.

C. Nickel-plated brass, split escutcheon plates with set screws or spring clamps shall be fitted on all bare pipes where they pass through walls or floors. The plates shall fit snugly around the pipe and against the wall, floor or ceiling, completely concealing the embedded sleeve.

2.02 PIPING MATERIALS AND APPURTENANCES

A. Piping materials shall be of the type and quality listed herein unless otherwise specified on the Drawings and shall be new and by an approved manufacturer.

B. Water Piping:

1. All potable water piping, 2 inches and smaller shall be Type K, hard temper, copper water tubing ASTM D-88. Fittings shall be solder-joint copper or brass fittings designed for use with such tubing.
   a. Gate valves shall be 125 psi, bronze solder joint ends screwed bonnet, rising stem, solid wedge.
   b. Globe valves shall be 125 psi bronze solder joints ends, screwed bonnet, rising stem, renewable seat.
   c. Check valves shall be 125 psi bronze solder joint ends, screwed cap.

2.03 INSULATION

A. Fittings, flanges and valves shall be insulated with fiber glass molded or segmented insulation, and neatly wrapped with joint sealing tape of matching color. Alternatively, fittings flanges and valves may be insulated with factory cut glass blanket, enclosed with Zeston, Ceel Co., Koverite, or equal PVC cover. The cover shall be mechanically fastened and the ends wrapped to the pipe insulation with joint tape. Jacketing on outdoor piping shall be recommended for such use.

B. Cold pipe insulation shall be heavy duty bonded fibrous glass sectional pipe insulation with all-service jacket, including factory-applied vapor barrier. The insulation thermal conductivity shall not exceed 0.26 BTU per hour per square

foot per degree F per inch thickness at 50 degrees F mean temperature. All longitudinal joints shall be sealed with vapor barrier adhesive and butt joints covered with 3-inch width of vapor barrier joint tape. Valves and fittings shall be insulated as described for hot piping valves and fittings, except that Chicago Mastic Co. 17-465, Foster 81-91, or equal vapor barrier adhesive mastic shall be used to seal nonvapor-proof surfaces, edges and perforations to prevent moisture penetration.

Hot & Cold = 1" thick insulation

PART 3 EXECUTION

3.01 INSTALLATION

A. All piping shall be installed in a neat, workmanlike manner, and the various lines shall be parallel to building walls and ceilings. Piping shall be installed to accurate lines and grades, and shall be supported by hangers to the type and spacing herein specified. Where temporary supports are used, they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Suitable provision shall be made for expansion where necessary.

B. All piping shall pitch toward low points, a provision shall be made for drainage these low points. Sanitary and roof drainage piping shall be pitched 1/4 inch per foot wherever possible, but under no circumstances less than 1/8 inch per foot.

C. All runs for roof drain piping to be insulated. Including roof drain bowels with 1" thick insulation.

D. Isolation valves shall be provided in all branches, sub branches and equipment connections.

E. Cleanout shall be installed in soil and waste piping at ends of branches, in traps and stacks, at points where direction of flow changes and at convenient points in long runs of pipe. End cleanouts for pipe buried under floor slab shall be brought up to just below the floor level and a flush access cover provided.

F. Before installation, uncoated pipe shall be placed on end and hammered to remove scale. After being cut to final lengths, the ends of steel pipe and copper tubing shall be reamed to remove burrs. Threads of all screwed joints shall be clean cut and of long taper. Screwed joints shall be made up with an approved pipe joint compound applied to the male threads only. Before assembly, all dirt and chips shall be removed from inside the pipe and fittings and from the threads. All pipe connected to recessed drainage fittings shall be screwed against the shoulder of the fittings.

G. Joints which are required to be backed off shall be entirely disjointed, the ends of both the pipe and fittings wiped clean, new joint compound applied, and the connection reassembled.

H. No close nipples shall be allowed.

I. Solder joints for copper tubing shall be prepared by cleaning the ends of the tubing and the inner surfaces of the fittings with steel wool until they are bright. The cleaned surfaces shall be given thin coating of approved soldering flux, and the tubing end inserted into the fitting as far as possible. Heating and finishing of the joint shall be done in accordance with the recommendations of the manufacturer of the fittings, using solid string or wire solder composed of 50 percent tin and 50 percent lead. The use of cored solder will not be permitted.

J. A sufficient number of unions shall be used to allow for the dismantling of all water pipe. In vent piping, tucker connections shall be used instead of unions.

K. Joints in soil pipe shall be made with picked oakum, packed tightly into the space between the hub; and the pipe, and molten lead at least 1 in. depth. Each joint shall be made in one pouring and caulked to ensure tightness.

L. Flared joints for copper tubing shall be cut and burred after which the sleeve nut shall be slipped on the tubing and; the end flared with a flaring tool. Care shall be taken in flaring not to crack or split the flared portion but if close inspection reveals such damage, the flare shall be cut off and a new flare made. The flared end shall be squarely seated on the fitting and the nut tightened.

M. Joints between soil pipe and steel pipe shall be made with malleable-iron, Manhoff fittings.

N. All changes in direction shall be made by using pipe and fittings unless other means are approved by the Owner.

O. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways, and equipment and shall not interfere with the servicing or maintenance of any equipment.

P. All plumbing, installations shall conform to the National Plumbing Code, and the local governing agency.

Q. All fixtures shall be trapped including floor drains.

R. Flashing for vents passing through the roof is included in Section 07600, FLASHING AND SHEET METAL WORK.

S. Install buried piping in accordance with Section 15001.

T. Wall pipes or pipe sleeves of proper size shall be provided for all through wall foundation piping and thoroughly grouted in place.

U. Plumbing fixtures shall be installed plumb and level in accordance with manufacturer's recommendations.

3.02 PIPE HANGERS AND SUPPORTS

A. Hangers for cast-iron flanged, soil, waste, and vent piping shall be adjustable, wrought-band hangers with iron rods equal to Grinnel Figure 269. Hangers for water and other pipes shall be of the cast, split-ring type with turnbuckle adjuster, equal to Grinnel Figure 115. Hangers for copper tubing shall be copper plated. Hangers for chromium-plated pipes shall be chromium-plated cast brass.

1. All piping and piping equipment shall be supported rigidly from the building structure by approved hangers and supports. Piping shall be supported to maintain the necessary pitch, to prevent vibration, and to provide for expansion and contraction.
2. Hangers shall be secured to beams or approved inserts wherever practicable. The Contractor shall furnish and set all inserts before the concrete is placed.
3. Vertical pipes shall be supported at each level by means of steel friction clamps. Long vertical drops shall be suitably braced at the top to prevent vibration.
4. Where several pipes are parallel, multiple hangers may be used.
5. The spacing of hangers shall be limited as follows unless directed otherwise.

PIPE SIZE	MAXIMUM HANGER SPACING, FT.
Up to 1 in.	7
1-1/4 in. to 2 in.	9
2-1/2 in. to 3 in.	11
4 in. and larger	14
Flanged pipe, all sizes	5

3.03 TESTING

A. Upon completion of installation, all pipelines shall be tested by the Contractor in the presence of the Engineer. Piping located underground shall be tested before being backfilled. Piping to be insulated or painted shall be tested before the insulation or paint is applied. Portions of piping which will be

concealed before completion shall be tested separately in the same manner as described below for the entire pipeline.

B. All materials, equipment, tools, and labor for testing shall be furnished by the Contractor.

C. Piping which carries water shall have air expelled and be filled with water and subjected to a pressure of 100 psi for a period of 30 minutes or longer as may be necessary to examine the piping for leaks.

D. Soil, vent, waste, and roof or other drain piping shall be tested by filling with water to the top of the highest vent stack above the roof, with all outlets plugged. The piping shall hold this water for a period of 30 minutes without showing a drop in level greater than 4 inches.

E. Should leaks be found, faulty joints shall be repaired, even to the extent of disassembly and remaking the joint. Caulking of threads or the use of chemical compounds to correct leaks will not be permitted. Defective pipe or fittings shall be replaced by the Contractor, and the tests shall be repeated until test requirements are met to the satisfaction of the Owner.

3.04 STERILIZATION OF WATER PIPING

A. After satisfactory completion of the piping pressure tests, all new potable water piping shall be sterilized for a period of 4 hours with a solution containing not less than 50 parts per million of available chlorine. After sterilization the solution shall be flushed from the lines with clean water until the residual chlorine content is not greater than 0.2 parts per million.

3.05 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under this section. Include the cost of such work in contract LUMP SUM price.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the electrical systems as shown on the drawings and specified herein.

Work Included:

1. Complete electrical power system to and including light fixtures, equipment, motors, outlets, etc.
2. Complete electrical power service system from Techalloy to and including service entrance equipment.
3. Complete grounding system.
4. Telephone service.
5. Complete lightning protection system.
6. Wiring of equipment furnished by others.
7. Electric Heating: Unit heater with thermostat.
8. Building exhaust fan with damper louver and screen and louver operator.
9. Air inlet louver damper, screen and louver operator.
10. Other work as set forth on the drawings.

B. Work Not Included:

1. Telephone wiring will be by others in raceways and conduits provided as part of the electrical work. Electrical Contractor arranges for telephone service.

1.02 CODES AND STANDARDS

A. Compliance with Code:

1. This Contractor shall conform to all requirements of the local legal governmental bodies and other regulations having jurisdiction over this installation, including the latest issue of the National Electric Code.

B. Job Information:

1. All equipment and materials are to be furnished as specified unless "or equivalent" is included in a particular note on schedule.
2. Provide operation and maintenance manuals for all electrical equipment to the Owner.
3. Where interferences develop in the field, conduit shall be offset or rerouted to clear such interferences. This Contractor shall coordinate installation location of conduit and electrical equipment with the work of the other trades.
4. All roof penetrations shall be flashed to the roof. For all electrical equipment which requires support in the walls or structures, such supports shall be provided by this Contractor. Wood support blocks shall be fire treated.

C. Permits, Fees, Taxes, Inspections:

1. This Contractor shall:
   a. Pay all applicable charges for such permits or licenses that may be required.
   b. Pay all applicable fees and taxes imposed by the State, municipal, and/or regulatory bodies.
   c. Pay all charges arising out of required inspections by the codes, permits, licenses or as otherwise may be required by an authorized body.
2. Other Standards:
   a. All materials installed shall be new (unless specifically noted to the contrary on the drawings or elsewhere in this division) and the best of their respective kind.
   b. All workmanship shall be neat and first class in every respect and shall be performed by skilled mechanics, recognized as such in their respective trades.
   c. For all electrical material, where an independent agency testing standard is available, the material must be approved by that agency.

D. Cleaning the Building:

1. Keep Owner's premises and adjoining premises clean from excess material, debris and rubbish caused by his operations at all times.
2. Leave job broom clean and ready for use upon completion of each phase of construction.

E. Guarantees and Warranties:

1. The entire installation shall be guaranteed by this Contractor for a period of one year.

F. Protection and Safety:

1. This Contractor shall put up and maintain such barriers and lights required to adequately warn pedestrians and vehicular traffic and to prevent accidents as a consequence of his work.
2. This Contractor is responsible for the job safety of his employees and shall comply with all applicable local, state and federal codes, regulations and safety requirements.

G. Examination of Drawings:

1. Before starting the work of this contract, this Contractor shall examine all project drawings. If any discrepancies occur between them and these specifications, this Contractor shall report the discrepancies to the Engineer, in writing, and obtain written instructions on how to proceed.
2. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment. It should be understood that the Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of conduit and raceways so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
3. Because of the scale of the drawings, certain basic items, such as fittings, boxes, outlets, etc., may not be shown, but where such items are required by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.
4. If an item is either shown on the drawings or called for in the specifications, it shall be considered sufficient for including same in this contract.
5. Where the words "provide", "install", or "furnished" are used on the drawings or in the specification, it shall be taken to mean to furnish, install, and connect up complete and ready for operation, the items mentioned.

H. Site Examination:

1. Bidders shall visit the Site and familiarize themselves with existing conditions and satisfy themselves as to the nature and scope of the work and the difficulties that attend its executions.
2. The submission of a Proposal will be construed as evidence that such an examination has been made and later claims for labor, materials, or equipment required or for difficulties encountered, which could have been foreseen had such an examination been made, will NOT be acceptable.
3. Before ordering any materials or fabricating any supports, pipes, or ducts, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.03 TEMPORARY SERVICE

A. Electrical Service:

1. This Contractor shall provide temporary electrical service of sufficient capacity for construction performed by all trades. This Contractor shall coordinate the service with Owner. The Owner shall pay all associated fees and charges.

B. Lighting:

1. This Contractor shall provide light adequate to move about in the building. Light levels shall conform to requirements of local codes and authorities but shall not be less than 3 footcandles (0.3 watts per square foot, incandescent).
2. Lighting required to perform work shall be the responsibility of the individual contractors.

1.04 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Shop Drawings shall be submitted in accordance with Section 01300 and the supplemental requirements below.

1. Certified manufacturer's drawings for equipment shall be submitted to the Engineer for review before installation.
2. Shop drawings shall be assembled into sets and shall be bound in a file folder complete with index and with each item cross referenced to the material list item.
3. Shop drawings shall bear the Contractor's stamp of approval before they are submitted to the Engineer.
4. Items for which shop drawings are required shall not be installed until the Contractor has received reviewed copies from the Engineer.

B. Shop drawings shall be submitted for the following:

1. Switches
2. Fuses
3. Combination Panelboard/Transformer
4. Main Distribution Switchboard
5. Manual Motor Starters
6. Thermostats
7. Electric Unit Heaters
8. Exhaust Fans
9. Louvers and Operators

1.05 WARRANTY

A. Provide one-year warranty for all fixtures, equipment, materials and workmanship.

B. Warranty requirements shall extend to correction, without cost to the final user, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear.

C. Lamps used during construction shall be replaced with new lamps at the time the warranty period starts. Replacement of lamp burnouts after the warranty period starts shall be the responsibility of the final user.

1.06 MEASUREMENT AND PAYMENT

No separate payment will be made for work performed under Division 16 of these specifications. Include the cost of all electrical work in contract LUMP SUM price.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 16111

CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized Intermediate Conduit (IMC).

B. Galvanized Rigid Conduit (RGS-Heavy Wall).

C. Liquidtight Flexible Metal Conduit.

D. Fittings.

E. Rigid Non-Metallic Conduit and Fittings.

PART 2 PRODUCTS

2.01 INTERMEDIATE METALLIC CONDUIT (IMC)

A. Conduit: Galvanized steel.

B. Acceptable Manufacturers: Allied, Triangle, Steelduct, or approved equal.

2.02 RIGID METALLIC CONDUIT (RGS)

A. Rigid Steel Conduit: ANSI C80.1

B. Acceptable Manufacturers: Allied, Triangle, Steelduct, or approved equal.

2.03 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT

A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Pyle-National, or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover sheath.

2.04 FITTINGS

A. Fittings and conduit bodies for IMC and RGS conduit shall be of steel or malleable iron construction and hot-dip galvanized. Acceptable

Manufacturers: O-Z/Gedney, Thomas & Betts, Appleton Electric, Crouse Hinds, and Pyle National, or approved equal.

B. Fittings and conduit bodies for liquidtight metallic conduit (Seal-Tite) shall be:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed for grounding.

2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

3. Acceptable Manufacturers: Appleton Electric, O-Z/Gedney Co., Ideal Industries, Efcor, Thomas & Betts, Midwest, or approved equal.

2.05 RIGID NON-METALLIC CONDUIT AND FITTINGS

A. Rigid Smooth-Wall Non-Metallic Conduit: NEMA TC 2.

B. Acceptable Manufacturers: Amco Type 40, Carlon Type 40, Cantex, GPS, or approved equal.

C. Construction: Schedule 40 rigid polyvinyl chloride (PVC), UL labeled for 90°C.

D. Fittings and Conduit Bodies: NEMA TC 3;sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

E. Plastic cement for joining conduit and fittings shall be supplied by the conduit manufacturer.

F. Where non-metallic conduit is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be made before conduit becomes exposed. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.

G. All bends of rigid non-metallic conduit shall be made with the manufacturer's approved bending device. The use of spot heating devices, such as blow torches, will not be permitted.

PART 3 EXECUTION

3.01 CONDUIT SIZING

A. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, size conduit to avoid damage to the

conductors. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the National Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

B. Minimum Conduit Size (Unless Noted Otherwise):
   1. Above Grade: 1/2"

C. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.02 CONDUIT ARRANGEMENT

A. Arrangement shall be as inconspicuous as possible, in a neat and symmetrical manner. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Conduit runs shall be as shown on large scale drawings. Conduit routing on drawings scaled 1/4":1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, professional experience, applicable codes, and coordination with other contractors.

C. Route exposed conduit parallel and perpendicular to walls and adjacent piping.

D. This Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

E. This Contractor shall cooperate with all Contractors on the project. This Contractor shall obtain details of other Contractor's work in order to insure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. Repairing of work damaged as a result of neglect or error of This Contractor shall be done by the trades involved on order from the Engineer, but the cost of same shall be paid for by This Contractor.

3.03 CONDUIT SUPPORT

A. Conduit shall <u>not</u> be supported from ductwork, water or other piping, etc., unless approved by the Engineer. All supports shall be from the building

structure, unless noted otherwise, and coordinated with all other applicable Contractors.

3.04 CONDUIT TERMINATIONS

A. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

B. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, or approved equal.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with liquidtight flexible metallic conduit and fittings approved for grounding. Motors in hazardous areas, as defined in the National Electrical Code, shall be connected using flexible conduit rated for the environment.

F. All conduit ends shall be plugged with plastic, wood or brass plugs immediately after installation to prevent the entrance of moisture, plaster and other foreign matter during construction. The plugs shall be removed and the conduit blown clear and swabbed dry BEFORE any wires or pull cords are pulled in.

END OF SECTION

SECTION 16120

WIRE AND CABLE

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

2.01 BUILDING WIRE

A. Thermoplastic-insulated Building Wire: NEMA WC 5.

B. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600 volt insulation, THHN/THWN or as shown on the drawings.

C. Feeders and Branch Circuits Larger than 6 AWG in Underground Conduit: Copper, stranded conductor, 600 volt insulation, THWN.

D. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600 volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.

E. Control Circuits: Copper, stranded conductor 600 volt insulation, THHN/THWN or as shown on the drawings.

2.02 WIRE FOR SPECIALIZED SYSTEMS

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed:

1. Data/Link Alarm, Monitoring and Function Control System.

PART 3 EXECUTION

3.01 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.

B. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet.

C. The ampacity of multiple conductors in one conduit shall be derated per National Electrical Code, Article 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 hp, panelboards, motor control centers, etc.

D. Place an equal number of conductors for each phase of a circuit in same raceway or cable.

E. Splice only in junction or outlet boxes.

F. Neatly train and lace wiring inside boxes, equipment, and panelboards.

G. Make conductor lengths for parallel circuits equal.

H. All conductors shall be continuous in conduit from last outlet to their termination.

END OF SECTION

SECTION 16130

BOXES

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

2.01 OUTLET BOXES

A. Sheet Metal Outlet Boxes: Galvanized steel, minimum of 14 gauge, with 1/2 inch male fixture studs where required.

B. Outlet boxes for light fixtures to be 4" octagon box not less than 1-1/2" deep, deeper if required by the number of wires or construction.

C. Switch and receptacle outlet boxes for local light control and convenience outlets shall be FS or FD cast boxes (malleable iron or copper free aluminum) with steel coverplate.

2.02 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: Galvanized steel.

B. Sheet Metal Boxes Larger Than 12 Inches in Any Dimension: Hinged enclosure, unless otherwise noted.

PART 3 EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned.

C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc.

D. Locate and install to maintain headroom and to present a neat appearance.

END OF SECTION

SECTION 16141

WIRING DEVICES

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

NOT APPLICABLE

PART 3 EXECUTION

3.01 INSTALLATION

A. Install wall switches 48 inches above floor, OFF position down.

B. Install convenience receptacles 18 inches above floor, grounding pole on top.

C. Install specific-use receptacles at heights shown on the Contract Drawings.

D. Install receptacles vertically with ground slot up.

E. Install galvanized steel plates on outlet boxes and junction boxes.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

2.01 MATERIAL

A. Support Channel: Galvanized or painted steel.

B. Hardware: Corrosion resistant.

C. Steel Angle-Painted: Where indicated on the drawings.

PART 3 EXECUTION

NOT APPLICABLE

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

2.01 MATERIALS

A. Nameplates: Engraved three-layer laminated plastic, black letters on a white background.

B. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

PART 3 EXECUTION

3.01 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in switches, starters, panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

3.02 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates to identify all electrical distribution and control equipment, and loads served. Letter Height: 1/8 inch for individual switches and loads served, 1/4 inch for distribution and control equipment identification.

B. Obtain from Owner the wording or symbol required to identify equipment.

3.03 CONDUCTOR COLOR CODING

A. In each pull box, outlet cabinet, switch, starter, etc., the wires and cables when visible shall be color coded. the same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

B. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders and branch circuits, shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel, in colors specified below. The tape shall be applied at each conductor

termination with two 1" tape bands at 6" centers. Color coding shall be applied at all panels, switches, boxes, etc., where terminations are made.

C. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

D. Conductors shall be color coded as follows:

1. 120/240V, 3-Wire:

2. 460V, 3-Wire:
   A-Phase - Black
   A-Phase - Brown
   B-Phase - Red
   B-Phase - Orange
   Neutral - White
   C-Phase - Yellow
   Ground Bond - Green
   Neutral - Gray
   Ground Bond - Green

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

2.01 DISCONNECT SWITCHES

A. Fusible Switch Assemblies: NEMA KS 1; heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class R fuses.

B. Non-fusible Switch Assemblies: NEMA KS 1; heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: Type as indicated on the drawings.

2.02 ACCEPTABLE MANUFACTURERS - FUSES

A. Bussmann.

B. Littelfuse.

C. Shawmut.

2.03 FUSES

A. Fuses 600 Amperes and Less: Class RK1; or as indicated on the drawings; dual element, current limiting, 250 or 600 volt (to suit system voltage).

B. Interrupting Rating: 200,000 rms amperes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

END OF SECTION

SECTION 16470

PANELBOARDS/TRANSFORMER ASSEMBLY

PART 1 GENERAL

NOT APPLICABLE

PART 2 PRODUCTS

2.01 BRANCH CIRCUIT PANELBOARDS

A. Lighting/Appliance Branch Circuit Panelboards: Circuit breaker type.

B. Copper bus.

C. Copper ground bus.

D. Minimum Short Circuit Rating: 10,000 amperes rms symmetrical for 240 volt panelboards.

E. Molded case, plug-on type thermal magnetic trip circuit breakers. Common trip handle on 2 pole circuit breakers. Branch circuit breakers UL listed as Type SWD for lighting circuits.

2.02 TRANSFORMER SECTION

A. Dry type.

B. 2 - 5% FCBN taps.

C. Primary and secondary main circuit breakers.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboard/transformer assembly to wall providing auxiliary support devices needed.

B. Connect transformer primary terminals to 480 Volt, 3 phase service.

C. Connect branch circuits to circuit breaker in panelboard section.

D. Provide typed circuit directory.

3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at the panelboard. Should the difference at the panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION

SECTION 16480

SWITCHBOARD/MOTOR CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Main Service Switch

B. Combination Motor Starters

C. Distribution Switches

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D Company

B. General Electric Company

2.02 CONSTRUCTION

A. Factory-assembled, dead front, NEMA 3R weatherproof metal-enclosed, and self-supporting assembly conforming to NEMA PB2, and complete from incoming line terminals to lead-side terminations.

B. Electrical ratings and configurations as shown on the drawings.

C. Line and Load Terminations: Accessible from the front only, suitable for the conductor materials used.

D. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB2.

E. Bus Connections: Bolted, accessible from front only for maintenance.

F. Bus bars shall be fully isolated, braced for minimum 22,000 amperes rms symmetrical.

G. Provide a 1 X 1/4 inch copper ground bus through the length of the switchboard.

H. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

I. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.

2.03 SWITCHING AND OVER-CURRENT PROTECTIVE DEVICES

A. Fusible Switch Assemblies (600 Amperes and Smaller): Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class 'R' fuses, type as specified, with Class 'R' rejection clips.

B. The main switch of the assembly shall serve as the service disconnect.

2.04 MOTOR CONTROL DEVICES

A. Magnetic motor starter - NEMA ICS2; AC general purpose Class A magnetic controller rated in horsepower.

B. Full Voltage starting.

C. 120 Volt coil operating voltage.

D. Size as shown on drawings.

E. Auxiliary Contacts - Refer to drawings.

F. Hand/Off/Auto selector switch mounted in cover.

G. Provide phase loss protection relay with contacts to deenergize the starters. See drawings.

H. Assemble motor magnetic starter and fusible switch to form a combination starter in a common compartment.

PART 3 - EXECUTION

3.01 SUBMITTALS

A. Submit shop drawings and product data.

B. Indicate on shop drawings, front and side views of enclosures with overall dimensions. Include conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

C. Provide product data on combination motor starters, relays, pilot devices, and switching and over-current protective devices.

D. Submit manufacturer's instructions. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

3.02 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Install fuses in fusible switches.

C. Select and install heater elements in motor starters to match installed motor characteristics.

D. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

SECTION 16510

LIGHTING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior and exterior luminaires and accessories.

B. Lamps.

C. Ballasts.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site.

B. Store and protect products.

PART 2 PRODUCTS

2.01 MATERIALS

A. Refer to the Material List on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install lamps in luminaires and lampholders.

B. Support surface-mounted luminaires directly from building structure.

3.02 RELAMPING

A. Relamp luminaires which have failed lamps at completion of work.

3.03 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

B. Touch up luminaire finish at completion of work.

3.04 LUMINAIRE SCHEDULE

A. As shown on the drawings.

END OF SECTION

SECTION 16830

ELECTRIC UNIT HEATER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Horizontal discharge electric unit heaters.

PART 2 PRODUCTS

2.01 HORIZONTAL DISCHARGE ELECTRIC UNIT HEATERS

A. UL listed and labeled assembly, terminal box and cover, fan guard, and built-in controls. Blow-through design. Suitable for horizontal or vertical mounting.

B. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.

C. Cabinet: Heavy gauge steel with baked enamel finish, adjustable louvers, and mounting bracket.

D. Fan: Direct drive propeller type, statically and dynamically balanced.

E. Motor: Permanently lubricated sleeve bearings, totally enclosed, built-in thermal overload protection.

F. Control: Unit mounted thermostat, fan delay control, control voltage transformer, unit mounted disconnect switch. Automatic reset thermal overload.

G. Refer to the Material List on the drawings.

H. Acceptable Manufacturer: Q'mark.

PART 3 EXECUTION

3.01 INSTALLATION

A. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by the manufacturer.

B. Mount in accordance with manufacturers instructions.

END OF SECTION

SECTION 16840

EXHAUST FAN

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Propeller type fan, direct drive.

B. Wall Sleeve.

C. Operable louver with electric operator.

PART 2 PRODUCTS

2.01 EXHAUST FAN

A. Direct drive type.

B. Cast aluminum propeller.

C. Square steel frame.

D. Deep drawn Venturi orifice.

E. Totally enclosed motor with ball bearings.

F. See the Material List on the drawings.

G. Acceptable Manufacturers: Cook or Coolair.

2.02 WALL SLEEVE

A. 14 gauge galvanized steel.

B. Size to fit fan frame.

C. 1/2" galvanized hardware cloth in a frame.

2.03 OPERABLE LOUVER

A. Extruded aluminum, 0.081" thick.

B. Nylon shaft bearings.

C. Vinyl blade edges to seal.

D. 1/2" x 1/2" aluminum screen in frame.

E. See the Material List on the drawings.

F. Electric 2-position louver motor operator, 120 volt, not stall type, connected to terminals of fan motor.

G. Acceptable Manufacturers: Dowco or Arrow.

PART 3 EXECUTION

3.01 INSTALLATION

A. Assemble fan, operable louver, louver operator and screens into wall sleeve.

B. Frame opening in wall, provide auxiliary support steel and install assembly in opening.

C. Complete circuit connections and adjust operation.

D. Refer to the drawings for detail.

END OF SECTION

SECTION 16850

INLET LOUVER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Operable Louver with Electric Operator.

B. Wall Sleeve.

PART 2 PRODUCTS

2.01 OPERABLE LOUVER

A. Extruded aluminum, 0.081" thick.

B. Nylon shaft bearings.

C. Vinyl blade edges to seal.

D. 1/2" x 1/2" aluminum screens.

E. Electric 2-position louver motor operator, 120 volt, not stall type.

F. See the Material List on the drawings.

G. Acceptable Manufacturers: Dowco or Arrow.

2.02 WALL SLEEVE

A. 16 gauge galvanized steel.

B. Size to fit operable louver.

C. Aluminum screen in frame.

PART 3 EXECUTION

3.01 INSTALLATION

A. Assemble operable louver, louver operator and screens into wall sleeve.

B. Frame opening in wall, provide auxiliary support steel and install assembly in opening.

C. Complete circuit connections and adjust operation.

D. Refer to the drawings for details.

END OF SECTION

APPENDIX H

OPERATION AND MAINTENANCE PLAN

APPENDIX H
OPERATION AND MAINTENANCE PLAN

H.1 INTRODUCTION

This Operation and Maintenance (O&M) Plan has been prepared consistent with the requirements of Interim Measures Design as set forth in the Consent Order. The O&M Plan describes the general guidelines to be followed for effective operation and maintenance of the pump-and-treat system. The pump-and-treat system will be operated by Techalloy Company, Inc. (Techalloy) or one of its representatives.

The O&M Plan presents the purpose of the pump-and-treat system, general safety guidelines, general procedures for operation, and routine maintenance procedures for various equipment. The groundwater monitoring plan is presented in Subsection 6.2 of the Interim Measures Design Report. The O&M Plan does not incorporate vendor-supplied O&M literature on the various equipment items. Vendor O&M literature will be provided after the construction contractor has ordered the various equipment items. As part of the construction contract, the construction contractor will be required to compile vendor-supplied detailed O&M information for inclusion as attachments to this O&M Plan.

H.2 PURPOSE OF PUMP-AND-TREAT SYSTEM

A groundwater plume originating from the northern half of the Techalloy facility and migrating in a northwestward direction has been identified. The chemicals of concern in groundwater are 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), and tetrachloroethene (PCE). The main purpose of the pump-and-treat system is to prevent further migration of impacted groundwater, and to treat extracted water to acceptable levels for proper disposal.

H.3 PROCESS SUMMARY

The proposed system will extract the impacted groundwater, treat the impacted groundwater in a packed tower air stripper, and discharge the treated effluent to the South Branch of the Kishwaukee River. The pump-and-treat system will consist of a system of pumps, tanks, valves, instruments and electrical controls. The process flow is shown in Figure H-1.

The extraction well will pump at a design operating rate of 350 gallons per minute (gpm). The estimated average VOC concentrations in extracted groundwater are 1,450 ug/L 1,1,1-TCA, 150 ug/L TCE, and 110 ug/L PCE. The inorganic constituents of concern are iron and total suspended solids. The estimated concentrations of iron and total suspended solids in extracted groundwater are 5 mg/L and 94 mg/L, respectively.

Extracted groundwater will be pumped to the treatment system building using a submersible well pump. The pipeline conveying the extracted groundwater to the treatment system will be high density polyethylene (HDPE) with secondary containment. The double walled piping will also have a leak detection system.

The extracted water will flow to an aeration/surge tank. This tank will act as a flow equalizer and will oxidize iron in water to oxidation states that are insoluble in water. The water will then flow through a system of separator and cartridge filters for removal of suspended solids and insoluble iron oxides. The water will then flow through a packed bed air stripper for VOC removal.

From the air stripper, the water will flow through a cartridge filter for additional removal of metal oxide precipitates and suspended solids to meet Illinois effluent standards. The system has been designed to achieve 200 ug/L 1,1,1-TCA, 5 ug/L TCE, 5 ug/L PCE, 2.0 mg/L iron and 15 mg/L total suspended solids in effluent water. The treated water will be discharged using an effluent pump to the nearby South Branch of the Kishwaukee River.

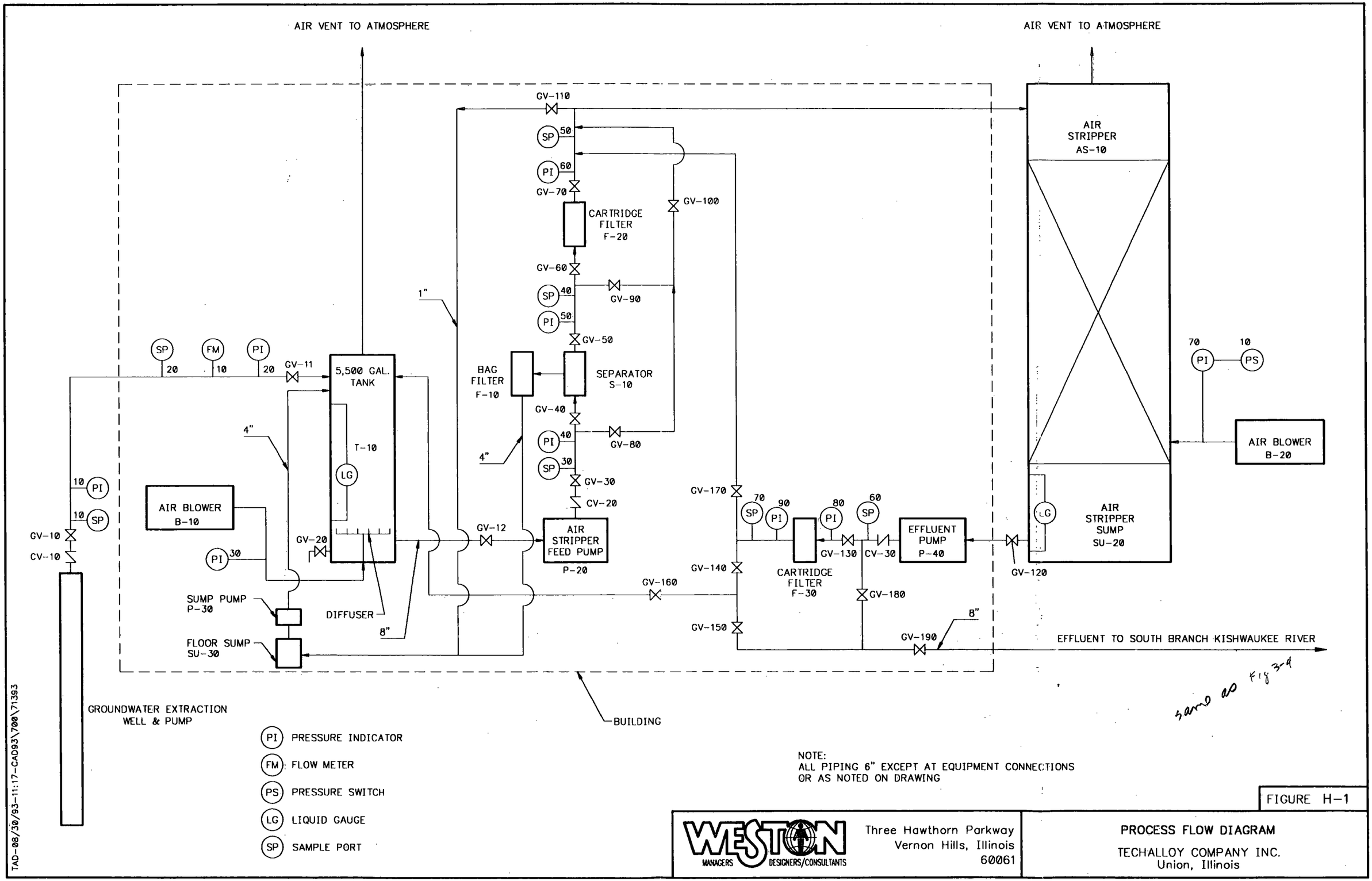


FIGURE H-1

WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

PROCESS FLOW DIAGRAM

TECHALLOY COMPANY INC.
Union, Illinois

H.4 SAFETY GUIDELINES

Safety procedures and lists of any hazardous materials must be made and kept with responsible personnel for reference and use during operation and maintenance. Periodic review of safety procedures is recommended. All procedures must be in compliance with OSHA. Specific safety requirements associated with the operation and maintenance of various equipment will be provided by the vendors. However, general safety guidelines for the treatment system is summarized below.

Environmental

The water being treated by this plant is contaminated by organic compounds. These contaminants are not present in high concentrations, but have been shown in some cases to be carcinogenic (cancer causing) or in other ways harmful to human health. Following general safety guidelines must be used:

1. Prevent contact with human skin by the water being treated.
2. Repair all leaks immediately. Water that has leaked or been spilled should be routed to the floor sump, where it will be pumped to treatment.
3. Ventilate the room if leaks are very large volume or long in duration. Some of the contaminants will evaporate from the water and be present in the air.

Chemical

Chemicals which may be used for cleaning and any other purposes may be hazardous. Cleaning chemicals may pose some hazards where splashing and/or spraying could occur. Suitable protective clothing, eye protection, and gloves are recommended and should be used as required by the chemical manufacturer.

Electrical

The treatment system may present a danger of electrical shock. All motors, instruments, and panels should only be serviced by an Illinois licensed electrician. Pumps and blowers are equipment that rotate at high rpm. Keep all guards in place. Do not wear loose clothing or jewelry around this equipment. When working on a motor, pump or blower, the equipment should be turned off at the motor control panel. Check twice to confirm that the equipment has been properly isolated and locked out. Safety procedures should be strictly followed with respect to equipment tagging out.

H.5 PUMP-AND-TREAT SYSTEM OPERATION

This subsection describes the basic operation of the pump-and-treat system. This will help in understanding and adjusting the operation of the plant. Figure H-1 shows the process flow.

Well Pump (P-10)

There is one groundwater extraction well on the site. A pump hanging by a cable in the well transfers water from the well through a sampling port (SP-10), a pressure indicator (PI-10) and an underground pipeline to the treatment system building. The pipeline has secondary containment with a leak detection system. Check valve, CV-10, will prevent water in the pipeline from flowing back into the well pump. A gate valve, GV-10, will be provided after the check valve CV-10. The pumping rate will be controlled by a gate valve (GV-11) located in the treatment building.

Well Level Control

A level control switch in the well prevents the well pump from running dry. The pump will be damaged if it runs without proper water flow. When the water level drops below the lower switch the relay drops out and the pump stops. A red light will show on the main

control panel. To restart the well, the water level must rise above operating level switch, latching the circuit. A green light shows on the main control panel when the well is running.

Pressure Indicators (PI-10, PI-20)

Pressure indicator indicates the head produced by the pump at the current flow. The pressure indicator along with the flowmeter will confirm that the pump is running. Exact readings can be compared to the pump curve to indicate the condition of the pump. If pressure is indicated but there is no flow, the pump must be turned off until the closed valve or the source of the blockage is found.

Flowmeter (FM-10)

The flowmeter in the treatment building provides a visual reading of the rate of flow from the well in gallons per minute.

Sampling Ports (SP-10, SP-20)

Sampling port SP-20 will be utilized for monitoring influent water quality. For the Interim Measures Pump and treat system, sampling port SP-10 will provide the same data as SP-20. However, if additional wells are added to the extraction system during corrective measures, SP-10 will provide extracted water quality data for the well, and SP-20 will provide water quality for the influent to the treatment system

Extraction System Piping and Leak Detection System

Underground piping made of high density polyethylene (HDPE) transports the extracted groundwater to the surge/aeration tank in the treatment system building. The piping is double walled to provide secondary containment and includes a leak detection system. The leak detection system consists of a sensor cable with a relay for remote indication of an alarm condition at the control panel.

Surge/Aeration Tank (T-10)

Extracted water accumulates in the surge/aeration tank (T-10) for equalization of flow and iron oxidation. The tank is equipped with water level gauges and an air inlet duct. A high level switch in the surge tank shuts down the well pump in the event that the water level exceeds the high level set point. A low level switch in the surge tank shuts down the air stripper feed pump in the event that the water level goes below the low level set point. The tank also has a gate valve (GV-20) at the bottom to drain any water from the surge tank for maintenance. Water will run to the floor sump (SV-10). Gate valve GV-12 has been provided to shut off water supply when the air stripper feed pump (P-20) is taken out for maintenance.

Surge Tank Blower (B-10)

The surge tank blower (B-10) introduces air at the bottom of the surge tank through a diffuser assembly. The blower is equipped with a pressure indicator (PI-30). The blower will shut off if excessive pressure develops at the blower discharge.

Pretreatment Filter System

The pretreatment filter system consists of a separator (S-10) and a cartridge filter system (F-10). The separator (S-10) removes dense and large size particles before water enters the cartridge filter (F-20). The separator has a timer that activates the blow down from the separator in 3-7 second intervals. The timer between blowdowns can be adjusted as desired. The blowdown goes through a bag filter (F-10). Solids are retained by the bag filter, and water drains by gravity to the floor sump (SU-10). The cartridge filter (F-20) removes finer size particles.

Floor Sump (SU-10)

Floor sump, SU-10, receives water from the bag filter (F-10) and any water spilled on the floor. In addition, during maintenance, drain water from the surge tank (T-10) is also directed towards the floor sump. Water from the floor sump is pumped to the surge tank using a sump pump (P-30). The sump pump (P-30) is controlled by a level switch in the pump. The floor sump (SU-10) also has a high level switch connected to an alarm at the control panel.

Pressure Indicators (PI-40, PI-50, PI-60)

Pressure indicators PI-40, PI-50 and PI-60 monitor pressure upstream and downstream of separator (S-10) and cartridge filter (F-20). Excessive pressure indicates that the equipment is getting clogged and needs maintenance.

Sampling Ports (SP-30, SP-40, SP-50)

Sampling port SP-30 can be used to determine the extent of oxidation in the surge tank (T-10) and to determine if there are any dense and large size particles. Sampling port SP-40 can be used to determine effectiveness of the separator (S-10) and to determine requirements for the cartridge filter (F-20). Sampling port SP-60 can be used to determine effectiveness of the cartridge filter (F-20) and to provide influent water quality for the air stripper (AS-10).

Pretreatment System Gate Valves (GV-40, GV-50, GV-60, GV-70, GV-80, GV-90, GV-100, GV-110)

If separator (S-10) and cartridge filter (F-20) are used, gate valves GV-40, GV-50, GV-60 and GV-70 should be open, and gate valves GV-80, GV-90, GV-100 and GV-110 should be closed.

If it is determined that the separator (S-10) is not required, gate valves GV-80, GV-90, GV-60 and GV-70 should be open, and gate valves GV-40, GV-50, GV-100 and GV-110 should be closed.

If it is determined that both the separator (S-10) and the cartridge filter (F-20) are not needed, gate valves GV-80 and GV-100 should be open, and gate valves GV-40, GV-50, GV-60, GV-70 and GV-90 should be closed.

Gate valve GV-110 will be open only when the air stripper (AS-10) is not in operation. This will allow water in the pipeline to drain to the floor sump (SV-10) and thus avoid freezing during winter.

Packed Column Air Stripper (AS-10)

The air stripper utilizes a single stage packed bed countercurrent flow scheme. Influent water enters at the top of the tower utilizing an influent water distribution system. Air is introduced at the bottom of the tower. The air stripper sump (SU-20) has a high level switch which will override the air stripper feed pump control and shut off the air stripper feed pump. A gate valve GV-120 has been provided to shut off water supply to the effluent line during effluent pump (P-40) maintenance.

Air Stripper Blower (B-20)

The air stripper blower (B-20) introduces air at the bottom of the air stripper. The blower is equipped with a pressure switch (PS-10) and a pressure indicator (PI-70). The pressure switch (PS-10) shuts off the blower if excessive pressure develops at the blower discharge. The shut down of the blower by the high pressure results in the activation of the alarm and the shut down of the air stripper feed pump. The excessive pressure indicates that cleaning of packings in the air stripper is needed.

Air Stripper Feed Pump (P-20)

The feed pump develops pressure to transfer the water from the surge tank (T-10) through a filtration system and to the top of the air stripping column. The feed pump is controlled by switches in the surge tank. A low level switch is the surge tank shuts off the pump so that the pump does not operate without water. An operating level switch in the surge tank allows the feed pump to restart after the pump has been shut off by the low-level switch. a high level switch in the air stripper sump (SU-20) overrides the air stripper feed pump control and shuts off the air stripper feed pump. The feed pump rate is controlled by gate valve GV-30. A check valve, CV-20, is provided to prevent any water from flowing back into the feed pump.

Effluent Pump (P-40)

The effluent pump (P-40) develops pressure to force the water from the air stripper sump through a second stage of cartridge filtration and to the discharge location at the South Branch of the Kishwaukee River. The effluent pump is controlled by switches in the air stripper sump. A low level switch in the sump shuts off the pump. An operating level switch allows the effluent pump to restart after the pump has been shut off by the low level switch. A check valve CV-20 has been provided to prevent any water from flowing back into the pump (P-40).

Effluent Cartridge Filter (F-30)

The effluent filter system consists of a cartridge filter (F-30). This filter provides for additional removal of any metal oxide precipitates and suspended solids to meet Illinois effluent standards.

Pressure Indicators (PI-80, PI-90)

Pressure indicators PI-80 and PI-90 monitor pressure upstream and downstream of the effluent cartridge filter (F-30). Excessive pressure indicates that the filter (F-30) is getting clogged and needs maintenance.

Effluent Sampling Ports (SP-60, SP-70)

Sampling port SP-60 can be used to determine if there is any need for effluent filter (F-30). If water sample collected from sampling port SP-60 meets Illinois effluent limitations, then the effluent filter (F-30) can be bypassed. If water sample collected from sampling port SP-60 does not meet Illinois effluent limitation, then water will pass through the effluent filter (F-30) and effluent water quality will be monitored by sampling port SP-70.

Effluent System Gate Valves (GV-130, GV-140, GV-150, GV-160, GV-170, GV-180)

If water sample from sampling port SP-60 meets Illinois effluent limitations, gate valve GV-180 should be open, and gate valves GV-130, GV-140, GV-150, GV-160 and GV-170 should be closed.

If the effluent cartridge filter (F-30) is needed and water sample from sampling port SP-70 meets Illinois effluent limitations, gate valves GV-130, GV-140 and GV-150 should be open and gate valves GV-160, GV-170 and GV-180 should be closed.

If flooding occurs in the air stripper (AS-10), gate valves GV-180, GV-150 and GV-160 should be open, and gate valves GV-130, GV-140 and GV-170 should be closed.

If a cleaning solution is utilized for cleaning the air stripper (AS-10) packings, gate valves GV-180, GV-150, GV-140, and GV-170 should be open, and gate valves GV-130 and GV-160 should be closed.

H.6 REGULAR INSPECTION AND MAINTENANCE GUIDELINES

Regular inspection and maintenance of the pump-and-treat system is required for effective operation. Detailed inspection and maintenance information will be provided by equipment specific vendor. General inspection and maintenance guidelines are provided below.

- Note pressure indicated by all pressure indicators.
- Note flow rate indicated by all flowmeters.
- Note any alarms on the control panel. If high pressure alarm has occurred, determine which equipment is fouled. Reset alarm and perform maintenance. If leak detection alarm has occurred, determine location of the leak. Reset alarm and perform required maintenance.
- Check pump oil level and add as required to raise to the level of the lower plug.
- Grease blower bearings.
- Disassemble and clean level gauges and flow indicators as required.
- Determine the cause of all new noises and vibration in rotating equipment, and correct.

H.7 EFFLUENT MONITORING

The discharge of treated water to the South Branch of the Kishwaukee River will be monitored according to the requirements of the NPDES permit. Sampling ports SP-60 and SP-70 will be utilized for this task, as necessary.

APPENDIX I

CONSTRUCTION QUALITY ASSURANCE PLAN

APPENDIX I

CONSTRUCTION QUALITY ASSURANCE PLAN
INTERIM REMEDIAL MEASURE
TECHALLOY SITE

1 INTRODUCTION

The objective of this Construction Quality Assurance (CQA) Plan is to ensure the completion of the groundwater extraction, treatment and discharge system in strict accordance with the construction plans and specifications. This CQA Plan will outline the roles and responsibilities of the Engineer and Contractor with respect to inspection and testing activities throughout the course of construction. This CQA Plan will describe reporting and documentation procedures to be used to verify and certify that construction was completed in accordance with the plans and specifications. Through the use of this plan, the contractor and Engineer will be able to identify deficiencies in or deviations from the specifications, and resolve the issues quickly and efficiently. A copy of the CQA Plan and all CQA documentation will be retained at the site by the Engineer.

This plan has been developed in accordance with generally acceptable construction quality assurance procedures. The plan is submitted in accordance with the requirements of the Consent Order for the Interim Measures at the Techalloy site in Union, Illinois.

1.1 Quality Assurance and Quality Control

This plan has been prepared to assist the engineer with daily inspection activities and testing required to ensure the interim remedial measure is constructed in accordance with the plans and specifications. The specifications discuss both quality assurance and quality control activities to be performed during the course of construction. Quality assurance and quality control are defined in this CQA Plan as follows:

- Construction Quality Assurance is a planned and systematic set of activities designed to allow the Engineer to review testing results, verify construction

practices and generally provide a satisfactory level of confidence that the work has been completed in accordance with the contract specifications and regulatory requirements. The management of CQA activities is the responsibility of the Engineer.

- Construction Quality Control is a planned and systematic set of activities performed by the contractor to verify the construction materials and practices are consistently meeting the specifications and regulatory requirements outlined in the contract documents.

This plan also provides a framework for overseeing the contractors CQC requirements detailed in the individual specification sections. Each specification section describes the specific material and workmanship testing required to ensure that the activity is completed in accordance with stated requirements and includes the frequency of inspections and specific documentation and reporting requirements. CQA activities are performed independently of CQC activities, but together provide a means of comparing and verifying inspection results and construction techniques throughout the prosecution of the work.

1.2 Scope of the Remedial Action

The main objective of the Interim Measures pump-and-treat system is to prevent further migration of impacted groundwater. The major elements of the interim remedial measure are summarized as follows:

- Groundwater Extraction System
  - Extraction well
  - Extraction system piping
  - Pumping system
  - Control Systems
  - Equipment Enclosure

- Groundwater Treatment System
  - Pretreatment system

- Air stripping system
- Effluent filter system
- Treatment system pumps and piping
- Control systems
- Equipment Enclosure

- Discharge System

  - Treated Water Discharge Piping
  - Treated Water Discharge Pumping System
  - Control Systems

1.3 Scope of the CQA Plan

The plan outlines the procedures to be followed by the Engineer during construction and installation of the groundwater extraction, treatment and discharge system at the Techalloy site. Specifically the CQA Plan describes the following:

- Responsibility and Authority - The plan identifies each organization and its respective role and responsibility in the quality assurance process. Additionally, it identifies the qualifications of each CQA inspection staff member and delineate that persons authority over construction activities.

- Inspection activities - The plan outlines the specific tests and inspections required to be performed by the Engineer prior to, during and at the completion of construction activities.

- Documentation - The plan identifies the reporting requirements, frequency and information required to fully document each phase of construction to ensure compliance with the contract documents.

2 PROJECT ORGANIZATION AND RESPONSIBILITY

Successful completion of the interim remedial measure is dependent on successful communication and delegation of responsibilities among all parties involved with the

planning, oversight, and construction of the interim remedial treatment system. The roles and responsibilities of each party is outlined below.

- U.S. Environmental Protection Agency - The U.S. EPA has the responsibility to review plans, provide regulatory guidance, and approve construction methods and materials on a project wide basis. Final approval of the remedial measure and certification of contract completion is the responsibility of the U.S. EPA.

- Techalloy - The Techalloy company is responsible for implementing the interim remedial measure at the prescribed location. Techalloy will comment on the detailed design plans, provide approvals for modifications to specific design requirements suggested by the Engineer, and will review CQA reports and testing documentation provided by the Engineer during construction.

- Engineer - The Engineer will supervise all field inspection and construction activities to ensure compliance with the plans and specifications. The Engineer will complete periodic inspections of materials and constructed work and will document the results of each inspection on weekly inspection forms to be submitted to the U.S. EPA after review by Techalloy. The Engineer may assign a resident engineer to act as CQA Manager at the site during construction. The CQA Manager will be present and verify activities related to quality assurance. The CQA Manager will report directly to the Engineer.

- Contractor - The contractor will be responsible for all aspects of quality control required to complete the work in accordance with the plans and specification. The contractor shall be held solely responsible for completing construction of the interim remedial measure in accordance with the plans and specifications.

3 MEETINGS AND STATUS REPORTS

Meetings will be held throughout the construction process to ensure effective communication and efficient problem resolution. Through the use of this meeting forum, discrepancies or deficiencies can be identified early in the project and can be resolved while maintaining project schedule and contract budget. A brief description of each type of meeting follows:

3.1 Pre-Construction CQA Meeting

The pre-construction meeting will occur directly after the award of the contract to the remedial contractor. The meeting attendees will include the U.S. EPA, Techalloy, the Engineer and the remedial contractor. The purpose of the meeting will be to ensure an understanding of the scope of work, discuss schedule and coordination issues prior to mobilization, determine lines of authority and levels of responsibility, and to determine procedures/protocols for documentation and communication between organizations. delete

3.2 Weekly Progress Meetings.

Weekly progress meetings will occur on a preset day, determined by the Engineer, to discuss specific construction activities for the previous week. The meeting will be attended by the Engineer and the on-site remedial contractor representative. The meeting will cover specific tasks such as CQA/CQC testing completed, project schedule to date, areas of concern or possible deficiencies as identified by the Engineer, invoicing or payment concerns, or documentation issues. Minutes of each meeting will be prepared by the Engineer and distributed to all members of the construction team to allow for continued discussion and awareness to site specific situations.

3.3 Problem or Work Deficiency Meetings

Problem or work deficiency meetings will be held on an as needed basis. Any party can request a problem or work deficiency meeting to discuss issues requiring immediate attention. The list of attendees will depend on the agenda item requiring attention. The Engineer and contractor will discuss possible solutions to the situation and determine the most appropriate course of action. The Engineer will then either authorize the work, if within his authority, or request approval from the appropriate agency.

4 CONSTRUCTION QUALITY ASSURANCE TESTING AND INSPECTION

The testing and inspection activities described in this CQA Plan will be completed by the Engineer to document and verify results of CQC testing and inspections performed by the

contractor during construction activities. The Engineer will use this data along with the contractor quality control testing and inspection reports to certify that the construction was consistent with the contract plans and specifications and meets all regulatory requirements.

This section will describe the specific quality assurance tests and inspections required to be performed by the Engineer during construction of the interim remedial measure. Quality control requirements to be performed by the contractor are described in the specific specification section pertaining to the item.

4.1 Mobilization

Prior to mobilization activities, the Engineer will review the contractor health and safety plan including certifications of each site worker and site specific training and instruction. The Engineer will review material specifications to ensure material destined for installation conforms to the specifications. The Engineer will oversee mobilization activities to ensure the site access and easements are appropriate for the work being completed. The Engineer will maintain a record of all initial training, briefings and preparation work completed during mobilization activities.

4.2 Groundwater Extraction System

Prior to installation of the groundwater extraction well, the Engineer will document, through photograph, the existing site conditions in and around the well site. The Engineer will be present during installation of the extraction well and ensure that proper drill logs are prepared to document the subsurface geology existent near the well installation. The Engineer will inspect the materials used for construction of the well, the vertical alignment, the development of the well, management of drill cuttings and development water, and the filter pack and backfill material used to complete the well installation. The Engineer will verify that the well is installed in accordance with the plans and specifications.

4.3 Extraction/Discharge Piping

The Engineer will inspect the extraction/discharge system piping to verify the material conforms to the specifications. The Engineer will review material certifications provided with the material when delivered and will visually inspect each shipment of piping and piping components to ensure no damaged or defective material is delivered to the site. During installation, the Engineer will document the type of bedding material used and the placement techniques. The in-place density as determined by the contractor will be recorded by the Engineer. All equipment used for excavation, fusion and backfilling will be inspected by the engineer for safety and serviceability. The location and depth of piping will be documented in accordance with the plans and specifications.

The contractor will provide the Engineer with the necessary certifications to ensure the welding machine operator has sufficient experience to perform the necessary work in accordance with the specifications. The Engineer will inspect and record to operating temperatures of all HDPE welding machines used for pipe fusion operations. The Engineer will inspect the double walled piping for proper placement of the support and spacer system. The Engineer will periodically inspect pipe sections to ensure no obstructions or foreign matter exists within the pipe sections prior to installation.

4.4 Pumping System

The Engineer will inspect each component of the pumping system to ensure the material supplied to the site meets the design requirements set forth in the plans and specifications. The Engineer will observe the unloading and storage of all pump components and will visually inspect delivered material for defects or damage. The Engineer will reject any material that is not in compliance with the specifications or has been damaged during transportation or delivery. The Engineer will be present during pump system installation to ensure all quality control testing is completed in accordance with the specifications.

4.5 Groundwater Treatment System

The Engineer will inspect the air stripper treatment unit and all additional components for compliance with the plans and specifications. The Engineer will visually inspect the unit for damage or missing/defective components. The unit will be installed by the contractor as stated in the specifications and the manufacturers recommendations. The Engineer will document all installation activities through the use of daily progress reports and photographs.

The Engineer will coordinate, inspect, and document a comprehensive system start-up program to ensure that all of the system components function as intended. The system start-up will consist of operating the groundwater treatment system at a reduced rate and inspecting and adjusting, as necessary, all mechanical and electrical control features of the system. Each system alarm condition will be activated to insure that the system shut-down and alarm circuitry functions as intended. All start-up activities will be documented and all deficiencies noted and corrected prior to full scale system operation.

4.6 Mechanical and Electrical Inspection

The Engineer will inspect and fully document all mechanical and electrical installation for both the extraction well/pumping system and the treatment/discharge unit. The mechanical and electrical components (i.e. valves, meters, gauges, etc.) shall meet the requirements of the specifications and shall be installed in accordance with the specifications and manufacturer recommendations. All valves and gauges will be inspected to ensure the units are properly oriented to the direction of flow. All electrical equipment will be inspected to ensure the proper grounding and power is supplied to allow for proper functioning of the equipment.

4.7 Equipment Enclosures

The Engineer will review and approve all equipment enclosure designs prior to delivery to the site. The Engineer will inspect the plans for constructability, long-term durability and suitability for the intended use. Manufacturer certifications of materials will be reviewed by the Engineer at the time of delivery. The Engineer will visually inspect the enclosures during construction for stability and completeness. Any deviations from the approved plans and specifications will be corrected or modified in accordance with the specifications.

5.0 CQA DOCUMENTATION

Successful completion of the project depends on the strict adherence to the plans and specifications. Verification of compliance with the plans and specifications is documented through the use of a detailed and well managed construction quality assurance/quality control plan implemented by both the Engineer and the contractor. Quality control activities are performed by the contractor and documented through various methods by both the Engineer and the contractor. This section describes the documentation procedures to be followed during construction activities.

5.1 Daily Recordkeeping

The contractor will prepare and submit to the Engineer a daily progress report covering all activities performed by the contractor that day. The report will include weather conditions, subcontractors present on-site that day, work completed to include location, description and contractor completing work; equipment status reports to include down time of critical pieces of equipment, and material type and quantities delivered to the site. This information will be presented on a daily basis on the preprinted form shown in figure 1.

In addition to logistics information, the daily report will include discussions of conflicts or deficiencies in plans and the action taken by the contractor and/or the Engineer to resolve such conflicts.

5.2 Field Logbooks

Both the Engineer and the contractor's representative will maintain a field logbook. The field logbook will be a bound, hard cover logbook in which the Engineer or contractor records specific field incidents as they occur. The information documented in this logbook will be used to prepare the daily progress report. The logbook should also be used to document general site conditions, visitors, incidents or specific visual inspections for use at a later date in recreating events of the day. Each log entry will be dated, each event's time of occurrence logged in, and the daily entry will be signed by the holder of the logbook.

5.3 Photographic Records

The Engineer will periodically take photographs to document major portions of installation activities or incidents to allow for more accurate reporting on the daily progress forms. Photographs will be identified with a specific, unique numbering system and the corresponding number identified in the daily progress report form. Photographic documentation shall be used as a means of supplementing the daily progress report, but shall not be a substitute for a properly completed daily report.

5.4 Problem Identification and Corrective Measures Reporting

Information concerning a problem or corrective measure may be reported on a daily progress report or may be included as a separate document. At a minimum, this document should include a detailed description of the problem to include location, time of event, and personnel present during identification of the problem. A discussion on how the problem was located (i.e., reference to a specific inspection procedure/report, etc.) should be included to document supporting data that could be used in problem resolution. Finally, an analysis of the probable causes and potential solutions to the issue should be provided. Following receipt of the problem identification report, the Engineer will review the situation, determine a course of action and provide guidance on the selected remedy.

5.5 Acceptance Reports

Following completion of each major task under the scope of the specifications, the Engineer will conduct all necessary quality assurance inspections and prepare an acceptance report documenting the successful completion of that portion of the contract work. This report will be provided to the contractor to allow the contractor to continue with installation of additional components of the treatment system without further delays caused by inspection activities. The acceptance report will be supplemented by quality control and quality assurance testing reports to provide a clear description of the work in place. The issuance of this acceptance report by the Engineer in no way relieves the contractor from the responsibility of completing the work in accordance with the plans and specifications. This acceptance report is an administrative tool to provide notification to the contractor that sufficient time has been given to the Engineer to complete the required inspection activities. If, at a later date, the Engineer discovers work was not completed in accordance with the specifications, the contractor will be required to repair or replace the work at no additional cost to the Engineer.

5.6 Storage of Records

During construction, the Engineer shall be responsible for managing and maintaining all documents pertaining to construction quality assurance. This includes the contract plans and specifications, daily progress reports, supplemental conflict/deficiency submittals, acceptance reports, and all inspection data sheets. The Engineer may elect to maintain a duplicate file at another location to avoid loss of this information if the originals were to be destroyed. Once construction is completed, the Engineer will provide copies of the quality assurance documentation to the U.S. EPA and maintain a permanent record file.

Figure 1

CONSTRUCTION QUALITY CONTROL DAILY REPORT

COMPANY NAME: _____
INSPECTOR: _____

REPORT NO. _____ CONTRACT NO. _____ DATE _____
LOCATION OF WORK: _____

DESCRIPTION: _____

WEATHER ____, RAINFALL ____ INCHES, TEMP.: MIN. ____ MAX. ____

1. Work Performed Today by Prime Contractor (Plant and Labor Breakdown):

_____
_____
_____
_____
_____
_____
_____

2. Work Performed Today by Subcontractors (Plant and Labor Breakdown):

_____
_____
_____
_____
_____
_____
_____
_____

3. Type: (Circle one: P-Preparatory, I-Initial, F-Final).

   Results of Inspection: (Include Satisfactory Work Completed or Deficiencies with Action to be Taken).

_____
_____
_____
_____

4. List Type and Location of Tests Performed and Results of These Tests:

_____
_____

5. Verbal Instructions Received from CQA Personnel on Construction Deficiencies or Re-testing Required: _____

_____

6. Safety Violations Observed and Actions Taken: _____

_____

_____

7. Remarks: _____

_____

_____

8. CERTIFICATION: I certify that the above report is complete and correct and that I, or my authorized representative, have inspected all work performed this day by the prime contractor and each subcontractor and have determined that all materials, equipment, and workmanship are in strict compliance with the plans and specifications, except as may be noted above.

Contractor Quality Control Representative

_____

Signature