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April 17, 2013

Jan Palumbo (AWT -121)
United States EPA, Region 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101

Subject: Corrective Measures Study, Revision 3
J.H. Baxter Arlington Facility
Docket No. RCRA-10-2001-0086

Dear Ms. Palumbo:

On behalf of J.H. Baxter & Co., please find enclosed two copies of the Corrective Measures Study, Revision 3, for J.H. Baxter's Arlington Facility. This Corrective Measures Study is being submitted in accordance with the conditions provided in the Administrative Order on Consent, U.S. EPA, Region 10 Docket No. RCRA-10-2001-0086. A compact disk containing the electronic files is also included. If you have any questions, please do not hesitate to contact me at (503) 639-3400.

Sincerely,

AMEC Environment & Infrastructure, Inc.

J. Stephen Barnett
Associate Geologist

c: Georgia Baxter, J.H. Baxter & Co.
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Corrective Measures Study
Revision 3

J.H. Baxter & Co.
Arlington, Washington Facility

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to evaluate the information submitted. I certify that the information contained in or accompanying this submittal is true, accurate, and complete. As to those identified portion(s) of this submittal for which I cannot personally verify the accuracy, I certify that this submittal and all attachments were prepared in accordance with procedures designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those directly responsible for gathering the information, or the immediate supervisor of such person(s), the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Signature: Georgia Baxter Date: 04/16/13

Georgia Baxter
Chief Executive Officer
J.H. Baxter & Co.

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
AMEC	AMEC Environment & Infrastructure, Inc.
AOC	Administrative Order on Consent
Arlington facility	Former J.H. Baxter & Co. wood treating facility in Arlington, Washington
Baxter	J.H. Baxter & Co.
bgs	below ground surface
BNSF	BNSF Railway Company
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CLARC	Clean-Up Levels and Risk Calculations
CMOs	corrective measure objectives
CMS	Corrective Measures Study
COCs	constituents of concern
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CSM	conceptual site model
DCP	dichlorophenol
DNAPL	dense nonaqueous-phase liquid
DROs	diesel-range organics
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
facility	Former J.H. Baxter & Co. wood treating facility in Arlington, Washington
GAC	granular activated carbon
gpm	gallons per minute
ICs	institutional controls
ISCST3-PRIME	Industrial Source Complex-Short Term Plume Rise Model Enhancements
LNAPL	light nonaqueous-phase liquid
MCLs	Maximum Contaminant Levels
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NAPL	nonaqueous-phase liquid
NPDES	National Pollutant Discharge Elimination System

OSWER	US Environmental Protection Agency, Office of Solid Waste and Emergency Response
PAHs	polycyclic aromatic hydrocarbons
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
PCP	pentachlorophenol
pg/g	picograms per gram
POTW	publicly owned treatment works
PPE	personal protective equipment
PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act
RRO	residual range oil
RSL	Regional Screening Level
SI	site investigation
site	Former J.H. Baxter & Co. wood treating facility, in Arlington, Washington, and areas of soil and/or groundwater affected by releases from the facility
Stella-Jones	Stella-Jones Corporation
TCP	trichlorophenol
TeCP	tetrachlorophenol
TEQ	toxicity equivalents
WAC	Washington Administrative Code

CORRECTIVE MEASURES STUDY - REVISION 3
Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

1.0 INTRODUCTION

The J.H. Baxter Project Team, consisting of J.H. Baxter & Co. (Baxter) and AMEC Environment & Infrastructure, Inc. (AMEC), has prepared this revised Corrective Measures Study (CMS) for the former Baxter wood-treating facility located at 6520 188th Street NE in Arlington, Washington (Arlington facility or facility [Figure 1-1]).

This revised CMS is being implemented pursuant to Paragraph 53 of the United States Environmental Protection Agency (EPA) Administrative Order on Consent (AOC) dated April 30, 2001 (EPA, 2001). All CMS activities are consistent with guidance provided by EPA in the Resource Conservation and Recovery Act (RCRA) Corrective Action Plan (Final), dated May 1994 (EPA, 1994), the Corrective Action Advance Notice of Proposed Rulemaking (EPA, 1996), and the AOC.

This Revision 3 incorporates the July 27, 2012, comments received from EPA (EPA, 2012) on the March 2011 CMS Revision 2 (Baxter, 2011a). Revision 2 incorporated the July 19, 2007, comments received from EPA (EPA, 2007a) on the January 12, 2007, CMS (Baxter, 2007a), as well as information related to the pilot study conducted with EPA approval to assess performance of the recommended alternative presented in the January 12, 2007 CMS. The pilot study was undertaken to satisfy EPA concerns as to the implementability of the recommended alternative, and was conducted as outlined in the Remedial Action Pilot Study Work Plan (Baxter, 2007b), which was approved by EPA on October 16, 2007 (EPA, 2007b).

Various companies have worked with Baxter since initiation of the AOC, including Premier Environmental Services Inc. (now Earthcon Consultants, Inc.), who primarily coordinated field investigation, groundwater monitoring, and reporting activities. In addition, Geomatrix Consultants Inc. and AMEC Geomatrix Consultants Inc. (both now AMEC) provided engineering and construction support for the project. AMEC is currently supporting Baxter with both investigative and engineering tasks. Citations used in this CMS to reference earlier studies may identify one of the above referenced companies as the prime author; however, in cases of collaborative work, references may be cited as "Baxter," or the "J.H. Baxter Project Team." References are provided in Section 12.

1.1 PURPOSE AND OBJECTIVES

The purposes of this document are to:

- Define corrective measures objectives for the Baxter Arlington site, which comprises the Arlington facility and areas of soil and groundwater affected by releases from the facility (site);
- Present proposed cleanup levels for constituents of concern (COCs);
- Present corrective measures alternatives developed for the facility based on the results of the previously completed site investigation (SI) (Baxter, 2005) and subsequent supplemental facility investigations (Premier, 2011); and
- Present the results of the pilot study conducted at the facility.

COCs, the affected media, and the potential receptors and exposure pathways were identified during the site investigation (Baxter, 2005) for each area of the facility. Functional and quantitative remedial action objectives are developed in this CMS to address conditions where concentrations of COCs are greater than proposed cleanup levels. EPA will develop final cleanup levels as part of the remedy selection process.

A range of corrective measures technologies that were potentially applicable to the remediation of affected media and COCs were identified and screened. Those technologies that were advanced through the screening process were then combined and developed into corrective measures alternatives for further evaluation.

The objective of the evaluations conducted in this CMS is to identify and select a technically responsive and cost-effective set of corrective measures to be implemented at the Arlington facility.

1.2 DOCUMENT OVERVIEW

This CMS includes the following sections:

- **Introduction (Section 1):** This section describes the purpose and objectives of the CMS and provides an overview of the report contents and organization.
- **Environmental Setting and Facility History (Section 2):** This section provides a brief description of the operations and history, environmental history, and current conditions of the Arlington facility.
- **Proposed Cleanup Levels (Section 3):** This section evaluates the regulatory requirements applicable to the Arlington facility and develops proposed cleanup levels that are used to determine affected areas requiring corrective action.

- **Findings of Previous Investigations (Section 4):** This section summarizes the findings of the completed SI and supplemental facility investigations performed since 2005; and compares the results to the proposed cleanup levels to identify affected areas requiring corrective action.
- **Conceptual Site Model (Section 5):** This section summarizes the conceptual site model (CSM) developed from the SI and supplemental facility investigations performed since 2005.
- **Corrective Measures Considerations (Section 6):** This section describes features of the facility operations and subsurface conditions that must be considered as part of the proposed corrective measures.
- **Corrective Measures Objectives (Section 7):** This section provides a discussion of applicable cleanup requirements; cleanup levels; qualitative and quantitative corrective measure objectives; and special conditions at the Arlington facility that affect the selection of corrective measures.
- **Technology Screening (Section 8):** This section describes the screening of potentially applicable technologies to address subsurface soil and groundwater cleanup at the facility.
- **Corrective Measures Alternatives (Section 9):** This section describes the corrective measures alternatives evaluated for the Arlington facility.
- **Detailed Evaluation of Alternatives (Section 10):** This section provides a detailed analysis of each alternative for each balancing criterion.
- **Comparative Evaluation of Corrective Measures Alternatives (Section 11):** This section provides a comparison of each corrective measure alternative to each of the other alternatives.
- **References (Section 12):** This section provides a list of references cited in this document.

In addition, the following appendices are included in this document:

- **Appendix A: Data Tables:** Soil and groundwater sampling results collected during the SI and Supplemental Groundwater Investigation and used in this CMS are provided in this appendix.
- **Appendix B: Model Toxics Control Act Worksheets:** The worksheets to calculate Model Toxics Control Act (MTCA) Method C cleanup levels are provided in Appendix B.
- **Appendix C: Cost Worksheets:** Detailed cost data are provided for each corrective measure alternative in Appendix C.
- **Appendix D: Groundwater Hydrographs:** Groundwater hydrographs were generated using data collected during the pilot study and subsequent monitoring and are provided in Appendix D.

- **Appendix E: Groundwater Elevation Data:** This appendix includes groundwater elevation contour maps for the facility since 2008.
- **Appendix F: Pentachlorophenol Isopleth Maps:** This appendix includes figures showing pentachlorophenol (PCP) concentrations in groundwater since 2008.
- **Appendix G: Groundwater Flow Modeling:** This appendix includes a summary of the groundwater modeling activities conducted during the evaluation of Alternative 6.

2.0 ENVIRONMENTAL SETTING AND FACILITY HISTORY

This section provides background information on the Arlington facility, including its location and the history, nature, and extent of facility-related releases. The existing features of the Arlington facility are shown in Figure 2-1.

2.1 FACILITY LOCATION

The Arlington facility is a wood preserving operation that occupies approximately 57 acres of land. Its primary business is the manufacture and preservation of telephone poles and other wood products. The facility is located in southwest Arlington, Washington, at 6520 188th Street NE. The facility lies southeast of the intersection of 67th Avenue NE and 188th Street NE.

For discussion purposes in this CMS, the property currently owned by Baxter will be divided into four parcels, as shown on Figure 2-2 and described below:

- **Parcel A** encompasses approximately 17 acres and includes the Main Treatment Area, where wood is treated, and the Treated Pole Storage Area, where treated poles are stored.
- **Parcel B (Untreated Pole Storage Area)** is approximately 28 acres in size and includes the area south of Parcel A where untreated poles are peeled (if necessary) and stored.
- **The Closed Woodwaste Landfill** is approximately 7 acres in size and was used for disposal of bark and wood shavings from pole-peeling operations. The Woodwaste Landfill was closed during the early 1990s.
- **The Northwest Parcel** is a 5-acre property purchased by Baxter in 2003. Baxter maintains a small office on the parcel, and the property is zoned industrial.

These four parcel designations do not reflect property boundaries, but are defined solely to facilitate evaluation in this CMS. Current conditions of these four parcels and areas hydraulically downgradient of the facility are described in Section 2.5. Results from the SI and supplemental facility investigations are summarized in Section 4.

2.2 ENVIRONMENTAL SETTING

This section describes the environmental setting, including geology, hydrogeology, and other environmental conditions.

2.2.1 Regional Geology

The Arlington facility lies in the Marysville Trough, a broad outwash plain located generally between Arlington and Marysville, Washington. The trough was originally carved by riverine and/or

glacial erosion and then subsequently filled in with a thick sequence of recessional outwash (coarse-grained glacial deposits). The recessional outwash deposits are estimated to be at least 100 feet thick in the area of the facility (Minard, 1985; Newcomb, 1952). Figure 2-3 presents a regional geologic map and cross section across the Arlington facility.

The Getchell Hill upland lies to the east of the facility. This glaciated upland sequence includes a till cap underlain by a thick sequence of advance outwash (fine-grained glacial deposits). The advance outwash deposits have been mapped to a thickness of up to 250 feet (Minard, 1985); however, most of these deposits were scoured and replaced by the recessional outwash of the Marysville Trough. The advance outwash deposits are underlain by fine sand, silt, and clay of the Transitional Beds Unit (Minard, 1985).

2.2.2 Regional Hydrogeology

Regional groundwater flow directions in the outwash deposits are to the north and northwest, with a groundwater divide estimated to lie about 1 mile south of the Arlington facility (Figure 2-4) (USGS, 1997). Portage Creek, a tributary to the Stillaguamish River, lies approximately 5,000 feet north and northwest of the facility and is likely the principal discharge point for groundwater in the outwash deposits (Newcomb, 1952).

The facility also lies on the northernmost boundary of the Quilceda Creek watershed. In this area, surface water flow from the Getchell Upland to the east is directed to a man made ditch that flows south along the BNSF Railway Company (BNSF) railroad tracks on the east side of the facility (Figure 2-1). A network of drainage ditches conveys surface water from the ditch bordering the facility to Quilceda Creek approximately 2 miles south of the Arlington facility.

2.2.3 Local Hydrostratigraphic Units

Lithologic data collected from the facility have been used to define five distinct hydrogeologic units at the Arlington facility: Fill Material; Gravelly Sand; Fine to Medium Sand; Coarse Sand and Gravel; and Silt and Clay. These units are described briefly in the following paragraphs. The lithology is further illustrated in the four cross-sections included as Figures 2-5 through 2-8. Figure 2-8 is a cross section that extends from the Main Treatment Area to the farthest downgradient well, and includes the approximate location of the dissolved-phase PCP plume discussed in Section 4.

Fill Material: Various fill materials are present at the Arlington facility, including woodwaste and backfill material. Typical depths of fill range from 0 to 4 feet below ground surface (bgs); however, fill has been observed at depths up to 15.5 feet bgs in the Main Treatment Area and is reportedly present at depths up to about 23 feet bgs in the Closed Woodwaste Landfill. These fills are

typically distinguished from native material based on the presence of wood chips, organic material, charcoal, and higher silt content.

Gravelly Sand: The Gravelly Sand unit is the uppermost native material at the Arlington facility and is present below the Fill Material. This unit typically occurs from 0 to 4 feet bgs, depending on fill thickness, to a depth of 15 to 25 feet bgs; however, Gravelly Sand has been observed as deep as 44 feet bgs. The Gravelly Sand unit is typically gray to brown gravelly sand with little silt.

Fine to Medium Sand: The Fine to Medium Sand unit is typically present beneath the Gravelly Sand at depths below 15 to 46.5 feet bgs, depending on the location at the facility. The Fine to Medium Sand typically contains small amounts of silt.

Coarse Sand and Gravel: The Coarse Sand and Gravel unit is present beneath the Fine to Medium Sand at depths of approximately 40 to 50 feet bgs. This unit consists of coarse sand with gravel and silt.

Silt and Clay: The Silt and Clay unit is present beneath the Coarse Sand and Gravel at depths of approximately 100 feet bgs or greater. The Silt and Clay unit consists of dense silt to dense clay.

2.2.4 Local Hydrogeology

Groundwater is present beneath the facility at depths between 8 and 44 feet bgs, depending on time of year and location within the facility. Groundwater elevations are highest on the south and east sides of the facility. Seasonal water level fluctuations average approximately 4 to 5 feet; however, fluctuations of 10 to 20 feet have been observed in response to long-term precipitation cycles. Data indicate that groundwater elevation is directly related to the amount of precipitation at the facility.

Groundwater elevation contour maps for February and August 2012 are illustrated on Figures 2-9 and 2-10, respectively. These potentiometric surface maps are derived using data from wells installed during early investigations, the SI, the pilot study (Baxter, 2007b), and the supplemental groundwater investigation (Premier, 2011). Groundwater generally flows to the northwest. Hydraulic gradients vary across the facility, indicating possible differences in aquifer permeability.

Bail test data from facility wells and grain size analysis (Hazen's test) from subsurface soil samples were used to estimate hydraulic conductivity. Hydraulic conductivity values range from 2 to 20 feet/day in the Fine to Medium Sand, and 100 to 150 feet/day in the Gravelly Sand.

Based on the hydraulic conductivity data, observed gradients from October 1999, and an assumed porosity of 0.3, groundwater flow velocities are estimated to be between 0.2 and 2.0 feet/day in the

Fine to Medium Sand (Main Treatment Area), and 0.4 to 5.0 feet/day in the Gravelly Sand (northwest portion of the facility).

2.2.5 Surface Water

The Arlington facility is situated within the Marysville Trough glacial outwash plain. The outwash plain consists of sands and gravels that drain readily, leaving few natural surface water drainage features. Because of the internal drainage, the majority of the precipitation in the area infiltrates and becomes part of the groundwater system. Groundwater in the area flows primarily to the north-northwest toward the Portage Creek Valley (USGS, 1997 [Figure 2-4]). The closest surface water feature is a ditch along the eastern boundary of the facility (Figure 2-1).

Stormwater runoff that does not infiltrate into the ground is contained at the facility and treated prior to discharge into a permitted infiltration gallery.

Surface water and sediment have been eliminated from consideration in this corrective measures evaluation due to the upgrades to the collection system installed by Baxter and the construction and operation of the stormwater treatment system.

Process water and oil removed during the stormwater treatment process is managed separately from stormwater. Process water, as well as any stormwater falling on the drip pads and aprons, is transferred to an oil/water separator, where the oil is recovered and recycled in the system in accordance with RCRA. Activated carbon is used to treat process water leaving the oil/water separator. The treated water is sent to the cooling tower for use in cooling condensers or recycled in the treatment process.

2.2.6 Surrounding Land Use

The facility lies in an area zoned Industrial by the City of Arlington. Land to the north, south, east, and west is also zoned Industrial. The closest property zoned Residential is 300 feet to the east and hydraulically upgradient of the facility, and is separated from the facility by other industrial land use and 67th Avenue NE. Non-conforming-use residences are present on properties adjacent to the facility to the northwest and southeast. A mobile home park lies to the northwest, approximately 400 feet from the facility boundary. A single-family residence lies southeast of the facility on a parcel that is bordered by the Untreated Pole Storage Area on three of four sides (Figure 2-2).

2.2.7 Groundwater Use

The Marysville Trough comprises a large unconfined aquifer that extends from Arlington to Marysville (Figure 2-4). The aquifer is estimated to extend to a depth of 100 to 150 feet bgs. Because of the highly productive nature of the aquifer, there is considerable use of this resource for domestic and industrial water supply.

In 1988, Baxter conducted a beneficial use survey of water supply wells in the area (EMCON, 1989). Baxter updated this survey in 2000 and 2001 (Hart Crowser, Inc., 2000 and 2001). Within the survey area, 26 water wells were identified. Of these, 21 are being used for water supply (i.e., domestic, irrigation, or industrial). The other five wells identified have been abandoned (Hart Crowser, Inc., 2001). A City of Arlington water supply well is located approximately 1,500 feet west of the facility.

From June 2001 to January 2003, Baxter conducted semiannual monitoring of drinking water in 21 off-site drinking water wells. The purpose of the drinking water sampling was to determine if historical operations at the Arlington facility had affected drinking water in neighboring wells. A survey of drinking water wells in the area around the Arlington facility was conducted by reviewing state water well databases and city water service records, and by completing a door-to-door survey of residents in the surrounding area (Baxter, 2005).

All functioning drinking water wells identified in the survey were sampled and analyzed for PCP and tetrachlorophenols (TeCP). No PCP or TeCP were detected in any of the wells during the 2-year period (Baxter, 2004). EPA collected split samples in January 2002, which confirmed Baxter's sampling results (Baxter, 2004). Based on these results, EPA determined that drinking water well sampling could be discontinued. In 2010, Baxter performed an updated survey of drinking water wells in the vicinity of the facility. Based on a review of well logs and water rights, no new drinking wells have been established since the drinking water well survey performed in 2001 (Premier, 2010).

2.3 PREVIOUS INVESTIGATIONS

Environmental investigations have been performed at the Arlington facility since 1988. A brief listing of the completed investigations is provided below.

- Closed Woodwaste Landfill Investigations (1988);
- Closed Woodwaste Landfill monitoring (ongoing);
- Soil and Groundwater Investigation (1990);
- Site Hazard Assessment (1992);

- National Pollutant Discharge Elimination System (NPDES) Groundwater Monitoring (2000 - 2005);
- NPDES Stormwater Monitoring (1994 - 2002);
- NPDES Lysimeter Monitoring (2001 - 2005);
- Polychlorinated dibenzo-p-dioxins (PCDD)/polychlorinated dibenzofurans (PCDF) Study (1997 - 1998);
- Drinking Water Well Sampling Program (2001 - 2003);
- All Known and Reasonable Measures of Prevention, Control, and Treatment Study, (1997);
- Remedial Investigation (1999 - 2001);
- Site Investigations (2002 - 2004);
- Remedial Action Pilot Study Construction (2008);
- Remedial Action Pilot Study monitoring (ongoing);
- Supplemental Groundwater Investigation (2010); and
- State Waste Discharge Permit monitoring (ongoing).

The integrated results of these investigations through 2005 were discussed in the SI report (Baxter, 2005). Investigation results since 1998 are summarized in the Stand Alone Data Document (Baxter, 2012a).

2.4 PILOT STUDY

A pilot study was performed at the facility to evaluate the performance of an enhanced biodegradation recirculation system with passive light nonaqueous-phase liquid (LNAPL) recovery, which was the recommended corrective measure alternative to address known contamination associated with the Main Treatment Area (Figure 2-2) in the original CMS (Baxter, 2007a). EPA expressed reservations and concerns as to the implementability and effectiveness of this recommended alternative, and a pilot study was therefore conducted to assess the performance of the alternative. The full-scale pilot system was installed in accordance with the Remedial Action Pilot Study Work Plan, which was submitted to EPA in September 2007 (Baxter, 2007b), and subsequent comments received from EPA. Installation was completed on January 30, 2008. The system was commissioned on January 31, 2008, and has been operating since that date. A comprehensive Remedial Action Pilot Study Report, which provides detailed analysis of system performance through the first quarter 2010, was submitted to EPA in October, 2010 (Baxter, 2010a). Section 9.2.4 summarizes the implementation of the pilot study and results through the third quarter of 2012.

2.5 CURRENT FACILITY CONDITIONS

The Arlington facility imports raw logs and processes them into utility poles. Processing activities include debarking, trimming, marking, seasoning, and treatment. The finished products are then shipped to utilities and other users by truck or rail. Current features at the Arlington facility are shown on Figure 2-1.

On February 28, 2007, Baxter entered into an agreement with Stella-Jones Corporation (Stella Jones), in which Stella-Jones has leased Parcels A and B of the facility (Figure 2-2) and has assumed operation of the wood-treating facility. Baxter retains ownership of the property and buildings. Baxter also retains control of all remediation work related to the AOC.

This section summarizes the current condition of the facility, including the history and operations at each of the parcels. In addition, the site investigation results for each parcel are described briefly.

2.5.1 Parcel A

Parcel A (leased by Stella-Jones) consists of the Main Treatment Area and the Treated Pole Storage Area (Figure 2-2).

2.5.1.1 Main Treatment Area

The Main Treatment Area is located in Parcel A in the central portion of the facility (Figure 2-2). Pole treating has been conducted in this area since the middle to late 1960s. Baxter purchased this parcel in 1970 and has continued wood-treating operations in this area. Numerous process upgrades and improvements have been made since Baxter purchased the property. Many of the upgrades were designed to reduce or eliminate the potential for releases of facility-related chemicals. Specific improvements made to address historic releases included the excavation and disposal of ditch material containing low concentrations of PCP in 2004 (Baxter, 2005).

Existing features in the Main Treatment Area include:

- Three retorts used for vacuum drying and pressure treating of wood poles with heated PCP in carrier oil solution - an oil/water separator, oil recycling, and activated carbon water treatment system;
- One in-ground butt tank used for partial immersion of pole butts in heated copper naphthenate solution and PCP;
- Butt-treating plant and main treatment plant tank farms in secondary containment structures;
- Subpart W drip pads with paved aprons;

- Process water collection and treatment system (located in the main treatment plant);
- Canopy-covered tram storage area next to main treatment building;
- Two natural-gas-fueled kilns for pole drying; and
- PCP storage building.

The results of the SI indicate historic releases of PCP, diesel range organics (DROs), and polycyclic aromatic hydrocarbons (PAHs) in Parcel A. The facility-related chemicals detected in this area likely originated from butt tank overflows and releases of treating solutions during historic operations. See Section 4 for more information on the SI and results of subsequent investigations.

2.5.1.2 Treated Pole Storage Area

The Treated Pole Storage Area is also part of Parcel A and is located in the northern portion of the facility, north of the Main Treatment Area (Figure 2-2). Treated pole storage has been conducted in this area since the middle to late 1960s. Baxter purchased this parcel in 1970 and continued wood-treating and pole storage operations. Specific improvements made to address historic releases include the excavation and disposal of ditch sediments containing low concentrations of PCP in 2004 (Baxter, 2005).

Existing features in the Treated Pole Storage Area include:

- Pressure-treated and butt-treated poles stored on skids;
- A stormwater collection system; and
- Office, machine shop, and main shop buildings.

2.5.2 Parcel B (Untreated Pole Storage Area)

Parcel B consists of the Untreated Pole Storage Area (leased by Stella-Jones), located in the southern portion of the facility (Figure 2-2). It was purchased by Baxter in the early 1970s and had no prior industrial usage. A portion of the parcel is used to peel poles.

Existing features in the Untreated Pole Storage Area include:

- Untreated pole storage;
- Lunch room;
- Wire storage building;
- Incisor;
- Framing building;

- Pole peeler; and
- Stormwater treatment system and infiltration gallery.

Data from the SI show that some detectable levels of COCs are present in Parcel B, though none of the constituents related to wood treating have been detected above proposed cleanup levels (Section 3). Therefore, no additional investigation or corrective action is warranted for this parcel.

2.5.3 Closed Woodwaste Landfill

The Closed Woodwaste Landfill is located on the 7-acre plot of land west of Parcel A and north of Parcel B (Figure 2-2). The landfill is a separate tax parcel from Parcels A and B. This former gravel pit contains wood shavings from peeling operations. In the early 1990s, the gravel pit/landfill was capped with clean soil and certified as closed as a monofill landfill through the Snohomish County Health District. A stormwater retention pond on the southwestern corner of the parcel collects runoff from the landfill cap. Quarterly groundwater monitoring is conducted in accordance with Snohomish County Health District post-closure requirements. No activities were included in the SI for this parcel, and the landfill is not an area of concern. Since the closed landfill is not an area of concern, it will not be considered further in this CMS.

2.5.4 Northwest Parcel

The Northwest Parcel was purchased by Baxter in 2003 and is located in the northwest portion of the facility (Figure 2-2). The parcel is zoned Industrial and houses a small office building and storage building.

The results of the SI and subsequent groundwater investigations indicate the presence of a groundwater plume (primarily PCP) beneath the Northwest Parcel. The plume extends across 188th Street NE to the northwest in the direction of groundwater flow. The groundwater plume originates in the Main Treatment Area (Parcel A). See Section 4 for more information on the Site Investigation, Remedial Action Pilot Study monitoring, and Supplemental Groundwater Investigation results.

3.0 PROPOSED CLEANUP LEVELS

This section of the CMS outlines the approach used to develop proposed cleanup levels that were used for this CMS. The proposed cleanup levels must be established for affected media and must be appropriate for the land use and relevant exposure pathways. Affected media identified in the SI include soil and groundwater underlying Parcel A and groundwater extending to the northwest beneath the Northwest Parcel. Affected media identified during supplemental groundwater investigations also include groundwater hydraulically downgradient of the Northwest Parcel. Air monitoring conducted at the Arlington facility indicates that current and historic releases are not affecting ambient air and no proposed cleanup levels are needed for air. In addition, stormwater runoff that does not infiltrate into the ground is contained within the facility boundary and treated prior to discharge into a permitted infiltration gallery. Therefore, proposed cleanup levels are not needed for surface water or sediment.

As noted previously, the Arlington facility is zoned for heavy industrial use. The facility has a long industrial history, and it is expected to remain under industrial use for the foreseeable future. The Arlington facility has not been used for residential purposes. Based on the historic and expected future land use, Baxter anticipates that the proposed cleanup levels used for the CMS will be based on industrial land use rather than unrestricted land use and that institutional controls (ICs) restricting use of the facility will be part of the remedy selected. It is also expected that any approval issued by EPA regarding corrective measures at the Arlington facility will specify that ICs are necessary to protect human health and the environment.

EPA will develop the final cleanup levels for the facility, and these final cleanup levels may be different from the proposed cleanup levels used in this CMS. The proposed cleanup levels were developed as described in this section and were used (1) to evaluate which areas of the facility require corrective actions and (2) to identify and evaluate corrective measures alternatives. To establish the scope and objectives of corrective measures, data from previous investigations will be compared to proposed cleanup levels that are considered appropriate for the Arlington facility and for the purposes of this CMS.

3.1 PROPOSED GROUNDWATER CLEANUP LEVELS

The proposed groundwater cleanup levels are presented in Table 3-1. Proposed groundwater cleanup levels are based on a general analysis of groundwater use and comply with Washington State cleanup regulations, specifically the MTCA methodology for establishing Method B cleanup levels. MTCA Method B cleanup levels were used for groundwater because they are applicable to all parcels and because groundwater flow to locations beyond the Baxter property has occurred;

therefore, Method C groundwater cleanup levels are not appropriate. The highest use considered for groundwater beneath and downgradient from the Arlington facility is as drinking water.

The MTCA regulations (Washington Administrative Code [WAC] 173-430-720) specify the methodology for development of MTCA Method B groundwater cleanup levels. Under WAC 173 340 720(4)(b)(ii), Method B cleanup levels for groundwater may exclude protection of surface water if it can be demonstrated that hazardous substances from a site are not likely to reach surface water. Based on the SI and ongoing monitoring at the facility, data from monitoring wells indicate that the plume is either stable or shrinking. Prior to implementation of the Pilot Study, Baxter conducted a Mann-Kendall trend analysis for two primary wells (MW-3 and MW-15) in accordance with the Guidance for Data Quality Assessment, Practical Methods for Data Analysis (EPA, 2000a). The results of the trend test indicated that the PCP trend was stable in MW-3 and decreasing in MW-15.

Groundwater data collected from monitoring wells indicate that constituents released at the Arlington facility have been detected at concentrations above EPA Maximum Contaminant Levels (MCLs) in groundwater downgradient of the Baxter property. However, surface water quality standards are not considered appropriate or applicable to groundwater beneath the Arlington facility due to the limited extent of affected downgradient groundwater and the large distance to the principal groundwater discharge point at Portage Creek. Therefore, proposed groundwater cleanup levels will be based solely on drinking water use of the groundwater.

The process used to develop proposed cleanup levels for groundwater is outlined below. Since the highest groundwater use is for drinking water, the proposed cleanup levels are based on criteria for drinking water. A hierarchical process was used to establish the proposed cleanup levels, as follows:

1. The MCLs established for the primary drinking water standards (Code of Federal Regulations [CFR], Title 40, parts 141.61 and 141.62) were used to establish proposed groundwater cleanup levels.
2. For constituents with no MCL, a standard MTCA Method B cleanup level for drinking water was obtained from the Washington State Department of Ecology (Ecology) Clean-Up Levels and Risk Calculations (CLARC) website (Ecology, 2013).
3. If the MTCA Method B cleanup level for drinking water was not available from the CLARC website, the MTCA Method A groundwater cleanup level was used as the proposed cleanup level.
4. If no MTCA Method A cleanup level was available, EPA Regional Screening Levels (RSLs) for tap water were used as the proposed cleanup level.

5. If no MCL, MTCA Method B or Method A cleanup level, or EPA RSL for tap water was available, no proposed cleanup level was established for that constituent.

The proposed groundwater cleanup levels for the Arlington facility are summarized on Table 3-1. Table 3-1 also shows the MCLs, MTCA Method B cleanup levels, MTCA Method A cleanup levels, and EPA RSLs. For carcinogenic PAHs (cPAHs), the MTCA Method B cleanup level for benzo(a)pyrene was compared to calculated total toxicity-equivalent concentrations for cPAHs, according to WAC 173-340-708(8)(e). The total toxicity-equivalent concentrations of cPAHs is calculated following each routine monitoring event using analytical data from groundwater samples. Following the criteria above, the RSLs for individual cPAHs would be used only if MTCA Method B or MTCA Method A cleanup levels were not available.

3.2 PROPOSED SOIL CLEANUP LEVELS

The proposed soil cleanup levels are shown in Table 3-2. Proposed cleanup levels for soil were developed using MTCA methodology based on industrial land use, assuming that the final corrective measures will include appropriate ICs for industrial land use. Based on differences in historic activities conducted on Parcels A and B, two sets of proposed soil cleanup levels were established for the Arlington facility: one set for Parcel A and one set for Parcel B. The proposed soil cleanup levels for each of the parcels were established in accordance with MTCA regulations.

The MTCA regulations (WAC 173-340-745) establish procedures to develop Method C cleanup levels for industrial soil. MTCA Method C procedures employ a risk-based evaluation of potential human health and environmental exposures based on an industrial exposure scenario. This evaluation considers potential exposure pathways relevant to soil contaminants, including direct contact/ingestion, volatilization and inhalation, and desorption to groundwater. As noted previously, the chemicals used at the Arlington facility were semivolatile constituents with low volatility; the volatilization and inhalation pathway is therefore not considered appropriate for establishing cleanup levels. Proposed soil cleanup levels are presented for Parcels A and B in the following subsections.

3.2.1 Parcel A

The proposed soil cleanup levels for Parcel A (Figure 2-2), as shown on Table 3-2, are based on industrial land use. Since both soil and groundwater at Parcel A have been affected by historic releases, proposed soil cleanup levels must be established so that they are protective of groundwater.

The following process was used to determine proposed soil cleanup levels for Parcel A:

1. MTCA Method C soil cleanup levels based on direct contact/ingestion were obtained from the CLARC website (Ecology, 2013).
2. For each soil constituent, MTCA Method C soil cleanup levels protective of groundwater were calculated using the Ecology spreadsheet tool MTCASGL11.0 (Ecology, 2006). The proposed groundwater cleanup levels listed in Table 3-1 were used in the calculations as the groundwater standard. Default parameters for the MTCASGL model and toxicity parameters were obtained from the CLARC website.
3. The MTCA Method C cleanup level (i.e., the lower cleanup level from steps 1 and 2) was selected as the proposed soil cleanup level for Parcel A.
4. For constituents with no available MTCA Method C cleanup levels, the MTCA Method A cleanup level for industrial facilities was selected as the proposed soil cleanup level.
5. For constituents with no available MTCA Method C or Method A soil cleanup levels, the EPA RSLs for industrial sites were selected as the proposed soil cleanup levels.
6. If no MTCA Method C or industrial Method A cleanup level and no industrial RSL was available, no proposed cleanup level was established for that constituent.

The MTCA regulations (WAC 173-340-747) establish the process for deriving soil cleanup levels that are protective of groundwater. For Parcel A, partitioning calculations were performed to calculate soil concentrations protective of groundwater. The partitioning calculations were done using the Ecology spreadsheet MTCASGL11.0 (Ecology, 2006), using toxicological parameters obtained from the CLARC website (Ecology, 2013). Default values were used for the other model parameters. Since groundwater cleanup levels were calculated as a total toxicity-equivalent factor as described in Section 3.1, the individual cPAH RSLs were used in the protection-of-groundwater calculations where individual MTCA cleanup values were not available. Copies of the spreadsheets for these calculations are included as Appendix B. The proposed soil cleanup levels for Parcel A are summarized in Table 3-2.

3.2.2 Parcel B

Proposed soil cleanup levels for Parcel B (Figure 2-2) were established using a procedure similar to that used for Parcel A. However, the approach used for assessing protection of groundwater for Parcel B is different from that used for Parcel A.

Several alternate approaches are presented under the MTCA regulations for deriving soil concentrations for protection of groundwater (WAC 173-340-747). One of the methods cited under

the rule provides for an empirical demonstration (WAC 173-340-747[3][f]) and 173-340-747[9]) that existing soil concentrations will not cause an exceedance of groundwater cleanup levels. The regulation specifies that this demonstration be based on site-specific groundwater and/or soil data.

Site-specific data collected for the SI and during routine groundwater monitoring demonstrate that current constituent concentrations in Parcel B soil are not adversely affecting groundwater. As is further described in Section 4, concentrations of COCs in groundwater in Parcel B are below proposed cleanup levels based on direct contact/ingestion. Groundwater samples have been collected for multiple rounds at two groundwater monitoring wells: MW-14 (two rounds since 2001) and BXS-4 (13 rounds since 2001). Seven direct-push groundwater samples were collected as part of the SI at locations SB-52 through SB-58. In addition, soils with detectable concentrations of COCs in Parcel B are confined to the near surface (generally less than 5 feet in depth), whereas the depth to groundwater is greater than 20 feet (Figure 2-5). Thus, groundwater is separated from the COCs present in soil by approximately 15 to 20 feet. The time frame that these COCs have likely been present is long enough that future migration to groundwater is extremely unlikely. Based on the site specific data discussed above, existing contaminant concentrations in affected soil at Parcel B are protective of groundwater.

The following procedure was used to determine proposed soil cleanup levels for Parcel B:

1. MTCA Method C soil cleanup levels based on direct contact/ingestion were obtained from the CLARC website (Ecology, 2013).
2. For those constituents with no available MTCA Method C cleanup level, the MTCA Method A cleanup level for industrial facilities was selected as the proposed soil cleanup level.
3. For constituents with no available MTCA Method C or Method A soil cleanup level, the EPA RSLs for industrial sites were selected as the proposed soil cleanup level.
4. If no MTCA Method C or industrial Method A cleanup level and no industrial RSL was available, no proposed cleanup level was established for that constituent.

The proposed soil cleanup levels for Parcel B will ensure that soil is protective of industrial use. Existing concentrations of COCs in soil in Parcel B are protective of groundwater, based on the site specific evaluation presented above and discussed further in Section 4.2. Proposed soil cleanup levels for Parcel B are summarized in Table 3-2.

4.0 FINDINGS OF PREVIOUS INVESTIGATIONS

This section of the CMS describes the distribution of COCs in soil and groundwater throughout the different areas of the facility that will be used as the basis for remedy design. This summary is based on the findings of multiple facility investigations; the most comprehensive investigation is presented in the SI Report (Baxter, 2005). Other resources documenting the extent of COCs in groundwater since completion of the SI include the Stand-Alone Data Document (Baxter 2012a), the Remedial Action Pilot Study Report (Baxter, 2010a), and a supplemental groundwater investigation (Premier, 2011). Collectively, the SI and subsequent reports provide data tables and figures that quantify the distribution of COCs in surface soil, subsurface soil, sediment, and groundwater both on and off the Baxter property. These tables and figures are included in this CMS by reference; data summary tables, including results for investigations performed since the SI, are included in Appendix A.

Based on the results of previous investigations, PCP has been found to be the most widely distributed COC in groundwater. This groundwater COC has high solubility and is mobile in the environment. Therefore, PCP has been used as the primary indicator constituent for groundwater and has been used to assess the extent of affected groundwater for the Arlington facility.

Tables 4-1 and 4-2 present the highest detected concentrations of COCs in groundwater and soil, respectively, in Parcels A and B, and also show the proposed cleanup levels developed in Section 3. As these tables show, only a limited number of COCs exceed proposed cleanup levels. The data used to develop Table 4-1 include groundwater sampling data collected since 2001. Table 4-2 is based on the data tables included as Appendix A. Appendix A contains data tables that support the descriptions of COC concentrations in Sections 4.1 and 4.2.

4.1 PARCEL A

Parcel A includes the Main Treatment Area and the Treated Pole Storage Area (Figure 2-2). This section summarizes results of investigations for these two areas. Figure 4-1 shows the areas of Parcel A that have historically exhibited surface and subsurface soil and groundwater affected by COCs at concentrations above the proposed cleanup levels. The affected areas are described briefly below.

4.1.1 Main Treatment Area

The Main Treatment Area has been used for treating poles since the 1960s and is the area at the Arlington facility where all treatment operations have occurred. This area is considered the source area for affected groundwater (Baxter, 2005).

4.1.1.1 Surface Soil

Results presented in the SI indicate the presence of COCs in surface soil in the Main Treatment Area. Samples were collected at one sample location (SS-24) from depth ranges that varied from 0 to 2 inches to 6 to 18 inches. Analytical results included concentrations of PCP (0.23 to 0.56 milligrams per kilogram [mg/kg]) that exceeded proposed cleanup levels. Samples collected for analysis of PCDD/PCDFs contained concentrations of 494 picograms per gram ([pg/g] 10 to 12 grams) toxicity equivalents (TEQ), which do not exceed proposed cleanup levels for soil. Near the Pentachlorophenol Storage Shed, one surface soil sample collected from the 0 to 6 inch depth interval (SS-25) contained a concentration of PCP of 1.9 mg/kg, exceeding the proposed cleanup level for PCP.

4.1.1.2 Subsurface Soil

Investigations performed through the 2005 SI identified the presence of COCs in subsurface soils in portions of the Main Treatment Area. In general, samples collected and analyzed from borings drilled adjacent to the Old Butt Tank, where several historic spills have been reported, contained the highest concentrations of COCs in subsurface soils in the Main Treatment Area. The areal extent of soil affected by facility COCs is shown on Figure 4-1.

Samples were collected at a number of depth intervals, with the shallowest interval being 4 to 6 feet and the deepest interval being 38 to 40 feet, at 13 sample locations (SB-35 through 42, SB-61 through 63, and MW-12 and 13). Analytical results showed concentrations of PCP (0.013 to 1,300 mg/kg), DROs (3,500 to 45,000 mg/kg), and multiple PAH compounds greater than proposed cleanup levels. Exceedances were observed at most depths, with the highest results generally coming from the sample collected at the depth interval of 10 to 12 feet at SB-39 and the sample collected at the depth interval of 32 to 34 feet at MW-13.

Residual LNAPL was observed during installation of many of the pre-SI subsurface soil borings, as well as several borings installed during and after the SI. All of the borings in which residual LNAPL was observed are located within the Main Treatment Area. Residual LNAPL in these borings was observed at depths ranging from 10 to 42 feet bgs. LNAPL has been observed in three monitoring wells (MW-12, MW-13, and MW-19) installed in this area.

Low to non-detectable concentrations of COCs were reported for subsurface soil samples collected at depths of approximately 31 to 43 feet bgs to investigate the possible presence of COCs south, west, and east of the retorts (SB-41, SB-42, MW-10, MW-11), and at 4 to 6 feet bgs in the area of the treatment solution spill from the Old Butt Tank in 1990 (SB-47 through SB-51).

4.1.1.3 Groundwater

Groundwater monitoring wells in the Main Treatment Area are MW-1, MW-12, MW-13, MW-19, MW-20, MW-21, MW-25, and MW-32. LNAPL has been observed at a thickness of up to 5.57 feet in wells MW-12 and MW-13, which are located in the Main Treatment Area. The highest concentrations of COCs in groundwater were observed in well MW-13, located near the old butt tank; these concentrations coincide with the presence of LNAPL. Currently, monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are being used as passive LNAPL recovery wells (see Section 9.2.4).

Concentrations of COCs higher than proposed cleanup levels have been detected in well MW-32 (1,700 micrograms per liter [µg/L] PCP) and MW-25 (240 µg/L PCP). LNAPL was not observed during the installation of MW-25 and MW-32; however, both wells are located hydraulically downgradient of the suspected source area.

4.1.2 Treated Pole Storage Area

The Treated Pole Storage Area includes a large portion of the Arlington facility located north of the Main Treatment Area and smaller areas surrounding the Main Treatment Area to the east, south, and west.

4.1.2.1 Surface Soil

PCP and PCDD/PCDFs have been detected in surface soils during previous investigations in the Treated Pole Storage Area. PCP concentrations in pre-SI surface soil samples ranged from 5.3 mg/kg to 90 mg/kg, and PCDD/PCDF concentrations (TEQ) ranged from 4,700 pg/g to 6,400 pg/g TEQ. PCP concentrations in slightly deeper pre-SI samples (0.8 foot) at the same locations were much lower, ranging between 0.096 mg/kg and 16 mg/kg.

Fourteen surface soil sample stations were established from a random grid in this area during the SI (locations SS01 through SS14). At each location, soil samples were collected from the 0- to 2-inch depth interval and from the 6- to 18-inch depth interval. PCP concentrations ranged from 0.1 mg/kg to 10.0 mg/kg in the 0- to 2-inch depth interval and 0.018 mg/kg to 2.0 mg/kg in the 6- to 18-inch depth interval, all of which are above the proposed cleanup level of 0.0158 mg/kg. PCDD/PCDF concentrations (TEQ) ranged from 87 pg/g to 645 pg/g, which are below proposed cleanup levels. Concentrations of COCs in samples collected during the SI were generally lower than those in pre SI surface soil samples, but concentrations in many SI sample results were greater than the proposed cleanup levels (Appendix A).

4.1.2.2 Subsurface Soil

Subsurface soil samples were collected from four locations in the Treated Pole Storage Area (MW-10, MW-11, SB-2D, and SB-3D). Samples were collected from a number of depth intervals ranging from 4 to 6 feet up to 96 to 98 feet. Analytical results included concentrations of PCP above the proposed cleanup level (0.018 to 0.5 mg/kg) in samples collected at depths between and 52 feet bgs. Samples collected at shallower and deeper depths had concentrations below the proposed cleanup level (Appendix A).

4.1.2.3 Groundwater

Twelve wells (HC-MW-5, HC-MW-6, MW-2, MW-3, MW-10, MW-11, MW-22, MW-23, MW-24, MW-26, MW-27, and MW-35) are considered to be associated with the Treated Pole Storage Area.

Wells HC-MW-5, MW-3, MW-10, MW-11, MW-22, MW-23, MW-24, MW-26, and MW-33 are located outside the Main Treatment Area near its outer boundary. Concentrations of COCs higher than proposed cleanup levels (up to 2,400 µg/L PCP) were detected in samples collected from well MW-3, which does not contain LNAPL and is located hydraulically downgradient (northwest) of the Main Treatment Area. Analytical results from MW-3 have also shown detections of DROs and PAHs (up to 9.92 µg/L total PAHs) above the proposed cleanup levels in samples collected since 2002 (Appendix A).

COCs have consistently been below proposed cleanup levels in samples collected from wells located upgradient of the source area (HC-MW-5, MW-10, and MW-11). Samples collected from wells within the Treated Pole Storage Area that are cross gradient from the source area (HC-MW-6, MW-2, MW-26, MW-27, and MW-35) have not exceeded proposed cleanup levels for PCP since 2001. Together, analytical data collected from wells inside the Main Treatment area and the Treated Pole Storage Area indicate the presence of a contaminant plume in groundwater extending from the Main Treatment Area to the northwest (Baxter, 2005 [Figure 4-1]).

4.1.3 Northwest Parcel and Downgradient Areas

4.1.3.1 Soil

The SI results (Baxter, 2005) demonstrated that soils in this area were not affected by historical releases related to Baxter facility operations (Figures 2-2 and 4-1).

4.1.3.2 Groundwater

Wells HC-MW-7, MW-15 through MW-17, MW-29, MW-30, MW-31, MW-34, and MW-36 through MW-41 are located in the Northwest Parcel area. COCs have been detected in MW-15 with concentrations of PCP up to 790 µg/L, DROs up to 320 µg/L, and total PAHs up to 0.52 µg/L. Concentrations of COCs have been consistently below proposed cleanup levels in MW-16, MW-17,

and HC-MW-7, which are located either downgradient or cross-gradient of MW-15 and near the property boundary.

Wells MW-29, MW-30, MW-31, MW-34, MW-36, and MW-37 were installed as part of the preferred alternative pilot study. PCP concentrations above cleanup levels have been detected at MW-29, MW-34, MW-36, and MW-37. The highest PCP concentrations in the Northwest Parcel were detected in samples collected from MW-29 (up to 1,600 µg/L), MW-34 (up to 1,900 µg/L), and MW-37 (up to 1,100 µg/L). However, PCP concentrations have dropped dramatically since installation of the pilot recirculation system (Appendix A). Groundwater samples from wells MW-30 and MW-31 have not exceeded proposed cleanup levels for PCP. Analytical results from these wells demonstrate a fairly narrow groundwater plume extending northwest from the source area in the Main Treatment Area toward the MW-29/MW-34 well pair and MW-37.

Wells MW-38 through MW-41 were installed in August 2010, during the Supplemental Groundwater Investigation, to characterize COC distributions deeper in the water-bearing zone. Results show that PCP concentrations exceed proposed cleanup levels at MW-39 (up to 130 µg/L), MW-40 (up to 420 µg/L), and MW-41 (420 µg/L). Analytical results also indicate that PCP concentrations are below the proposed cleanup level at MW-38.

During the SI, Well MW-18 was installed across 188th Street NE from the Baxter property, in an area hydraulically downgradient (i.e., northwest) from the Main Treatment Area. No COCs have been detected above proposed cleanup levels in well MW-18. As part of the Supplemental Groundwater Investigation, wells MW-42 and MW-43 were installed to monitor groundwater for COCs deeper within the water-bearing zone in areas located downgradient of the Northwest Parcel. Analytical data from samples collected from MW-42 in indicate PCP groundwater concentrations (up to 17µg/L PCP) above the proposed cleanup level. Analytical data from sample collected from MW-43 and four discrete groundwater samples collected between 80 and 110 feet bgs during MW-43 installation exhibited PCP concentrations below cleanup levels.

All functioning off-site drinking water wells in the vicinity of the Arlington facility were sampled during four sampling events between June 2001 and January 2003. No PCP or TeCP was detected in any of these wells during the 2-year period; no further testing has been required by EPA.

Wells BXS-1, BXS-2, BXS-3, and MW-28 are located slightly south of wells located in the Northwest Parcel in the area of the Closed Woodwaste Landfill. In samples collected since 2001, dioxins/furans have been detected at BXS-1, BXS-2, and BXS-3 with TEQs below the 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD) proposed cleanup level. Additionally, PCP has been detected above the proposed cleanup level (up to 94 µg/L) at BXS-1, which is located hydraulically

downgradient of the Main Treatment Area. PCP concentrations in groundwater samples collected from MW-28 have not exceeded the proposed cleanup level.

4.2 PARCEL B (UNTREATED POLE STORAGE AREA)

Parcel B consists of the entire southern portion of the Arlington facility, as shown on Figure 2-2. Figure 4-1 shows the locations on Parcel B where sampling results have exceeded proposed cleanup levels. The following subsections discuss the SI results for Parcel B.

4.2.1 Surface Soil

There are 11 surface soil sample locations in this area (SS-15 through 22). At each location, soil samples were collected from the 0- to 2-inch depth interval and from the 6- to 18-inch depth interval. Analytical results for all surface soil samples are below the proposed cleanup levels.

4.2.2 Subsurface Soil

Ten soil borings (SB-52 through SB-60, MW-14) were installed along the southern boundary of Parcel B to evaluate the potential for stormwater in this area to be a source of COCs to soil and groundwater. The borings were completed to depths ranging from 4 to 36 feet bgs. Residual range oil (RRO) was the only COC detected at concentrations above proposed cleanup levels in these subsurface soil samples in Parcel B. The general location of the affected soil in the vicinity of this boring is shown on Figure 4-1. This sample was collected at a depth of 4 to 6 feet bgs.

4.2.3 Groundwater

There are three groundwater monitoring wells in this area (MW-4, BXS-4, and MW-14). Additionally, seven direct-push locations (SB-52 through 58) were sampled for groundwater on Parcel B during the SI. COCs were not detected above the CMS proposed cleanup levels in any groundwater samples collected from Parcel B during the SI (2001 through 2005). Data from previous investigations show that groundwater beneath Parcel B has not been affected by facility COCs (Appendix A).

4.3 POTENTIAL AIR EMISSIONS

COC concentrations in air were evaluated by using the EPA Industrial Source Complex-Short Term Plume Rise Model Enhancements (ISCST3-PRIME) model to predict airborne COC concentrations at specific locations in the vicinity of the Arlington facility. A Tier II analysis resulted in no modeled COC concentrations in exceedance of applicable EPA Region 6 Ambient Air preliminary remediation goals (PRGs).

Five soil samples were collected outside the Baxter facility boundary as part of the air investigation to evaluate transport to soil by aerial deposition beyond the Baxter property boundary. Low concentrations of PCP and PAHs were detected in the off-site soil samples. PCDD/PCDFs were also detected in all soil samples outside the facility at concentrations ranging from 0.915 pg/g to 222.4 pg/g. It should be noted that the PCDD/PCDF concentrations at these off-property locations may not be related to Arlington facility emissions or releases, as these compounds can be related to any combustion sources, such as wood burning, trash burning, or forest fires.

4.4 BACKGROUND SOIL SAMPLES

Twenty stations were sampled in the vicinity of the Arlington facility to establish background concentrations of COCs in soil. PCP was detected at five of the 20 background soil sample stations, at concentrations ranging from 0.0028 mg/kg to 0.022 mg/kg. DROs were detected at 19 of 20 stations, at concentrations ranging from 5.3 mg/kg to 110 mg/kg; these results are below the proposed cleanup levels. Low levels of PAHs were detected in most of the off-site samples. The highest concentration was observed more than 2 miles west of the facility, and this location was the only location where a PAH (chrysene) was detected at a concentration above the proposed cleanup level at the time of investigation. It is unlikely that the Arlington facility is the source of the elevated chrysene concentration 2 miles away, which would likely be related to some other facility or source near the sample location.

4.5 ECOLOGICAL CONDITIONS

The Arlington facility property is developed and used solely for industrial operations. There are no areas at the facility that function as ecological habitats. Based on previous facility investigation data, no soil outside the facility property boundary has been affected by releases from the Arlington facility. Groundwater monitoring indicates PCP concentrations above cleanup levels extend approximately 420 feet downgradient of the facility boundary; however, this downgradient area does not include ecological habitat. Therefore, no conditions adverse to ecological risk have been identified for this CMS and on-site COC concentrations have not been compared to ecological screening levels.

4.6 SUMMARY: AREAS OF CONCERN

The primary area of concern is the subsurface soils in the Main Treatment Area of Parcel A, as shown on Figure 4-1. Vadose zone soils in this area are affected by COCs, residual LNAPL, and mobile LNAPL. Some of these affected soils are in contact with shallow groundwater. Those affected soils in contact with groundwater create a long-term source of groundwater contamination, which flows northwesterly toward the Northwest Parcel and the facility boundary.

Subsurface soils in the Treated Pole Storage Area are also affected by COCs. The measured COC concentrations in subsurface soils are below levels of concern for dermal contact, but exceed proposed soil cleanup levels. Groundwater beneath the Treated Pole Storage Area is affected by the groundwater plume originating in the Main Treatment Area. The contribution of dissolved-phase constituents from subsurface soils beneath the Treated Pole Storage Area is relatively minor.

In Parcel B, the Untreated Pole Storage Area, only low levels of COCs are present in surface and shallow subsurface soils. Only one analyte (RRO) in one soil sample exceeded the applicable proposed cleanup level for soil. Groundwater monitoring wells in or near Parcel B (MW-4, MW-10, MW-14, BXS-3, BXS-4, and HC-MW-5) have not indicated the presence of any COCs above proposed cleanup levels. Because of the low levels of COCs in shallow soils (in isolated areas), and the lack of COC detections in groundwater, existing concentrations of COCs in Parcel B soils meet the WAC 173-340-747 empirical demonstration requirements for groundwater protection, and corrective measures are therefore not warranted.

5.0 CONCEPTUAL SITE MODEL

This section presents the CSM for the Arlington facility based on a synthesis of the available physical and chemical data, historical operations compiled in the SI, and investigations performed since completion of the SI. The CSM presents an understanding of the contaminant sources, distribution, and transport pathways based on the available data.

A block diagram from the SI report visually depicting the CSM is presented in Figure 5-1. The block diagram illustrates the current understanding of the potential sources and releases of COCs, generalized hydrogeologic information, and COC distribution and transport at the facility. The CSM block diagram is separated into three discrete blocks that generally relate to the Untreated Pole Storage Area, the Main Treatment Area, and the Treated Pole Storage Area.

5.1 CONSTITUENTS OF CONCERN

Based on the operational history and investigations at the Arlington facility, the following COCs have been identified:

- **Pentachlorophenol:** Petroleum-hydrocarbon-based PCP solution continues to be used at the facility to treat wood products. The PCP solution is primarily PCP dissolved in carrier oil. The PCP solution also contains TeCP and trichlorophenol (TCP). Breakdown products of PCP include TeCP, TCP, dichlorophenol (DCP), pentachloroanisol, and other phenolic compounds. Contaminants in technical-grade PCP include PCDDs/PCDFs.
- **Petroleum hydrocarbons:** Petroleum hydrocarbon mixtures (generally referred to as total petroleum hydrocarbons or DROs) have been used at the facility as carriers for PCP and/or creosote. The carrier historically used for PCP treating solutions is medium aromatic oil with physical characteristics similar to No. 2 diesel oil.
- **Polycyclic Aromatic Hydrocarbons:** PAH compounds are the main components in creosote mixtures and were historically used at the facility. Additional sources of PAHs may include the petroleum-hydrocarbon-based carrier for creosote and PCP treating solutions.

5.2 PCP/CREOSOTE USE AND SOURCE AREAS

Two main chemical use/process source areas have been identified for the Arlington facility based on facility operations and the known and potential contaminant source areas at the facility: (1) the Main Treatment Area; and (2) the Treated Pole Storage Area (Figure 5-1).

5.2.1 Main Treatment Area

The Main Treatment Area is where current and historical wood-treating processes and chemical use have occurred. All currently used treating equipment, including the two pressure retorts, the new butt tank, and the tank farms, are located within concrete secondary containment structures. No spills from these current operations have occurred, and annual inspection records at the facility indicate that these secondary containment structures remain in good structural condition. Known sources of releases in the Main Treatment Area are historical and are potentially associated with the old butt tank, the old thermal tank, the old thermal retort, and the former drip area.

5.2.2 Treated Pole Storage Area

The Treated Pole Storage Area surrounds the Main Treatment Area and is used to store treated poles. Known historical or potential sources of releases in the Treated Pole Storage Area include a former old butt tank spill accumulation area, the stormwater ditches, and the former catch basins.

5.3 POTENTIAL AIR EMISSIONS SOURCES

Air emission sources include wood-treating operations in the retorts and butt tank, storage and handling of wood-treating solutions, recycling of wood-treating chemicals, treated water recycling and cooling tower operation, and fugitive emissions from process piping. However, the major COCs used at the facility (e.g., PCP) are not considered volatile organic compounds and do not readily volatilize. Therefore, corrective measures for potential air emissions are not considered in this CMS.

5.4 TRANSPORT PATHWAYS

Potential pathways identified in the SI for COC transport to human or ecological receptors include air transport and direct contact with soil, groundwater, LNAPL, and stormwater. Of these, direct contact with subsurface soil, groundwater migration, and LNAPL pathways were considered and evaluated in the SI as having a potential for ongoing effects on human receptors. The potential ongoing exposure pathways and receptors are depicted on Figure 5-2.

5.4.1 Direct Contact Pathways for Soil

Direct contact with surface soil is not a pathway of concern, as COC concentrations at the surface are below industrial RSLs, as defined in Section 3.2. Ditch sediments and stormwater have been eliminated as media of concern due to constructed improvements at the facility. These improvements include excavation and disposal of ditch sediments, and construction of drip pad

aprons, berms, and the stormwater treatment system. Potential exposure to subsurface soil remains a potential pathway in a trench worker scenario.

5.4.2 Groundwater and LNAPL Pathways

The groundwater and LNAPL pathways involve the movement of a COC (such as PCP or PAHs from creosote treating solution) in groundwater to potential downgradient receptors. To be considered a complete pathway, the COC must be incorporated into groundwater (1) in a dissolved (aqueous) phase, (2) sorbed onto particulate or colloidal particles, or (3) as LNAPL, and the COC must be transported to a point of contact with the end receptor (human or ecological). At the Arlington facility, groundwater transport of COCs may occur by the following mechanisms:

- Leaching of COC-affected soils or sediments in the vadose (unsaturated) zone and infiltration of the leachate to groundwater;
- Direct contact of COC-affected soils with groundwater;
- Direct contact of LNAPL (containing COCs) with groundwater;
- Migration of affected groundwater; or
- Migration of LNAPL.

Historically, all these processes may have occurred at the facility. Based on results of the SI, groundwater is in contact with LNAPL and with soil affected by COCs in the Main Treatment Area, and a dissolved-phase plume is present beneath the facility. However, the exposure is currently limited due to the lack of nearby receptors hydraulically downgradient of the facility. The closest downgradient residence that currently uses groundwater from a private well is located approximately 4,000 feet northwest of the facility. All residents and businesses in this area have access to the City water system.

5.4.3 Air Transport Pathways

The potential pathways for emissions from wood-treating operations at the Arlington facility include potential direct exposure to airborne vapors and potential deposition of vapors onto the ground. Deposition could occur both on and off the facility property. PCP could then accumulate in surface soils, where direct contact could occur or the chemicals could then migrate from surface soil into surface water or groundwater. The potential for inhalation by on-site workers was eliminated from consideration in the SI based on industrial hygiene testing that documented airborne concentrations of COCs only a small fraction of the allowable Occupational Safety and Health Administration workplace limits. Inhalation by nearby residents was also shown to be below risk-based screening levels by modeling air data. The air transport pathway is not a pathway requiring or considered for corrective action, as discussed in Section 4.3.

5.5 POTENTIAL RECEPTORS

Potential receptors for exposure pathways include on-site workers and nearby residents.

5.5.1 On-site Workers

Current and future on-site workers have the potential to contact surface and subsurface soil in the Main Treatment Area. Surface soil COC concentrations have been shown to be below risk-based industrial exposure levels. However, there is a possibility that a current or future on-site worker doing subsurface utility or construction work could come into contact with subsurface soil COCs above risk based industrial exposure levels. Typically, such workers at an industrial facility would use appropriate personal protective equipment (PPE) to avoid any adverse exposures; however, longer term corrective measures will need to be considered in development of alternatives to address this risk.

Groundwater containing COCs is present at depths greater than 10 to 15 feet bgs in the Main Treatment Area at the Baxter facility. This depth is in the upper end of the depth range for workers doing subsurface utility or construction work. Therefore, it is not reasonable to consider potential worker exposure to groundwater in developing corrective measures in this CMS.

5.5.2 Nearby Residents

On-site residential receptor exposure would occur only in the unlikely hypothetical future scenario that the plant is closed and redeveloped for residential use or if drinking water wells were installed at the facility. Existing land use zoning and ongoing industrial use at the facility eliminate these on-site receptors under current conditions; however, ICs will need to be implemented as part of any final corrective measure so that this risk is properly addressed.

The facility is an "industrial property" under WAC 173-340-200. Such property that is zoned for industrial use need not consider hypothetical future residential uses, and both site evaluations and remedial actions can be based on industrial pathways as the reasonable maximum exposure assuming that ICs will be part of the corrective measure. Corrective actions are considered by the EPA to be "complete without controls" only when the site meets all applicable cleanup levels, including residential. If corrective action is completed but residential cleanup levels cannot be met, restrictions or ICs may need to be placed on the site. Under this scenario, EPA would consider the site "corrective action complete with controls."

Although affected groundwater extends from the facility property, the leading edge of the plume remains approximately 3,600 feet from the nearest private drinking water well. Nearby residential receptor exposure would be associated only with potential migration of constituents by

groundwater migration to hydraulically downgradient private wells. Given the distance from the leading edge of the plume, PCP concentrations in groundwater are expected to attenuate before reaching downgradient private wells. Since residential receptors do not have the potential to be affected by facility releases, no corrective measure is anticipated for the residential groundwater pathway.

Surface soil has been tested at locations beyond the facility boundary and shown to have no concentrations of facility-related constituents above residential risk-based screening levels.

Ambient air at the facility has been modeled based on on-site air quality and compared to risk-based screening levels (PRGs - Ambient Air). The air quality models show that air from the facility poses no risk of adverse effects to downwind residents.

6.0 CORRECTIVE MEASURES CONSIDERATIONS

Unique conditions associated with the Arlington facility require consideration when developing and selecting a final corrective measure. The AOC also specifies several factors that must be evaluated during the technology screening process. These considerations include site conditions, operational conditions, contaminant characteristics, technology limitations, and regulatory issues, as discussed in the following subsections.

6.1 SITE CONDITIONS

The portions of the Arlington facility that require corrective action are Parcel A, Parcel B, groundwater underlying the Northwest Parcel, and affected groundwater extending downgradient from the Northwest Parcel (Figure 2-2). The Closed Woodwaste Landfill does not need to be addressed by further corrective action as it has been formally closed through the Snohomish County Health District. The Northwest Parcel and downgradient areas with affected groundwater have had no facility operations, but concentrations of PCP in groundwater exceed the proposed cleanup level as a result of releases from Parcel A. As such, corrective measures developed for the facility in the following sections will address affected groundwater that extends downgradient from the Main Treatment Area, including areas outside the Baxter property.

6.2 OPERATIONAL CONDITIONS

Parcel A encompasses the main industrial operations for the facility (Figure 2-2). It has served as the wood-treatment area since the middle to late 1960s prior to Baxter's purchase of the wood-treating operations. COC-affected soils within the Main Treatment Area are the primary source of COCs in groundwater at the Arlington facility and include an area of LNAPL. However, because this area is the hub of the Arlington facility operations, any technologies proposed to address soils affected with COCs in the area must also consider the effects of the remedial activities on facility operations and the facility operation's effects on the remedial activities. For example, excavation of soils in the Main Treatment Area would require shutting down the entire facility operations for a period of time. The costs of a facility shutdown, even for very short periods, would be high, particularly if a shutdown would require demolition of a portion of the existing facility and secondary containment structures.

As stated in Section 2.5, Stella-Jones owns and operates the treatment facility. Baxter retains ownership of the real property and receives lease payments from Stella-Jones under a long-term agreement. The lease payments fund the ability to perform the remedy. Interruption of operations may give Stella-Jones a claim that it has cause for lease termination. Baxter performs all remediation work related to the AOC. Any extended cleanup period or construction will affect the

tenant's ability to manufacture treated wood products, resulting in decreased revenue to the tenant and potential opportunity losses, which could include long-term loss of customers. These factors could result in a breach of contract and loss of the tenant and lease revenue to Baxter. In addition, any corrective measure planned in the area of the facility operations could be affected by the current operations. For example, operational constraints may preclude placing components of the remedy in the ideal locations. Evaluation of the proposed corrective measure alternatives will need to consider these effects.

Because the facility is currently operating, it is likely that this parcel will remain industrial for the foreseeable future. The facility is zoned industrial and meets the MTCA definition of an industrial property.

Parcel B, the Untreated Pole Storage Area, has had a less intense industrial use (Figure 2-2). Parcel B includes an area for untreated pole storage, a lunch room, a storage building, an incisor, a framing building, the pole peeler, and the stormwater treatment system and infiltration gallery. Parcel B was not purchased by Baxter until 1970 and has been used predominantly for industrial activities that have not involved handling hazardous materials. While the SI found soil in several locations within Parcel B with COC concentrations that exceeded proposed soil cleanup levels based on direct residential exposure (see Appendix A); however, none of the COCs in Parcel B exceed direct exposure cleanup criteria in an industrial setting. Since the property is zoned industrial and meets the MTCA criteria as an industrial site, corrective measures other than possible deed restrictions may not be necessary. Placement of a deed restriction on Parcel B results in a RCRA designation of "Corrective Action Complete with Controls."

6.3 CONTAMINANT CHARACTERISTICS

The primary area of affected soil and groundwater is located within Parcel A. Affected soil is confined largely to the Main Treatment Area, which also contains an area of residual LNAPL.

6.3.1 Soil and LNAPL

LNAPL has been observed in soil samples collected from borings ranging in depth from 10 to 42 feet. At time of installation, LNAPL was observed within three existing monitoring wells (MW-12, MW-13, and MW-19). Most of the residual LNAPL observed in these boreholes was present within the vadose zone soils and had not migrated to groundwater. Both EPA and MTCA regulations and guidance documents list source treatment or removal as a preferred corrective measure. The area containing LNAPL is considered the primary source affecting groundwater; however, the nature of the LNAPL underlying the Main Treatment Area presents challenges to removal. Pilot testing indicates that limited amounts of mobile LNAPL can be recovered by passive extraction

(i.e., bailing or absorbent socks), but several weeks or months are required before LNAPL thickness returns to pre-extraction thicknesses. It is not known why the residual LNAPL within the vadose zone has not migrated downward. It could be due to differences in viscosity (i.e., high viscosity LNAPLs are preferentially held in vadose zone soils due to greater capillary forces), or because the volume is below the residual saturation levels. The residual LNAPL, which is present over a large area and at varying depths, is recoverable only through invasive and disruptive remediation technologies, such as thermal or chemical processes (e.g., electrical resistance heating, steam injection, or chemical oxidation) or excavation.

Any potential excavation within the Main Treatment Area would carry significant cost including the potential need to shut down at least a portion of the facility. Other alternatives, such as thermal treatment or chemical oxidation, could be implemented at the facility during ongoing operations, with close coordination with the existing site operator and scheduling work activities in the evenings and weekends, although at a higher cost.

Treatment or removal of LNAPL associated with wood-treating operations and coal gasification facilities has proven difficult, especially when the nonaqueous-phase liquid (NAPL) is present at or below residual saturation levels (Cheremisinoff and Rosenfeld, 2010). The viscosity of LNAPL associated with wood-treating compounds varies greatly, from tar-like material that has very low mobility to less viscous material that could be more prone to migrate. Pure creosote tends to behave as a dense NAPL (DNAPL), but the PCP/diesel mixtures tend to behave as LNAPL. A common remediation approach used to limit LNAPL and DNAPL migration at wood treating sites includes containment technologies, thermal treatment, and chemical oxidation (EPA, 1992).

At the Baxter facility, the presence of diesel-based LNAPL on the water table and residual LNAPL in the vadose zone beneath an active production facility (i.e., the Main Treatment Area), combined with the presence of woodwaste in the subsurface, will limit the effectiveness and implementability of available technologies, and this situation needs to be considered in development of alternatives.

In addition, COC-affected soil excavated from Parcel A would be classified as a RCRA-listed waste, and therefore would have very high disposal costs. High disposal costs need to be evaluated against the benefit gained by potentially eliminating a source area.

6.3.2 Groundwater

The existing groundwater plume beneath the Baxter facility extends northwesterly from the source area under the Main Treatment Area to the Northwest Parcel and to areas immediately downgradient of the Northwest Parcel. PCP is the primary COC within the plume, with PAH compounds also present in groundwater near the source area (Figure 4-1). The presence of PCP

and likely dioxins in the groundwater creates regulatory considerations in evaluating technologies. Any water generated by a technology such as pumping or aboveground treatment would potentially be considered a RCRA-listed waste due to the presence of PCP. RCRA has an exemption from this waste listing if the water is discharged to a publicly owned treatment works (POTW), such as the POTW operated by the City of Arlington. Other options for disposal of treated groundwater include infiltration into the ground or discharge to the ditch located on the eastern margin of the Arlington facility. Extracted groundwater reinjected into the groundwater plume is exempted from the RCRA-listed waste issue, and the reinjection can be done under a Class V injection permit available through Ecology. Discharge of treated groundwater to the ditch would require a discharge permit and permission from BNSF, the owner of the ditch.

6.4 TECHNOLOGY LIMITATIONS

The subsections above outline specific factors to be considered for remedy selection based on site conditions and contaminant characteristics. In addition, for the types of COCs at the Baxter facility, technologies are limited in their application. Both EPA guidance and MTCA guidance have a preference for COC destruction or removal for both the source area and any associated plume. For wood-treating sites, the characteristics of the COCs are such that complete removal or destruction is unlikely even using very aggressive remediation technologies.

6.5 REGULATORY CONSIDERATIONS

EPA guidance (EPA, 1996) and policy require source areas to be addressed by permanent solutions to the extent practicable. The Washington MTCA regulations (WAC 173-340-360), which are applicable to this facility, also prefer permanent solutions. Both EPA and Ecology have a common goal: to eliminate the potential risk that a hazardous substance can remobilize in the future if a nonpermanent remedy fails. However, both EPA and Ecology recognize that permanent solutions are not always practical and allow exceptions to the goal of a permanent solution.

7.0 CORRECTIVE MEASURES OBJECTIVES

Corrective measure objectives (CMOs) are developed in this section as an initial step in the development of corrective measures for this facility. CMOs define the locations, media, constituents, and receptors that need to be addressed by the selected corrective measures in order to remediate potential adverse risks. The qualitative objectives are summarized in this section. Corrective measures are needed only to address potential human health risks, since no ecological habitats could be impacted by affected groundwater (see Section 4.5).

As agreed between Baxter and EPA, no site-specific quantitative risk assessment needs to be conducted for this facility. Although EPA will determine final cleanup levels, media-specific concentrations will be compared to risk-based screening levels, the proposed cleanup levels developed in Section 3, and corrective measure considerations discussed in Section 6 in order to identify those areas where corrective actions are warranted.

7.1 APPLICABLE REQUIREMENTS

The potentially applicable federal laws that will be considered for potential corrective actions and proposed cleanup levels include:

- Clean Water Act (including the National Toxics Rule and NPDES requirements);
- Safe Drinking Water Act (including Drinking Water Standards and Health Advisories);
- RCRA;
- Toxic Substances Control Act; and
- EPA RSLs.

Potentially applicable state laws and regulations include:

- Water Resources Act of 1971;
- Drinking Water Act (including Drinking Water Regulations);
- Hazardous Waste Management Act (including Dangerous Waste Regulations); and
- MTCA.

7.2 CORRECTIVE MEASURES OBJECTIVES

The requirements for CMOs are set forth in the AOC (EPA, 2001) and EPA guidance documents (EPA, 1994, 1996). General CMOs for designated areas and media at the facility are developed in this section. These will be discussed for each medium in the following subsections.

7.2.1 Subsurface Soil

COCs are present in subsurface soil in the Main Treatment Area as a result of the historic release of wood-treating chemicals. Concerns at the facility include soil concentrations of COCs above proposed cleanup levels and residual LNAPL retained in the vadose zone by capillary forces. The CMOs for subsurface soil are:

- Reduce COC concentrations to cleanup levels within a reasonable time frame;
- Prevent exposure to adverse concentrations of soil COCs by future on-site workers doing subsurface work via direct contact, ingestion, or inhalation; and
- Prevent or minimize the potential for adverse leaching of soil COCs to groundwater.

7.2.2 LNAPL

Mobile LNAPL is present in a limited area of the facility within the Main Treatment Area. The CMO for mobile and residual LNAPL is:

- Reduce the mass and area of leachable residual LNAPL and LNAPL present in the subsurface to minimize the potential for COCs to leach from the LNAPL into groundwater.

7.2.3 Groundwater

Affected groundwater currently occurs under the Main Treatment Area, the Treated Pole Storage Area, and the Northwest Parcel. Affected groundwater is also present in areas immediately downgradient of the Northwest Parcel. Mann-Kendall plots generated with monitoring data collected during the SI indicated that the PCP plume was stable; however, the plume area has decreased since implementation of the Pilot Study (see Section 9.2.4). Groundwater beneath the facility is currently not used for drinking water, but as a conservative measure, the overall corrective measure objective for groundwater is to prevent any adverse future human or ecological exposure to affected groundwater. The specific CMOs for groundwater are:

- Prevent future use of groundwater beneath the facility for drinking water;
- Reduce COC concentrations in groundwater to below drinking water standards within a reasonable time frame;
- Prevent downgradient migration of groundwater with COC concentrations above drinking water cleanup standards; and
- Minimize the mass and area of contaminants in affected groundwater over time.

7.3 OVERALL OBJECTIVES

In summary, the CMOs for the Arlington facility address subsurface soil at the facility and groundwater beneath the facility. The CMOs are:

- Prevent human exposure to subsurface soil containing COC concentrations above industrial cleanup levels;
- Prevent or minimize the migration of adverse concentrations of COCs from soil to groundwater;
- Prevent human exposure to groundwater COC concentrations above drinking water standards;
- Prevent migration of COCs in groundwater;
- Minimize the contaminant mass and area in subsurface soil, LNAPL, and groundwater; and
- Minimize concentrations of COCs in soil and groundwater to achieve cleanup levels and protect human health and the environment.

8.0 TECHNOLOGY SCREENING

In this section, technologies that may potentially be used to address conditions at the facility will be identified and screened based on their applicability to the specific site conditions and COCs at the Baxter facility. Technology screening is a very coarse assessment, with two possible results: (1) the technology is potentially suitable to site conditions and is therefore retained for further analysis; or (2) the technology is not appropriate or feasible for this facility and is therefore not retained.

8.1 GENERAL RESPONSE ACTIONS

General response actions are medium-specific actions that will satisfy the CMOs. General response actions may include treatment, containment, excavation, extraction, disposal, ICs, or a combination of these. General response actions considered for satisfying CMOs at the Arlington facility are summarized below.

8.1.1 Subsurface Soil

General response actions for subsurface soil in the Main Treatment Area include:

- Monitored natural attenuation (MNA),
- ICs,
- Containment,
- Recovery/removal,
- Ex situ treatment, and
- In situ treatment.

MNA is a general response action that relies on natural attenuation mechanisms to reduce contaminant concentrations to corrective measures goals. No efforts would be taken under this general response to remove, treat, or otherwise control the release of contaminants in the subsurface.

ICs are administrative measures undertaken to limit or prohibit activities that may interfere with a cleanup action or result in exposure to hazardous substances. They typically include legal restrictions, such as use limitations recorded on the property deed.

Containment technologies include the use of engineered barriers to isolate wastes. When properly constructed and maintained, these barriers often provide a reliable means of minimizing direct

exposure and controlling the spread of contaminants from a waste source. Containment technologies include both horizontal (e.g., caps) and vertical (e.g., slurry wall) barriers.

Recovery/removal refers to the physical removal of wastes from the subsurface. The most common recovery/removal response action for contaminated soil is excavation. Shallow soil is typically easy to excavate, and deeper soils may be removed with appropriate equipment or by using terraced excavations.

Ex situ treatment involves the excavation of contaminated soil and subsequent off-site treatment or direct landfill disposal without treatment. In situ treatment treats contaminated soils in place without excavation. In situ treatment technologies for soil typically use some form of chemical and/or physical process to reduce contaminant concentrations, or otherwise render contaminants immobile.

8.1.2 LNAPL

General response actions for LNAPL within the Main Treatment Area include:

- MNA,
- ICs,
- Containment,
- Recovery/removal,
- Ex situ treatment, and
- In situ treatment

MNA, ICs, and containment response actions would be the same as described in Section 8.1.1. General response actions for recovery/removal of LNAPL include the use of bailers, skimmers, or pumps to recover and remove LNAPL from the subsurface, plus in situ treatment options such as thermal and chemical processes. Ex situ treatment for LNAPL typically involves the physical separation of LNAPL from groundwater and subsequent off-site disposal via incineration.

8.1.3 Groundwater

General response actions for groundwater include the following:

- MNA;
- ICs;
- Containment;

- Recovery/removal;
- Ex situ treatment; and
- In situ treatment.

MNA, ICs, and containment response actions would be the same as described in Section 8.1.1. General response actions for recovery/removal of groundwater include the use of pumps to recover contaminated groundwater from the subsurface.

Ex situ treatment for contaminated groundwater typically involves the removal and/or destruction of contaminants via physical or chemical processes. Once treated, the water would be disposed of either on site (e.g., direct discharge to ground surface) or off site (e.g., discharge to a POTW).

In situ treatment technologies for contaminated groundwater typically use some form of chemical, physical, or biological process to reduce contaminant concentrations, or otherwise destroy contaminant mass.

8.2 POTENTIALLY APPLICABLE TECHNOLOGIES

A range of proven and innovative technologies has been considered to identify those that have potential applicability to subsurface soil and groundwater at the Arlington facility. Available technologies include ICs, engineering controls, and in situ and ex situ remediation technologies. This section describes the results of technology screening and identifies which technologies were retained.

Technology screening begins by identifying potentially applicable technologies. Retained technologies for each affected medium (subsurface soil, LNAPL, and groundwater) are evaluated relative to one another on the basis of three criteria:

- **Effectiveness:** The effectiveness criterion evaluates the technology for its protectiveness and reduction in contaminant toxicity, mobility, or volume. Both short-term and long-term effectiveness are evaluated. Short-term effectiveness addresses the construction and implementation periods. Long-term effectiveness evaluates the technology after the corrective action is in place.
- **Implementability:** The implementability criterion evaluates the technology for technical and administrative feasibility. Technical feasibility refers to the ability to construct, operate, maintain, and monitor the action during and after construction and meet technology-specific regulations during construction. Administrative feasibility includes factors such as the ability to obtain permits for off-site actions and the availability of specific equipment and technical specialists.

- **Cost:** The cost criterion represents the relative costs of different technologies so that the technologies can be compared in relative terms to each other. Typically, the full cost of a given technology cannot be determined at this screening level; however, knowledge of typical technology costs obtained from vendors, cost-estimating guides, EPA guidance documents, prior projects, and engineering judgment are used to determine the relative cost of a technology compared with similar technologies.

The evaluation of applicable remedial technologies for each medium is described below for unsaturated soil, LNAPL, and groundwater. Some technologies are classified under multiple media, and may be screened differently depending on the intended use.

Technologies that pass the screening evaluation are assembled into corrective measures alternatives, which are described in Section 9 and evaluated in Section 10. Alternate process alternatives ultimately may be selected for a cleanup action during the corrective measures design phase, based on design-level evaluation of similar options. Promising technologies for which design-level details need to be developed in order to fully evaluate their applicability are retained here, but subject to contingencies such as interim remedial pilot-scale testing.

8.2.1 Technologies for All Media: Institutional Controls

Potentially applicable ICs include:

- Deed restrictions addressing land use and soil excavation;
- Deed restrictions to preclude drinking water use;
- Use restrictions and monitoring requirements to prevent disturbance of caps or other engineered controls; and
- Public awareness and communication.

ICs have the potential to address a number of the residential and on-site worker exposure-related corrective measures objectives at the facility. A soil management plan requiring the use of PPE during any subsurface soil excavation work can reliably prevent worker exposure to subsurface soil contaminants and shallow groundwater. A deed restriction can also be applied to the property to prevent any future residential uses of the property, to prohibit on-site groundwater from being used for drinking, and to require a soil management plan with PPE during soil excavations. ICs to protect against exposure to affected downgradient groundwater could be implemented through public awareness and communication. Controls such as management plans and deed restrictions are proven and reliable and were retained for detailed evaluation.

8.2.2 Technologies for Subsurface Soil

Technologies for subsurface soil include both in situ and ex situ technologies, as well as soil removal. Each of the technologies screened is described below.

8.2.2.1 Thermal Treatment

Thermal treatment is a remediation technology that accelerates the removal of organic compounds from the subsurface, including LNAPL, soil contamination, and dissolved-phase contamination in groundwater. Steam or electrical energy is applied into the contaminated zone, and heat energy volatilizes contaminants into the vapor phase and dissolves contaminants into the groundwater. Groundwater extraction and treatment and dual-phase extraction technologies are required to remove and handle the contaminants that are removed from within the LNAPL and groundwater.

This technique was developed primarily to address NAPL or sites with volatile organic compounds, and has been successfully applied at several sites. A significant concern associated with this technique is that contaminants currently immobilized by capillary forces (e.g., residual LNAPL in the vadose zone) are mobilized by this technology (by increasing solubility). The risk for this technology is that it has the potential to significantly mobilize and further spread contamination.

The thermal treatment technology most applicable for the Arlington site is electric resistance heating (ERH). ERH is an in situ remediation technology that enhances recovery of soils contaminated with volatile and semivolatile organic compounds by applying electricity to heat the soil. ERH can simultaneously treat solvents found in saturated and unsaturated soil, groundwater, and pools below the groundwater table. Developed by the U.S. Department of Energy, ERH takes electricity from standard utility lines and applies it across electrodes placed in a grid pattern across an impacted site. As the subsurface resists the application of electricity, it is heated to the boiling point of water, producing steam and contaminant vapors. ERH can be applied from the subsurface to depths of 100 feet below grade. The soil heating volatilizes contaminants, which are then recovered by a total fluids recovery well and treated ex situ or recycled to the electrodes as wetting water. Each electrode can be constructed to function as a total fluid and vapor recovery well capable of recovering groundwater, LNAPL, steam and contaminant vapors from the subsurface. With proper engineering controls, ERH can be safely used under roads, parking lots, and occupied buildings without the disruption of traffic or occupancy.

There are two main types of ERH: three-phase and six-phase. Three-phase heating consists of electrodes placed in a repeating triangular pattern where electricity is conducted between adjacent electrodes. Six-phase heating involves a hexagonal pattern of six electrodes with a neutral electrode placed in the center.

This technology will require close coordination with the current operator to minimize plant downtime. It is expected that installation would occur during evenings and weekends; however, there may be a need for a partial plant shutdown to install system components.

In general this technology is most effective on fuel hydrocarbons, chlorinated solvents, and PAHs such as creosote and coal tar. ERH can be applied in all soil types, from clay to silt and from gravel to sand. Woodwaste in the subsurface at this site could represent a challenge for ERH. ERH was retained for further evaluation.

8.2.2.2 Excavation & Off-Site Disposal

Excavation and off-site disposal of contaminated soil is a traditional heavy construction technique for removing contaminated soil from a site and disposing of it in an appropriately permitted landfill, thereby eliminating the potential for on-site worker exposures and future leaching of soil constituents to groundwater. This technique is best suited to small areas of shallow soil in readily accessible areas.

At the Arlington facility, the application of this technique is limited by the physical constraints of the ongoing facility operations and facility structures that overlay much of the affected soils in the Main Treatment Area. In order for this approach to be implemented, much of the main facility operational system (retort, drip pads, sumps, tankage) would require either temporary or permanent relocation, and revenue-generating operations would likely cease for several months. This approach is further limited by accessibility constraints imposed by the depths of soil contamination (which in some areas has been detected at upwards of 30 to 40 feet bgs), the presence of affected soils below the water table, and the presence of structures. These site-specific conditions make complete soil excavation impractical at the Baxter facility. The presence of permanent structures makes the likelihood of removing all of the affected vadose-zone soils unlikely. In addition, soils excavated from the Main Treatment Area may be subject to land disposal restrictions. Despite these limitations, this traditional basic technology was retained for further evaluation as this technology would address all of the COCs in soil.

8.2.2.3 Soil Stabilization

This technology involves processes that react with the soil or contaminant to stabilize contaminants in the affected soil and reduce their leaching and migration potential. Stabilization methods include both in situ and ex situ techniques using materials such as Portland cement, asphalt, lime, polymers, resins, chemical oxidants, and sorbents to modify the physical and/or chemical properties of soil. Ex situ stabilization requires excavation of the soil to be treated. In situ treatment requires substantial disturbance to the soil in order to mix stabilization agents into the soil. These processes typically result in expansion of the soil volume due to the amount of material added and chemical reactions; the range of volume expansion typically encountered with this

technology is in the range of 10 to 25 percent. This technology has been most successful for metals; however, some success has been achieved in stabilizing organic contaminants at other wood treating facilities.

The size and depth of the affected area at the site, some of which is below the water table, and access constraints imposed by the ongoing operations at the facility reduce the applicability of both in situ and ex situ stabilization. Due to the depth of site contamination, volume expansion would substantially modify the site elevation, requiring either off-site disposal or site redevelopment. Soil stabilization is retained for further evaluation.

8.2.2.4 Chemical Oxidation

Chemical oxidants have been able to cause the rapid and complete chemical destruction of many toxic organic chemicals, and other organics are amenable to partial degradation as an aid to subsequent bioremediation. Reduction/oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). The oxidizing agents most commonly used are ozone, hydrogen peroxide, permanganate, hypochlorite, chlorine, and chlorine dioxide, and the most common application is in situ versus ex situ.

In general, the oxidants have been shown to be capable of achieving high treatment efficiencies for chlorinated ethenes (e.g., trichloroethene) and saturated aromatic compounds (e.g., benzene), but use on semivolatile organic compounds (e.g., PAHs) or highly chlorinated aromatic organics (e.g., PCP) is not as common. Field applications have clearly shown that matching the oxidant and in situ delivery system specifically to the COCs and the site conditions is the key to successful implementation and achieving performance goals. The presence of LNAPL would require multiple applications and high volumes of reagents. The handling of large quantities of strong oxidizers is also a disadvantage of this method. However, several newer oxidation products provide safer handling as a result of using a two-part mixture to release oxidants (rather than using oxidant in its pure form).

Where woodwaste backfill and COCs overlap, oxidants would be at best ineffectual and at worst a fire hazard (depending on the strength of oxidant used, presence of LNAPL, and moisture content of the woodwaste).

In general this technique is most cost effective on dissolved phase constituents, rather than LNAPL and COC-affected soils, due to the commensurately larger volumes of reagents and reduced soil permeability associated with LNAPL zones. This technology is a potentially effective alternative, and has been retained for limited use for subsurface soil.

8.2.3 Technologies for LNAPL

LNAPL can be removed from the subsurface by pumping fluids from wells or trenches. LNAPL recovered from wells (by various technologies, such as pumping or passive flow) or trenches can be recovered as a "pure-phase," or recovered with groundwater followed by subsequent separation in aboveground facilities. Alternative methods of LNAPL removal include steam or co solvent enhanced extraction, which is intended to mobilize COCs into the dissolved phase then recapture those mobilized COCs through a groundwater extraction system. Depending on the nature of the contamination and/or the source of the release, LNAPL and/or groundwater collected by liquid pumping or separated from other waste materials may be classified as a hazardous waste, and could require a RCRA permit for treatment. Options for management of recovered LNAPL include recycling and/or incineration.

8.2.3.1 Total Fluids (Dual-Phase) Recovery

Total fluids recovery, also known as multi-phase extraction, includes the recovery of groundwater and mobile LNAPL using extraction wells and then separation, treatment, and disposal of the extracted fluids. Typically this technique involves the installation of recovery wells in the LNAPL area with screens placed across the top of the water table and overlying LNAPL zone. Well pumping pulls in groundwater as well as mobile LNAPL that flows into the well. Groundwater extraction typically creates a cone of depression in the water table that can facilitate LNAPL collection by encouraging increased flow of LNAPL to the recovery well along the depressed slope of the water table surface. Care must be taken in the placement of the well screen depths so as not to cause LNAPL smearing across a greater zone while still utilizing the cone of depression to advantage. Phase separation and groundwater treatment of recovery fluids are required. Water generated and treated can be disposed of either through discharge to a POTW or reinjection into the existing groundwater plume. This technology is potentially applicable at the Main Treatment Area and was retained for further evaluation.

8.2.3.2 Thermal Treatment

Steam enhanced extraction and ERH are included in thermal treatment. Steam-enhanced extraction utilizes steam injection to vaporize organic contaminants in LNAPL so they can be more readily collected in extraction wells. For the Arlington facility, ERH has been selected as a representative thermal treatment system that can be adapted to the Arlington facility, as discussed in technologies for soil. ERH has therefore been retained as a thermal technology.

8.2.3.3 Co-Solvent-Enhanced Extraction

In situ co-solvent extraction involves flushing fluids containing water-miscible co-solvents through contaminated soil to facilitate the removal of contaminants by enhanced LNAPL dissolution and/or mobilization and enhanced desorption. These co-solvents achieve LNAPL removal through a

number of complementary mechanisms, including (1) reduction of interfacial tension between the aqueous and LNAPL phases; (2) enhanced solubility of the LNAPL components in the aqueous phase; (3) swelling of the LNAPL phase relative to the aqueous phase; and (4) under certain conditions, complete miscibility of the aqueous and LNAPL phases. Various co-solvents can preferentially partition into the LNAPL or aqueous phase. Co-solvent-enhanced extraction utilizes co-solvent injection to mobilize contaminants so they can be more readily collected in total fluids recovery wells for on-site treatment and/or disposal. A significant concern associated with this technique is that contaminants currently immobilized by capillary forces (e.g., residual LNAPL in the vadose zone) are mobilized by this technology (by increasing solubility). Unless groundwater recovery at a downgradient location is completely effective, the technology can significantly mobilize and further spread contamination. Given the relatively rapid groundwater flow rate in the sand and gravel aquifers underlying the affected area, and the relatively small dissolved-phase plume, other technologies are more suitable for the Arlington facility. For these reasons, this technology was not retained for further evaluation.

8.2.3.4 Passive Recovery

Passive recovery involves collection of LNAPL that passively flows into wells (either existing monitoring wells or specifically designed recovery wells) using bailers, sorbent socks, oil skimmers, or skimming pumps. This method relies on the gradual natural movement of LNAPL into wells without enhancement. LNAPL movement into wells is driven by the gradient created by reduced LNAPL levels in the well casings, maintained by repetitive removal of LNAPL from the wells, versus levels in the formation. The selection of the appropriate technology between different individual technologies (skimmers versus sorbent socks for example) is based on the amount of LNAPL present, the viscosity, the specific gravity, and operational issues, such as necessary treatment. At the facility, the flow of LNAPL into wells has been observed to be extremely slow, which suggests that passive LNAPL recovery approaches, such as sorbent socks, may be more appropriate than active recovery approaches using skimmers or skimming pumps. Skimmers or skimming pumps could be effective if LNAPL volumes are found to be high and LNAPL readily flows to the recovery wells. At very low recovery rates, passive sorbent materials or bailers would be more cost effective than active LNAPL recovery options. This technology is potentially applicable at the Main Treatment Area and was retained for further evaluation.

8.2.3.5 Interceptor Trench

Extraction of LNAPL-including collection using bailers, sorbent socks, skimmers, or pumps-can also be accomplished from interceptor trenches instead of wells. This method can enhance LNAPL collection by intersecting downgradient LNAPL migration at proportionally larger subsurface areas (trench area versus monitoring well circumference). This method relies on the natural movement of LNAPL into the interceptor trench without enhancement, and is typically applied to

sites with migrating LNAPL. This method is not applicable at the Arlington facility because no evidence exists for migrating LNAPL. Installation of a trench would be costly, and would not likely be effective at LNAPL removal. For these reasons, this technology was not retained for further evaluation.

8.2.3.6 Chemical Oxidation

Although not ideal for NAPL removal due to high chemical costs and potential hazards as discussed above, if carefully applied this method can be effective and would preclude management of recovered LNAPL. Careful selection of oxidant and use in a targeted manner is required to minimize hazards and costs. Chemical oxidation has been retained for further evaluation.

8.2.3.7 Management of Recovered LNAPL

LNAPL collected from liquid pumping or separated from other waste materials may be classified as a hazardous waste. Disposal options for LNAPL include:

- **Recycling/Reuse:** If available, recycling of recovered LNAPL at a wood-treating facility is the preferred and lowest cost method of disposal, but may not be practicable because of the potential for hazardous waste classification and the low demand for this product. The low demand for the recovered product from the Arlington facility is due to the presence of contaminants in the LNAPL from other historical wood-treating products, and the stringent specifications required by the American Wood Preserving Institute during the manufacturing process used by virtually all treating facilities. This management option has not been retained, as Baxter has not found a suitable recycling facility.
- **Incineration:** Recovered LNAPL is anticipated to be a listed hazardous waste (FO32) subject to land ban restrictions. Listed constituents in the LNAPL are likely to be at concentrations in excess of the Universal Treatment Standard (40 CFR 268.48). LNAPL would likely need to be shipped to a hazardous waste treatment facility and incinerated. This is typically a very expensive disposal technology, but the high energy content of LNAPL may reduce the cost somewhat. This technology has been retained for further consideration.

8.2.4 Technologies for Groundwater

Potentially applicable technologies for groundwater remediation are described and evaluated below. These technologies include groundwater monitoring, in situ treatment, and groundwater extraction and treatment.

8.2.4.1 Long-Term Monitoring

At the Arlington facility, long-term groundwater monitoring is a component of all groundwater corrective measures alternatives under consideration. Therefore, long-term groundwater sampling

and analysis to monitor the plume over time is included in the corrective measure alternatives to be evaluated further.

8.2.4.2 Monitored Natural Attenuation

MNA encompasses a variety of physical, chemical, and biological processes that, under favorable conditions, act without human intervention over time or distance to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. MNA is evaluated in the CMS in accordance with the following EPA guidance documents.

- Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites (EPA, 1997);
- Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA, 1998); and
- Performance Monitoring of Monitored Natural Attenuation Remedies for VOCs in Groundwater (EPA 2004).

For the purpose of this document, the term "monitored natural attenuation" will be used consistent with the EPA guidance on MNA (EPA, 2004). These in situ processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants. MNA is retained as a corrective measure technology for groundwater.

8.2.4.3 Physical Containment or Barriers

Physical containment technologies exist to restrict the flow of groundwater so that it cannot migrate off site or to a point where a potential human or ecological exposure may occur. Physical barrier technologies exist to re-direct the flow of groundwater around contaminated areas, to prevent migration of COCs off site or to prevent a potential human or ecological exposure. This technology includes the installation of barriers or walls in the subsurface to restrict or re-direct the natural flow of groundwater. Groundwater extraction and treatment and capping are sometimes necessary to minimize the groundwater that builds up behind the barrier. The physical barriers can include slurry walls, grout curtains, or sheet pilings. Such installations typically address shallow groundwater plumes and are installed into an underlying confining or lower permeability layer to prevent underflow around the barrier.

An underlying low-permeability layer is not present at the Baxter facility until approximate depths of 100 feet or more, which is too deep for seating the bottom of a containment wall. Barrier walls constructed without being seated into a lower permeability layer are called "hanging barriers" and typically make groundwater extraction to induce an inward gradient more costly than for barrier walls keyed to an aquitard, as higher volumes of water will need to be pumped to establish

hydraulic containment. This hanging barrier wall for physical containment is not an ideal remediation technology for groundwater at the site, but since the source material is floating on the top of the water column, this technology has been retained for further evaluation.

8.2.4.4 Groundwater Extraction and Treatment

Groundwater extraction and treatment is a proven technique for hydraulic control of affected groundwater. This basic technology involves the installation of recovery wells in a pattern sufficient to capture the groundwater plume at its leading edge, or to fully capture groundwater throughout the plume area, depending on the size of the plume. The recovered groundwater is then treated on site or off-site using treatment technologies appropriate for the specific contaminants in the plume. Although this technology has been used less frequently because of relatively high costs and low mass removal, it is a proven technology for plume containment/control and is therefore retained for further evaluation at the Arlington facility.

Treated groundwater from an extraction and treatment system can potentially be disposed of at a POTW or reinjected into the groundwater plume. Reinjection can be the most cost-effective disposal option for treated groundwater, but would typically be done under a Class V injection permit from the Washington Department of Ecology.

8.2.4.5 Funnel and Gate

A funnel and gate system is a passive remediation method that utilizes subsurface barrier walls (the funnel) to modify flow patterns so that groundwater flows primarily through high-conductivity gaps (the gate). The funnel and gate system uses heterogeneous (surface-mediated) reactions on porous media to degrade dissolved contaminants. It is typically installed immediately downgradient of contaminant source zones to prevent plume formation. The impermeable funnel serves to modify the natural flow direction toward a permeable gate containing a reactive agent (e.g., iron granules, carbon) that reduces or eliminates contaminant mass.

The funnel and gate technology is relatively new, and reactive media have not been proven for all types of contaminants. Funnel and gate applications are typically applied to chlorinated hydrocarbons, but have also been applied to wood-treating sites. Groundwater bypass around or under the funnel may be a potential problem, particularly in "hanging wall" applications. At the Arlington facility, the funnel would be a "hanging" wall because the funnel would not be keyed to the underlying aquitard, due to the excessive depth to the aquitard. Although potentially applicable for the facility, the high hydraulic conductivity of the aquifer and relatively narrow plume width makes the impermeable funnel unnecessary. Based on modeling of a hanging wall (see Appendix G, which was prepared as part of an evaluation of chemical oxidation), bypass of an impermeable wall would be a concern. As a result, the permeable reactive gate would likely be just as effective without the impermeable funnel.

Though these types of passive treatment systems are simple to apply at shallow depths and for low concentration levels of chlorinated organics, their applicability, and cost effectiveness are greatly limited at deeper depths and higher concentrations. Replacement of reactive media would be difficult at 30 to 50 feet bgs. Groundwater extraction and treatment (with reinjection) is a functionally equivalent technology has been proven to effectively capture the plume. Replacement of the shallow treatment trench is much easier than replacement of a reactive barrier at depth. Although other technologies may be more appropriate for the facility, the funnel and gate technology is retained for further consideration.

8.2.4.6 Surfactant Flushing

Surfactant flushing is a remediation technique whereby surfactants are used to increase the solubility and mobility of LNAPL or adsorbed soil contamination so that the constituents can biodegrade more easily in the aquifer or be recovered for aboveground treatment by a groundwater extraction and treatment system. The success of this technology requires use of the appropriate surfactant and effectively capturing dissolved-phase constituents via a groundwater extraction system. Surfactant flushing is not commonly used for contaminants with relatively high solubility, such as PCP. A significant concern associated with this technique is that contaminants currently immobilized by capillary forces (e.g., residual LNAPL in the vadose zone) are mobilized by this technology (by increasing solubility). Unless groundwater recovery at a downgradient location is completely effective, the technology can significantly mobilize and further spread contamination. Given the relatively rapid groundwater flow rate in the sand and gravel aquifers underlying the affected area, and the relatively small dissolved-phase plume, other technologies are more suitable for the Arlington facility. For these reasons, this technology was not retained for further evaluation.

8.2.4.7 Air Sparging

Air sparging (aeration) is a groundwater remediation technology that involves the injection of air or oxygen into a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the saturated aquifer matrix and the soil column, creating an underground biological reactor and stripper that can remove volatile and semivolatile organic contaminants by biodegradation and volatilization. Soil vapor extraction usually is implemented in conjunction with air sparging, when substantial levels of volatile compounds are present to recover and treat the vapor-phase contamination from the vadose zone. In addition, oxygen added to the contaminated groundwater and vadose-zone soils by air sparging can enhance aerobic biodegradation of contaminants below and above the water table. Air sparging has the potential for successful application for the organic constituents in groundwater at the Arlington facility and was retained for further evaluation.

An alternate method of aeration is to extract groundwater and recirculate the water through an aeration trench and the vadose zone to form an in situ biological treatment cell. Recirculating the

extracted groundwater through the aeration trench would supply dissolved oxygen to the groundwater similar to the effects of air sparging. Aeration trenches can be designed to facilitate oxygenation of the groundwater and can be used to capture the entire groundwater plume and treat the captured groundwater within the aeration trench. Groundwater recirculation to an aeration trench has been retained as a potential remediation method for groundwater.

8.2.4.8 Enhanced Bioremediation

Enhanced bioremediation is a process in which indigenous or inoculated microorganisms (e.g., fungi, bacteria, or other microbes) degrade (metabolize) organic contaminants found in soil and/or groundwater, converting them to innocuous end products. Enhanced bioremediation stimulates the activity of naturally-occurring microbes by circulating water-based solutions through contaminated soils to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other additives may be used to enhance bioremediation and contaminant desorption from subsurface materials. An in situ application includes the delivery of one or more of the following to the subsurface zone: an electron acceptor (oxygen, nitrate); nutrients (nitrogen, phosphorus); and an energy source (carbon). In a typical in situ bioremediation system, bioremediation amendments are injected directly or groundwater is extracted using one or more wells, mixed with bioremediation amendments, and re injected upgradient of or within the contaminant source. Generally, recoverable free product needs to be removed from the subsurface prior to operation of an in situ groundwater bioremediation system.

In situ groundwater bioremediation can be effective for the full range of petroleum hydrocarbons. Bioremediation techniques have been successfully used to remediate soils, sludges, and groundwater. In general, short-chain, low-molecular-weight, more water-soluble constituents are degraded more rapidly and to lower residual levels than are long-chain, high-molecular-weight, chlorinated, and less soluble compounds. This technology is potentially applicable to the Arlington facility and is therefore retained for further evaluation.

8.2.4.9 Thermal Treatment

ERH has been shown to be effective in removal of LNAPL, as noted in Section 8.2.2.1. ERH has therefore been retained.

8.2.4.10 Chemical Oxidation

As discussed in Section 8.2.2.4, this technology is potentially applicable at the Arlington facility. Oxidants could be delivered in liquid form for soil treatment or in gas form, similar to air sparging. Instead of injecting air, ozone could be sparged into the injection wells. Ozone is a strong oxidant that would promote the oxidative breakdown of organic contaminants in groundwater (as well as in

the saturated and unsaturated soil in the sparge zone) and also deliver oxygen, thereby supporting aerobic biodegradation. This technology is retained for further consideration.

8.2.4.11 Disposal of Extracted Groundwater

Potential groundwater disposal methods are described and evaluated below. Some disposal methods may require pretreatment, depending on the quality of the extracted groundwater. Inclusion of these technologies in corrective measures alternatives could also occur if short-term groundwater dewatering is required as part of construction.

Discharge to Sanitary Sewer: In this disposal option, groundwater is discharged to the local sanitary sewer system. Pretreatment of groundwater may not be required if concentrations of COCs meet discharge criteria. Fees for disposal of groundwater to the sanitary sewer are based on the volume discharged, and periodic chemical and physical monitoring of discharges are typically required. Allowable discharge volumes may be limited, particularly during the wet season. Because this option may allow discharge of groundwater without substantial on-site treatment, it has been retained for further consideration.

Discharge to Surface Water: Extracted groundwater may also be discharged to surface water, although this discharge option would likely require an NPDES permit. Water discharged to surface water would have to meet strict water quality requirements and would likely require treatment before discharge. This technology has not been retained because on-site infiltration is a viable alternative, and the existing infiltration facilities could be used, thereby simplifying implementation.

Reintroduction to Groundwater: Extracted groundwater may also be discharged on site to groundwater via infiltration galleries or injection wells. Treatment requirements for re-infiltration of contaminated groundwater must be evaluated to ensure regulatory requirements would be met. The most likely scenario would be reintroduction of actively treated groundwater through a Class V injection well in accordance with WAC 173-218-040(5)(a)(x). The Class V injection well would require registration in accordance with WAC 173-218-060. This technology has been retained for further consideration.

8.3 SUMMARY OF RETAINED TECHNOLOGIES

Based on the evaluation discussed in this section, the following technologies were retained for potential application to site-wide corrective measures alternatives developed in Section 9.

Medium of Concern	Retained Technologies
All Media	Institutional controls
Soil	Thermal treatment (ERH) Excavation and off-site disposal Soil stabilization Chemical oxidation
LNAPL	Total fluids (dual-phase) recovery Thermal treatment (ERH) Passive recovery Chemical oxidation Incineration of recovered LNAPL
Groundwater	Long-term monitoring Monitored natural attenuation Physical containment (barrier wall) Groundwater extraction and treatment Funnel and gate Air sparging Enhanced bioremediation Thermal treatment (ERH) Chemical oxidation Discharge to sanitary sewer Reintroduction to groundwater

9.0 CORRECTIVE MEASURES ALTERNATIVES

Potentially applicable technology options for the Arlington facility are described and screened in Section 8. In this section, the most promising retained technologies are combined to formulate a range of corrective measures alternatives. Each of these alternatives is evaluated with respect to the corrective measures considerations discussed in Section 6 and evaluation criteria specified in the CMS guidance (EPA, 1994, 1996) and the AOC (EPA, 2001).

The cleanup technologies suitable for the various areas of the facility that contain COCs in subsurface soil and groundwater could be grouped in various combinations. However, the corrective measures alternatives are selected and limited to compatible cleanup technologies that are combined to protect human health and the environment. The technologies applied to each medium also need to be complementary when implemented in combination.

For the purpose of this CMS, a broad range of corrective measures alternatives representing a wide spectrum of potentially appropriate remedial technologies was developed. These alternatives include different combinations of MNA, capping, removal, disposal, and treatment. When viewed together, the alternatives present a full range of potential remediation options available for the Arlington facility and recognize trade-offs associated with implementation of different technologies, consistent with the objectives of a CMS. Table 9-1 lists the corrective measures alternatives.

Two technologies described in Section 8 - soil stabilization and funnel and gate - were deemed to be potentially applicable for the facility, but were not included in the seven alternatives described in this section, as other technologies were determined to be more appropriate. Soil stabilization, while potentially an effective technology, would be more difficult to implement at the operating facility and have higher costs (due to the expansion of soils and requirement for off-site disposal) than other similarly effective technologies (such as thermal treatment included in Alternative 5). The funnel and gate technology, while also potentially effective, would be more difficult and costly to implement than the enhanced biodegradation recirculation system, which is included in Alternative 4, and which is already in place and meeting project objectives.

Because Parcel B is used only for untreated pole storage and has only one COC detected above proposed cleanup levels, and that COC was present only in shallow soils, corrective action is not appropriate. Therefore, no corrective measures alternatives are presented for Parcel B.

9.1 ELEMENTS COMMON TO ALL ALTERNATIVES

The elements common to all alternatives are ICs and groundwater monitoring.

9.1.1 Institutional Controls

ICs would be implemented for the Arlington facility to control future land use under all alternatives, in accordance with federal guidance (EPA, 2000b). Restrictions would be placed on future use of groundwater beneath the facility. Proprietary controls affixed to the deed would include a hazard notice describing the extent and type of contamination at the facility, covenants for appropriate land use restrictions (including groundwater use), and establishment of easements for necessary access, such as access to monitoring wells. The facility also would be registered with local and/or state registries of contaminated sites.

ICs also would be implemented to protect facility workers. A soil management plan would be implemented whereby facility workers would be notified of the existence of soil and groundwater contamination at the facility. This notification would consist primarily of amendments to the facility health and safety plan and addition of any material safety data sheets to describe the nature and extent of COCs. The soil management plan would also restrict subsurface work within the Main Treatment Area. Subsurface work in this area would have to be approved and authorized by established responsible parties (i.e., facility managers or facility health and safety officers). The soil management plan would outline authorization procedures for the responsible parties, as well as engineering controls and PPE required for performance of subsurface work at the facility.

ICs would also be required for downgradient groundwater that exceeds cleanup levels protective of human health. ICs for downgradient groundwater could be in the form of public awareness and communication.

9.1.2 Monitored Natural Attenuation

MNA of COCs in groundwater is included in all alternatives. For all alternatives except Alternative 3, 20 existing wells would be selected from the existing monitoring well network for groundwater elevation measurements and groundwater sampling. Alternative 3, which includes excavation of the source area, would result in more complete removal of COC-affected soil and fewer monitoring wells would be required (approximately 10). Wells would include locations in the Northwest Parcel and downgradient wells, which would be used to assess whether MNA is actively degrading COCs in the groundwater plume located in these areas. MNA systems would be designed in accordance with the guidance documents specified in Section 8.2.4.2.

The guidance documents are designed to be used during preparation and review of long-term monitoring plans for sites where MNA has been selected as part of the remedy. Design of the performance monitoring system depends on-site conditions and site-specific remedial objectives. This CMS provides information on technical issues to consider during the design process.

MNA refers to natural processes to reduce contaminant concentrations and migration potential from a source in environmental media. MNA processes may reduce the potential risk posed by contaminants at the facility in three ways:

1. The contaminant may be converted to a less toxic form through destructive processes, such as biodegradation or abiotic transformations.
2. Potential exposure levels may be reduced by lowering concentrations of COCs through destructive processes, or by nondestructive processes such as dilution or dispersion.
3. Contaminant mobility and bioavailability may be reduced by sorption to the soil or rock matrix.

Three types of evidence can be used to assess the effectiveness of MNA of chlorinated organic compounds:

1. Observed reductions in contaminant concentrations along the flow path downgradient from the source of contamination.
2. Documented loss of contaminant mass at the field scale demonstrated by:
   - Evidence from chemical and geochemical analytical data, including:
     - decreasing parent compound concentrations,
     - increasing daughter compound concentrations,
     - depletion of electron donors and acceptors, and
     - increasing metabolic by-product concentrations.
   - A conservative tracer to estimate residence time of specific contaminants along the flow path to document mass reduction and to calculate biological decay rates at the field scale.
3. Data from field or microcosm studies that directly demonstrate the occurrence of a particular MNA process at the site and its ability to degrade the COCs.

Long-term monitoring of a contaminant plume can provide empirical evidence of the effectiveness of MNA as a remedy. The long-term monitoring program would include a sampling and analysis strategy that would allow for evaluating the effectiveness of the remedy with respect to the lines of evidence presented above.

Groundwater samples used for MNA would be collected using low-flow sampling methods and analyzed for PCPs and PAHs. Collection of analytical data has demonstrated site conditions are favorable for MNA. Groundwater analytical samples collected during the pilot study and analyzed

for PCPs and PAHs have demonstrated a consistent reduction in plume contaminant mass and concentration (Baxter, 2010a). A summary of pilot study analytical results and system performance is provided in Section 9.2.4.

In order to estimate present value costs for the corrective measures alternatives considered in this CMS, we have assumed a tiered approach to groundwater monitoring:

1. Monitoring would be conducted semiannually for the first 15 years following implementation of Alternatives 1, 2, and 4. Groundwater elevations would be measured and groundwater samples would be collected during each monitoring event from each of the 20 wells included in the monitoring network. Groundwater samples from all 20 wells would be analyzed for PCP, while seven samples also would be analyzed for PAH compounds and MNA parameters.
2. Monitoring would be conducted annually beginning in Year 16 for Alternatives 1, 2, and 4, and the number of monitoring wells in the network would be reduced to 10. Groundwater elevations would be measured annually and samples would be collected from the 10 wells for analysis of PCP, and four of the samples would also be analyzed for PAH compounds and MNA parameters. For Alternatives 1, 2, and 4, annual groundwater monitoring would occur for approximately 100 years.
3. The monitoring frequency for alternatives where aggressive source control measures are used (e.g., Alternatives 3, 5, and 6) would include semiannual monitoring for the first 5 years, then annual monitoring for an additional 15 years for Alternatives 5 and 6, and 5 years for Alternative 3, which involves excavation and off-site disposal.

Groundwater samples would be collected using low-flow sampling methods (EPA, 2010a). Quality assurance and quality control sampling would include one duplicate and one equipment rinsate sample collected and analyzed during each sampling event. Upon selection of a final corrective measures alternative, a detailed performance monitoring plan will be developed.

The results of the groundwater sampling and analysis would be evaluated for changes in the concentrations of COCs, and the results reported to EPA. The decision to reduce the frequency of groundwater sampling to annually and reduce the number of wells monitored would be made based on the concentrations of COCs in tested samples and after approval from EPA.

9.2 PARCEL A

This section describes six corrective measures alternatives to address affected soils and groundwater in Parcel A, which consists of the Main Treatment Area and the Treated Pole Storage

Area. Each corrective measure alternative addresses affected soils within Parcel A and groundwater extending downgradient from the Main Treatment Area and Treated Pole Storage Area.

9.2.1 Alternative 1: Total Fluids Recovery, Air Sparging, and MNA

Alternative 1 would provide active recovery of the contaminants in the source area. The technologies employed under this alternative would include total fluids recovery of both LNAPL and groundwater by pumping from extraction wells, air sparging to promote biodegradation, implementation of ICs, and MNA (Figure 9-1).

Total fluids recovery would include groundwater capture at the source area, thereby providing remediation of LNAPL and the most highly contaminated groundwater. Total fluids recovery can be a more aggressive form of LNAPL removal than passive LNAPL extraction; however, all extracted groundwater would need to be treated and disposed of. Treatment of listed waste within a POTW complies with the RCRA/Dangerous Waste regulations provided that the POTW meets the requirements specified in the permit-by-rule regulations (WAC 173-303-802[4]). In addition, as a result of discussions with EPA and Ecology, the best option for treated water disposal is through reinjection into the aquifer. Disposal by reinjection on site is a less expensive option and is used for this alternative. In this analysis, we assume that the treated groundwater would be discharged to the infiltration gallery installed as part of the current pilot test. Either a RCRA Part B permit, a permit waiver, or a permit by rule determination would need to be obtained for the groundwater treatment and injection system, which would be treating and injecting a RCRA-listed waste. An injection permit also would be required from Ecology. Other disposal options, including potential off-site options such as discharge to the POTW or surface water ditch, would be reviewed as part of detailed design.

For this alternative, three existing wells located directly downgradient of the source area near MW-1 (Figure 9-1) would be used as groundwater recovery wells for total fluids recovery. Each recovery well has been assumed to operate at a flow rate of 15 gallons per minute (gpm) for a combined flow rate of 45 gpm. Based on results from the remedial action pilot study (see Section 9.2.4), which uses a groundwater capture approach with comparable pumping rates, this distribution of recovery wells would recover contaminant mass within the Main Treatment Area, as well as minimize further plume migration.

The extracted fluids would be pumped through an oil-water separator to recover LNAPL. The recovered LNAPL fraction would be characterized for off-site disposal, and the groundwater fraction would be treated on site by pumping through a granular activated carbon (GAC) treatment system. The GAC treatment system would consist of two GAC vessels piped in series and of

sufficient size to handle 45 gpm, plus additional contingency capacity should the remedial strategy change in the future.

Components of an air sparging system include a network of sparging/injection wells and a compressor to supply air. Sparge wells are typically designed to provide overlapping radii of influence to provide continuous coverage along the alignment of the wells. Due to the low volatility of site COCs, vapor collection would not be provided, as stripping would be minimal. Design of the air sparging system would require a pilot test to determine the radius of influence of the sparge wells and to identify any subsurface formations that would affect air flow. Existing wells could be used to conduct the pilot test.

Based on the findings of the pilot testing, the air sparge system would be designed for this facility. For the purpose of this CMS, it is assumed that 15 sparge wells, spaced 20 feet apart, would be installed along a line perpendicular to the plume at a location just downgradient of the drip pads near MW-3, as shown on Figure 9-1. This alignment would create an oxygenated zone of groundwater through which the groundwater would flow, thereby providing conditions to promote aerobic biodegradation of site COCs. The sparge wells may include four new multilevel wells to improve air distribution along the vertical column.

The specific air compressor would be selected after the pilot testing, based on anticipated flow rates and pressure requirements. For this CMS, we assume that the compressor would need to provide an air flow of 10 cubic feet per minute (cfm) per well, or a total capacity of 150 cfm. During the design, the pros and cons of utilizing multiple air compressors would be evaluated.

The aboveground air sparge equipment would be housed within a small building. The compressor building would house the necessary equipment and controls to operate the system, including a distribution manifold. The air would be pumped from the compressor building through the manifold, and then to the individual wells via underground distribution piping.

Upon system installation, an air sparging system monitoring plan would be developed and implemented for up to 100 years, although air sparging systems typically operate for a much shorter duration.

Measurements of dissolved oxygen in the aquifer in the area proposed for biosparging indicate that sufficient oxygen for biodegradation to occur is already present. It is possible that biosparging may not increase the biological activity sufficiently to meet corrective action objectives. If air sparging is found to be inadequate to reduce the size of the groundwater plume, chemical oxidation by ozone sparging could be used as a contingent remedy.

In lieu of injecting atmospheric air through the sparging system, gaseous ozone would be injected with air into the subsurface. Ozone gas would oxidize COCs directly or through the formation of hydroxyl radicals. The oxidation reaction occurs relatively rapidly. Due to the instability and reactivity of ozone, the ozone used in the system would be generated on site and closely spaced sparging wells would be required. For this reason, the sparge wells that would be installed under Alternative 1 would be spaced such that they would be effective in the event that ozone is used in conjunction with air. Unreacted ozone would also undergo in situ decomposition, which would lead to beneficial oxygen addition to the subsurface. Just as with air sparging, pilot testing would be required prior to implementation of a full-scale ozonation system.

A long-term groundwater monitoring program would be conducted as part of the MNA component. The long-term monitoring program would involve the use of existing monitoring wells and would be conducted as described in Section 9.1.2.

As part of this alternative, ICs would be implemented at the Arlington facility. ICs also would be required for downgradient groundwater that exceeds cleanup levels protective of human health.

9.2.2 Alternative 2: Physical/Hydraulic Containment and MNA

Alternative 2 includes installation of a hanging, low-permeability barrier wall and total fluids recovery and treatment, as well as ICs and MNA. This alternative is intended to contain the dissolved phase plume by maintaining a groundwater gradient such that groundwater flows toward the containment area. The containment approach would utilize a low-permeability barrier wall (such as a slurry wall) completely encircling the source area, and total fluids extraction wells placed inside the barrier wall area to reduce the source concentration and induce inward flow to the containment area.

A containment wall would ideally be keyed into bedrock or an aquitard to prevent contaminants from migrating underneath the barrier; however, the great depth of the aquitard at the Arlington facility makes a "keyed" barrier wall installation impractical. Therefore, the wall proposed under Alternative 2 would be installed to an approximate depth of 40 feet to contain the LNAPL and the upper portion of the contaminated groundwater. For this CMS, it is assumed that a 1,500-foot-long slurry wall would be constructed around the Main Treatment Area (Figure 9-2). Use of a soil bentonite slurry wall has been selected for this alternative over other potentially applicable technologies (sheet piling, etc.) because it is readily implemented, has a lower overall cost compared to other technologies, is compatible with site contaminants including LNAPL, and is a proven technology for low-permeability barriers.

Slurry walls are constructed by excavating a trench and then backfilling the trench with an engineered backfill, typically a low-permeability soil or soil and bentonite mixture. A bentonite slurry is used for trench stability during excavation. This operation requires a large area for the use of heavy construction equipment, as well as sufficient space for staging of excavated soil and mixing the backfill.

"Fluffing" (i.e., increased volume) of the excavated soil as well as addition of admixture (water and bentonite) would generate some excess soil that would require disposal. It is estimated that approximately 25 percent of the excavated soil would have to be disposed of off-site.

To minimize the flow of groundwater under the barrier wall and to extract LNAPL, total fluids extraction wells as described under Alternative 1 would be used to induce an inward flow gradient. Based upon groundwater pumping performed during the remedial action Pilot Study (see Section 9.2.4), it is anticipated that a relatively low flow rate of 5 gpm for each well would result in a slight inward gradient toward the containment area and result in capture of the plume within the source area. The pumping rate required to maintain an inward gradient would be evaluated as part of a pilot study following barrier wall installation.

The probable location of the containment wall is shown on Figure 9-2. The extracted liquids would undergo the same treatment process and permitting considerations described for Alternative 1 (oil/water separator and GAC units, Section 9.3.1). Similar to Alternative 1, we have assumed that water would be treated on site under a RCRA Part B Permit and disposed of on-site by reinjection. Reinjection would occur in the general location of the existing infiltration trench; however, the trench would require rehabilitation following installation of the barrier wall. Other disposal options would be reviewed during final design.

Alternative 2 would include the same ICs and groundwater monitoring program as Alternative 1.

9.2.3 Alternative 3: Excavation, Off-Site Disposal, and MNA

Alternative 3 is the most intrusive corrective measure to be considered and is based on excavation and off-site disposal of affected subsurface soil and LNAPL in the Main Treatment Area, as well as ICs and MNA. Alternative 3 meets EPA's preference for an aggressive source removal corrective action, as opposed to a containment approach described in the other alternatives. The excavation would be designed to include the entire source area of soils affected by COCs above the proposed cleanup levels. This would result in an excavated area with a surface extent of approximately 150 feet by 350 feet, with a maximum depth of approximately 35 feet (accounting for sloped sidewalls). The area of excavation is shown on Figure 9-3. This area currently includes a large portion of the Main Treatment Area and, therefore, would require (1) closure of the wood-treatment

facility; (2) demolition of several structures in this area, including the drip pads and aprons; (3) excavation of contaminated soil with off-site disposal; (4) backfilling of the excavation with clean imported fill material; and (5) rebuilding the wood treatment facility. All the affected soil down to the water table would be removed, including the majority of the LNAPL.

Since this alternative removes most if not all affected source area soils, the COCs in the groundwater would decrease more rapidly through MNA than for the alternatives that do not include source removal. There is the potential that some affected soil could remain following excavation; these risks would be addressed by ICs.

It is estimated that approximately 52,500 cubic yards (approximately 84,000 tons based on a density of 1.6 ton/cubic yard) of soil would be excavated and disposed of off-site, based on the dimensions of the excavation stated above. Excavated soil would be considered listed RCRA waste (FO32), which would require disposal at an appropriate hazardous waste landfill after treatment to the Universal Treatment Standard; alternatively, the soils may require incineration to achieve the Universal Treatment Standard.

This alternative would require the facility to be shut down, demolished, and then rebuilt following excavation. This alternative would therefore essentially put Baxter (or the current tenant, Stella Jones) out of business for a number of months and result in the layoff of employees. The opportunity costs (e.g., loss of sales, continued asset costs during downtime), personnel costs (severance), and the potential for permanent loss of customers would affect the total cost. However, for the purposes of this CMS, opportunity and personnel costs have not been estimated. On the other hand, this alternative would remove most, if not all, of the source material at the Baxter facility and ultimately could lead to a determination of "Corrective Action complete without controls" by EPA and closure of the AOC.

9.2.4 Alternative 4: Enhanced Biodegradation Recirculation System

Alternative 4 consists of continued operation of the existing enhanced biodegradation recirculation system, passive LNAPL recovery, implementation of ICs, and MNA (Figure 9-4). Passive LNAPL recovery would be continued, as described below.

In January 2008 and after consultation with and approval from the EPA, a pilot study for the enhanced biodegradation recirculation system and passive recovery of LNAPL was implemented to assess the effectiveness of Alternative 4 for known contamination associated with the Main Treatment Area at the Arlington facility. The biodegradation system is designed to address affected groundwater immediately downgradient of the source area and to reduce contaminant

loading to the groundwater plume, which extends across the Northwest Parcel and to areas immediately downgradient.

A detailed report on implementation and results of the pilot study was presented to EPA in October 2010 (Baxter, 2010a). Additional information has been provided to EPA in a series of quarterly operations and monitoring reports (Baxter. 2010b, c, and d; 2011b, c, d, and e; and 2012b, c, and d). Initial costs for installation of this Alternative as described have already been incurred, and are not included as part of the cost estimates provided in Section 10 and Appendix C. From late 2007 through the third quarter of 2012, Baxter's sunk cost for installation, performance monitoring, and operations and maintenance of the pilot system was approximately $967,000. Additional monitoring associated with the pilot system is not included in this total.

9.2.4.1 Pilot Study Design

Implementation of the pilot system for Alternative 4 included installation of a groundwater extraction and re-infiltration field northwest of the source area to treat affected groundwater, and installation of additional groundwater monitoring wells to augment the network of monitoring wells and piezometers used to monitor the remediation progress. The specific installations and requirements are described in the pilot study work plan (Baxter, 2007b).

A total of seven extraction wells (EW-1 through EW-7) and 19 additional monitoring wells and piezometers were installed (MW-19 through MW-37) and developed (except MW-19 through MW-21) from September to December 2007. The extraction and infiltration piping and vaults were installed during the period of November 12 through December 21, 2007. Installation of the electrical components was completed on January 30, 2008, and the system was commissioned on January 31, 2008.

The seven groundwater extraction wells and the infiltration gallery were both constructed in a chevron pattern. Groundwater extracted from the extraction wells is re infiltrated in the gallery. The infiltration trench is designed to mix the captured groundwater and increase the dissolved oxygen concentration of infiltrating groundwater by using coarse gravel to lengthen the unsaturated flow path of the water. The infiltration gallery is also backfilled with crush limestone to increase the pH of re infiltrated water. The pH buffering and aeration are designed to promote biodegration of PCP in groundwater and natural degradation of PCP located downgradient of the infiltration trench.

In addition to the groundwater recirculation trench, the pilot system also includes a passive recovery system for LNAPL. LNAPL is removed from five source-area recovery wells (MW-12, MW-13, and MW-19 through MW-21) using sorbent socks installed inside the wells.

In 2010, six additional monitoring wells (MW-38 through MW-43) were installed downgradient of the enhanced biodegradation recirculation system to provide additional sampling locations at deeper intervals within the water-bearing zone.

9.2.4.2 Monitoring Program

The pilot study included a groundwater monitoring program to monitor progress in achieving remedial action objectives. In total, a network of 40 monitoring wells and piezometers is currently used to monitor pilot system performance. These include both previously existing wells plus the new wells installed as part of the pilot study. The pilot study monitoring program currently consists of quarterly groundwater level measurements and water quality sampling. Each quarterly monitoring event currently includes the following elements:

- Groundwater sampling at selected monitoring wells and analysis of samples for PCP and select PAHs;
- Field measurement of groundwater water quality parameters for individual monitoring network wells;
- Field measurement of dissolved oxygen concentration and pH in groundwater from extraction wells;
- Collection of one field composite sample from the suite of extraction wells and analysis of the composite sample for PCP (and select PCP degradation species beginning in March 2009);
- Inspection of sorbent socks for passive LNAPL recovery and replacement of saturated socks when warranted; and
- Water level measurements in the monitoring well network.

In August 2010, EPA granted Baxter's request to reduce the frequency of selected monitoring tasks from monthly to quarterly (EPA, 2010b). Prior to August 2010, the following elements of the monitoring program described above had been conducted monthly following installation of the pilot system:

- Extraction well dissolved oxygen and pH measurements;
- Extraction well composite sampling, except between April and July 2008 (including analysis of select PCP degradation species beginning in March 2009);
- Water level measurements in the monitoring well network; and
- Inspection of sorbent socks in the LNAPL recovery wells.

9.2.4.3 Operations Summary

Overall system uptime from January 2008 through 2010 was in excess of 90 percent. Beginning in 2011, high water levels were observed in the infiltration gallery, causing automatic system shutdowns. Maintenance activities consisting of well and pump cleaning were conducted in May 2012, which improved infiltration rates in the gallery. In early 2013, high water levels were frequently observed, again causing the system to automatically shut down. The high water levels are likely caused by a combination of fouling in the infiltration gallery and seasonally high water levels. Baxter is currently developing a plan to replace and upgrade the infiltration gallery to enhance infiltration rates and overall reliability.

9.2.4.4 Results of Groundwater Monitoring

Evaluation of PCP plume stability indicates that between January 2008 and August 2012 the plume area and the average plume concentration has decreased significantly, as shown in the PCP isopleths included in Appendix F. The surficial area of the shallow PCP plume downgradient of the Main Treatment Area and in the Northwest Parcel decreased from approximately 4.4 acres in January 2008 to 3.4 acres August 2011, with a corresponding decrease in average PCP concentrations from 116 µg/L in January 2008 to 46 µg/L in August 2011 (Figures F-1 and Figure F-15 in Appendix F). The deeper portion of the PCP plume located downgradient of the MW-15/MW-40 well pair (Figure 9-4) also shows a decrease in aereal extent and PCP concentrations, though not as pronounced as in the shallow zone (Figures F-20 to F-22 in Appendix F:). Overall, the pilot system has proven effective in reducing plume size and PCP concentration in areas downgradient of the Main Treatment Area.

The groundwater recirculation system for recovery of the groundwater plume is consistently achieving groundwater capture, and recirculation of the contaminated groundwater is resulting in degradation of the PCP downgradient of the infiltration trench. Based on measured concentrations of PCP in the recovered groundwater being infiltrated (recirculated), the primary benefit of the infiltration trench is to reduce the overall PCP concentrations in groundwater in the center of the plume, resulting in PCP concentrations much more amenable to biodegradation of the PCP. The dilution of PCP improves conditions supporting biodegradation of the PCP plume, especially in areas immediately downgradient of the remedial action pilot system.

Prior to implementing the full-scale pilot test, groundwater contained very high concentrations of PCP (500 to 2,000 µg/L) along the center line of the plume, with these concentrations remaining high for the full length of the plume within the property boundary. The groundwater extraction system has effectively captured and homogenized the plume mass, and the infiltration trench has optimized conditions needed to allow natural processes to bioremediate the remaining PCP.

9.2.4.5 Passive LNAPL Recovery

Passive LNAPL recovery has been conducted as part of the pilot study. The amount of LNAPL recovered using sorbent socks in MW-12 from January 2008 through the third quarter of 2012 was 36.95 pounds. Over the same period, LNAPL recovery from sorbent socks in MW-13, MW-19, MW-20, and MW-21 was limited (6.04 pounds combined). At the time the LNAPL recovery wells were installed, free product was observed in MW-12, MW-13, and MW-19. Monitoring and replacement of spent sorbent socks will continue as long as free product recovery continues.

9.2.5 Alternative 5: ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation

Alternative 5 includes ERH, total fluids recovery, and enhanced biodegradation recirculation, as well as ICs and MNA (Figure 9-5). This alternative is intended to address the source area by treating the unsaturated and saturated zones simultaneously. Ideally, nearly the entire subsurface source area will be heated to the boiling point of the contaminant/water mixture. As the treatment area is heated, the contaminants may be removed from the subsurface as separate phase liquids, dissolved phase liquids, or as vapors by the total fluids and vapor recovery system. The only part of the known source area not heated would be areas with woodwaste backfill. This area would not be heated, in order to minimize drying of the woodwaste and the associated hazards (fire and subsidence).

As shown on Figure 9-5, two distinct areas have been targeted for treatment, based on the observed presence of residual LNAPL in boreholes. In the southern area, heating would extend from 5 to 35 feet bgs. Heating of the northern area would be complicated by the presence of wood chips found in the shallow vadose zone from near surface to approximately 10 feet bgs. To avoid the wood chips, heating in the northern area would extend from 15 to 35 feet bgs. Residual LNAPL is likely present within the wood chips and would not be treated.

To ensure robust heating, electrode spacing in each area would be set to 17 feet on center, producing a conservatively high power density of 103 electrodes throughout the treatment area (Figure 9-5). To measure and record subsurface heating, six temperature monitoring points would be placed in each treatment area and thermocouples will collect temperature data at 5-foot increments from the top of the heating intervals to a depth of 40 feet bgs. Data from the thermocouples would be collected automatically by the ERH power delivery system and used to prepare a subsurface thermal profile of the volume being heated. Electrodes will be placed to avoid site structures, buildings, roads, and rail road tracks.

Total fluids recovery would include wells capable of recovering LNAPL, groundwater, steam and contaminant vapors from the subsurface. Liquids extracted from the subsurface would be routed

from the wells by conveyance piping and passed through a liquid waste management system consisting of an oil/water separator, condenser, and liquid phase GAC vessels. Once through the GAC system the water would be recycled to the electrodes as wetting water, and the recovered LNAPL would be characterized for off-site disposal. Recovered vapors would pass through the condenser to be cooled and separated from steam and then treated using vapor phase GAC vessels.

Total fluids recovery can be a more aggressive form of LNAPL removal than passive LNAPL extraction; however, all extracted groundwater would need to be treated and disposed of. Treatment of listed waste within a POTW complies with the RCRA/Dangerous Waste regulations provided that the POTW meets the requirements specified in the permit-by-rule regulations (WAC 173-303-802[4]). In addition, as a result of discussions with EPA and Ecology, the best option for treated water disposal is through reinjection into the aquifer. Disposal by reinjection on site is a less expensive option and would be used for this alternative. In this analysis, we assume that the treated groundwater would be discharged back into the electrodes as wetting water. Either a RCRA Part B permit, a permit waiver, or a permit by rule determination would need to be obtained for the groundwater treatment and injection system, which would be treating and injecting a RCRA-listed waste. An injection permit would also be required from Ecology. Other disposal options, including potential off-site options such as discharge to the POTW or surface water ditch, would be reviewed as part of detailed design.

Components of the ERH system include a network of 100+ electrodes/recovery wells, traffic-rated well vaults, conveyance piping, electrical infrastructure, temperature monitoring points, and a liquid and vapor waste management system. Electrodes are typically spaced between 15 and 20 feet apart to provide uniform heating in the subsurface. It is expected that 130 days of heating will achieve a 90 percent reduction of PCP concentrations in soil; however, the cost estimates include an additional three months of heating to ensure complete remediation. It is anticipated that 90 percent destruction of the COC mass in the source area would result in sufficient reduction of dissolved-phase constituents in groundwater, such that natural attenuation process would rapidly degrade residual COCs in downgradient locations. Groundwater monitoring would be required to determine the effectiveness of the alternative following treatment.

During the initial four to five years after implementation of ERH, the existing enhanced biodegradation recirculation would be operated as described in Alternative 4 to control any COC-affected groundwater flowing from the source area. Commonly, ERH results in a temporary spike in COCs dissolved in groundwater during the treatment process, as the heating mobilizes COCs.

9.2.6 Alternative 6: Chemical Oxidation, and Enhanced Biodegradation Recirculation

Alternative 6 combines chemical oxidation, enhanced biodegradation recirculation, ICs, and MNA to remediate COCs (Figure 9-6). Pilot testing would be performed at four injection locations and include three injection events separated by two weeks, using an oxidant such as Regenox. Depending on pilot testing results, the technology may be screened out, the oxidant could be changed, and/or the dose may be reduced. Current design includes three injection events with injection points set 10 feet off center; however, this technology can be implemented in phases as appropriate. The initial design includes 60 injection points in the north treatment area, 80 injection points in the south treatment area, and four injection points in the pilot test area for each event. It is estimated that approximately 120,000 pounds of oxidant would be injected, based on the dimensions of the treatment areas. The treatment areas are shown on Figure 9-6. Injection areas from the three events would overlap, with injection points offset to improve chances of oxidant contact with COCs. The highest overlap would occur in the areas with greatest LNAPL thickness; areas with little to no LNAPL may be treated only once. The estimated time for all three injections could range from three to seven months, depending on drill rig availability and pilot test results. Alternatively, the injections could be phased over several years, with monitoring between each phase to determine the effectiveness of each treatment. The phased approach could be effective to either limit the total number of injections (and overall cost), or increase the total number of injections in specific areas to ensure treatment. For the purpose of this CMS, costs for three treatments are included in year 1 (Appendix C).

As described in Section 9.1.2, a long-term groundwater monitoring program would be conducted, including semiannual sampling with laboratory analysis for site COCs. The monitoring program would assess whether natural attenuation is actively degrading COCs and assess progress toward attainment of remediation objectives. A subset of the existing monitoring wells would be used for monitoring.

During the initial four to five years after implementation of ERH, the existing enhanced biodegradation recirculation would operate as described in Section 9.2.4 to control any COC-affected groundwater flowing from the source area.

Alternative 6 has minimum impact on site operations. Injection by push probe will occupy a small footprint on site at a time. Injections would occur after business hours and areas treated would be immediately available for site use the following day. Alternative 6 meets EPA's preference for an aggressive source removal corrective action, as opposed to a containment approach described in the other alternatives. However, injections would have to occur at depths greater than 10 feet to prevent surfacing of the oxidant. As a result, shallow soil will likely not be treated. In addition,

some areas of the site would be untreatable due to woodwaste backfill. Push probe cores would be considered listed RCRA waste (FO32), which would require disposal at an appropriate hazardous waste landfill after treatment to the Universal Treatment Standard; alternatively, the soils may require incineration to achieve the Universal Treatment Standard.

Since this alternative removes most if not all affected source area soils (a 60 to 90 percent reduction, depending on results of pilot testing), the COCs in the groundwater would decrease more rapidly through MNA than under the alternatives that do not include source removal. It is likely that some affected soil could remain following treatment including in the woodwaste; these risks would be addressed by ICs.

9.3 PARCEL B: UNTREATED POLE STORAGE AREA

Parcel B has one location, SB-57 on the south end of the parcel, where RRO exceeds the proposed cleanup levels for soil. RRO was the only COC detected above proposed cleanup levels. This parcel has had no known industrial activity from the wood-treating operations, and the source of affected soils is unknown. Groundwater in Parcel B is not affected by COCs at concentrations above proposed cleanup levels. Because Parcel B is used only for untreated pole storage, because the RRO detected at SB-57 was present only in shallow soils (4 to 6 feet bgs), and because it was the only cleanup level exceedance, corrective action is not appropriate. Except as noted for SB-57, all soils and groundwater meet the proposed cleanup levels. The only corrective measure needed for this parcel is ICs, including a deed restriction limiting Parcel B to industrial use, which is consistent with the current use and long-term zoning. For this parcel, development and comparison of corrective measures alternatives are unnecessary.

10.0 DETAILED EVALUATION OF ALTERNATIVES

Section 9 described a range of corrective measure alternatives potentially applicable to the Arlington facility. This section contains a detailed analysis of each of these alternatives. EPA guidance (EPA, 1994, 1996) establishes a two-phase evaluation process for corrective measures studies. The first phase is a screening to determine if alternatives meet specified threshold criteria that apply to all alternatives considered. The threshold criteria specified in the 1994 guidance have been incorporated into corrective measures objectives for this CMS. The corrective measures alternatives considered in this CMS have been developed to attain remedial objectives; therefore, all alternatives evaluated in the CMS attain the threshold criteria.

The second phase of evaluation is assessment of each alternative versus a set of balancing criteria. The balancing criteria are generally defined in the CMS guidance (EPA, 1994, 1996). EPA's AOC (EPA, 2001) has established a slightly different and more detailed set of balancing criteria that must be followed for this CMS. Meeting these AOC criteria would generally address the criteria identified in EPA's CMS guidance. Therefore, the criteria specified in the AOC is considered in this CMS report, and no evaluation against the specific balancing criteria cited in the 1996 CMS guidance was performed.

The balancing criteria identified in the AOC have been separated into technical criteria, human health criteria, environmental criteria, institutional criteria, and cost. The technical criteria have been further subdivided into performance, reliability, implementability, and safety. All of the balancing criteria used in this CMS are defined in Table 10-1. These criteria are generally consistent with the evaluation criteria specified in the MTCA regulations for feasibility studies and with the balancing criteria cited in EPA's 1996 CMS guidance.

Each of the corrective measures alternatives described in Section 9 is evaluated relative to the balancing criteria in Sections 10.1 through 10.6. Alternatives are rated qualitatively for effectiveness relative to each of the balancing criteria on a scale of 1 to 4, with 1 representing low effectiveness and 4 representing high effectiveness. Table 10-2 summarizes the alternatives evaluation. Cost estimates for each of the alternatives are summarized in Table 10-3, and detailed cost estimates are included in Appendix C.

All alternative costs are based on contractor or engineer estimates, and include costs for planning, permitting, engineering, installation, and construction management. In addition, annual (i.e., long-term costs) include estimates for ongoing operations and maintenance, periodic equipment replacement, labor for groundwater monitoring, laboratory analysis, and semiannual or annual reporting. No costs are included for interruption of operations, such as loss of rent for business interruption. The tenant may claim frustration of the lease and terminate the lease where the

interruption occurs over an extended period. These costs can only be determined after all engineering requirements are established. Finally, all future costs are discounted to present-day costs using a discount factor of 2 percent.

A comparative analysis of the alternatives is presented in Section 11, based on ranking of the alternatives in their relative performance with regard to both the threshold criteria and the balancing criteria.

10.1 ALTERNATIVE 1: TOTAL FLUIDS RECOVERY, AIR SPARGING, AND MNA

Alternative 1 includes LNAPL and dissolved-phase contaminant extraction within the source area using total fluids recovery, with groundwater remediation of the plume immediately downgradient of the source area by air sparging. Total fluids recovery would aggressively recover LNAPL and would provide hydraulic containment of the source area. This potentially feasible combination of remediation technologies provides an aggressive approach to both LNAPL recovery and groundwater remediation. ICs to limit potential direct exposure to affected groundwater and/or soil would be implemented under this alternative along with long-term groundwater monitoring.

10.1.1 Technical Criteria

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as shown on Table 10-1. Alternative 1 is evaluated against these technical criteria in the following subsections. The overall rating is shown on Table 10-2.

10.1.1.1 Performance

Alternative 1 would enhance the ongoing natural biodegradation processes in the plume downgradient of the source area with air sparging, which is expected to accelerate biodegradation reactions by establishing and maintaining aerobic conditions. Aggressive source control is included to remove LNAPL and highly contaminated groundwater, thereby reducing the toxicity, mobility, and volume of affected media and accelerating cleanup. Recovered groundwater would be treated to permanently destroy dissolved COCs.

Total fluids recovery is proven effective in recovering LNAPL and contaminated groundwater. Since groundwater is recovered in the immediate vicinity of the LNAPL, it is likely that more highly contaminated groundwater would be recovered compared to pumping downgradient of the source area, providing more contaminant mass recovery. Recovered COCs would be permanently destroyed as a result of groundwater treatment and LNAPL disposal.

Aerobic biodegradation of degradable constituents by air sparging downgradient of the source area would effectively and permanently destroy biodegradable constituents and reduce both the toxicity and volume of media affected by biodegradable COCs at the facility. As noted previously, natural conditions have served to immobilize many COCs due to soil sorption, thereby limiting the extent of migration to areas immediately downgradient of the facility boundary. The engineering systems included to facilitate biodegradation and to recover LNAPL are proven technologies, but require periodic operator attention and maintenance to operate effectively. The useful life for the air sparging system is typical for mechanical systems; major mechanical components would likely require replacement after 10 years of operation.

Mobility of COCs would be limited due to the hydraulic containment created by the operation of the total fluids recovery wells. By inhibiting high-concentration COCs to migrate downgradient and using air sparging to accelerate biodegradation rates, this alternative is expected to result in the contraction of the groundwater plume's leading edge. If fluid recovery pumping or air sparging were to fail, system warnings would indicate the malfunction; given the high hydraulic conductivity of the aquifer, system effectiveness would decrease shortly after a shutdown, and source area groundwater containing elevated COC concentrations would migrate downgradient of the remediation system.

Alternative 1 would provide a comparatively rapid reduction in the toxicity and volume of COCs, particularly in the source area. Alternative 1 also would reduce the contaminant loading to the downgradient portion of the plume, which would improve the rate of COC degradation due to the air sparging system. Potential risks to downgradient receptors would be minimal, based on the limited future mobility of COCs due to the combination of remediation technologies applied in this alternative.

Based on the above considerations, this alternative is rated moderately high for effectiveness and for reduction in the toxicity, mobility, and/or volume of affected media. Alternative 1 is rated low for useful life, due to its reliance upon multiple mechanical systems that require frequent operation and maintenance.

10.1.1.2 Reliability

Alternative 1 incorporates two mechanical systems (the total fluids system and the air sparging system) for corrective action with high operational and maintenance requirements. Both the total fluids recovery and the air sparging systems require periodic operator attention for proper operation. Since both systems include rotating equipment, regular maintenance is necessary. The groundwater treatment process required for operation of the total fluids system also requires operator attention and regular monitoring so that permit requirements are attained and that the

GAC units are replaced as needed. Based on these considerations, this alternative is rated low for long-term operation and maintenance.

Both air sparging and total fluids recovery have been proven appropriate for remediation of wood treating sites. However, both components rely on mechanical equipment to provide remediation; mechanical equipment can fail, and failure of the equipment would render this alternative ineffective for short time periods. Due to the reliance of this alternative on two separate mechanical systems that periodically fail, this alternative is rated low for demonstrated and expected reliability.

10.1.1.3 Implementability

This alternative would require fairly extensive construction to install the LNAPL collection system, the groundwater treatment system, the treated water discharge piping, the air sparging wells and equipment, and power systems. Wells currently used as passive LNAPL recovery wells would be converted to total fluids recover wells. Construction would require coordination with ongoing facility operations. For these reasons, construction would require careful planning and on-site management so that it is done safely and properly. The long-term groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring for the air sparge system. Fairly extensive construction, including tanks, vessels, piping, and controls would be required for a groundwater treatment system of the required size.

Implementing this alternative would require disposal of treated groundwater in accordance with applicable regulations. For purposes of the CMS, it is assumed that treated groundwater would be discharged to the subsurface through the existing or a newly-constructed infiltration gallery. Subsurface infiltration of the water would require appropriate permitting and on-site treatment would require either a RCRA Part B permit, a permit waiver, or a permit by rule determination.

The ICs included in this alternative could be readily applied to the facility and affected downgradient groundwater. It is expected that beneficial results would be attained in a comparatively short time frame for Alternative 1. For these reasons, Alternative 1 has been rated moderately low for both constructability and implementation time and moderately high for beneficial results time frame.

10.1.1.4 Safety

Alternative 1 could be implemented with moderate concerns for safety. Recovery of LNAPL could create some safety concerns for direct contact with the NAPL and for fire. Safety concerns would result from operation of a groundwater treatment system with contaminated groundwater mixed with LNAPL in above grade piping and vessels. Air sparging would not create significant safety

issues, as most COCs have fairly low vapor pressure. This alternative is rated moderately low for safety.

10.1.2 Human Health Criteria

Alternative 1 is rated moderately high for minimizing short-term exposure to COCs at the facility, because minimal invasive construction work is needed for implementation. This alternative is rated moderately high for minimizing long-term exposure, since it contributes to active degradation of many COCs and to aggressive recovery of LNAPL. There is some potential for human exposure, due to recovery of LNAPL and the associated operation and maintenance activities for the total fluids recovery and air sparging systems.

10.1.3 Environmental Criteria

Alternative 1 is rapidly provides hydraulic containment near the source area, aggressively recovers LNAPL, and provides enhanced bioremediation for the downgradient plume. Minimal short-term effects (adverse or beneficial) would result from implementation of this alternative, because only minimally invasive construction is necessary within affected media. Long-term beneficial effects would occur comparatively rapidly, although these beneficial effects would reach a steady-state condition rapidly due to the limitations of pump and treat systems in removing COC mass. This alternative would not produce any adverse long-term effects, and is ranked moderately high for environmental criteria.

10.1.4 Institutional Criteria

Alternative 1 is rated moderately low for institutional criteria, because it may be very difficult to obtain necessary permissions for discharge of treated groundwater and to address RCRA permitting requirements. Discussions with the City of Arlington indicated that the local POTW may not have the capacity to accept the anticipated flow rate of treated groundwater on a long-term basis. There are also several permitting and administrative impediments related to the surface discharge. For the purposes of this CMS, it has been assumed that treated groundwater would be discharged to the existing infiltration gallery installed as part of the pilot study for Alternative 4 (Section 9.2.4). Additionally, construction of the facilities needed for the total fluids groundwater/LNAPL recovery and treatment system, in addition to the air sparging system, could interfere with ongoing facility operations.

10.1.5 Cost

The estimated total net present value for this alternative (based on the assumptions used for estimation) is $4,309,600. However, the cost could potentially be much higher if treated groundwater could not be disposed of via on-site infiltration or at the local POTW. If it is necessary

to transport the treated water for disposal at another POTW it could increase annual costs by $2,000,000 to $3,000,000, which would substantially increase the net present value. Business interruption and loss of lease income could also substantially increase the cost over the above stated estimate. First-year costs associated with this alternative include costs to install 15 air sparge wells, a groundwater treatment system, and associated piping and equipment plus program costs and costs to implement ICs. Annual costs would include operation and maintenance costs (for air sparging, total fluids recovery, and groundwater treatment), maintenance of ICs, and groundwater monitoring for a period of 100 years. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed estimate worksheets are included in Appendix C. Due to its high cost, this alternative is rated moderately low for the cost criterion.

10.2 ALTERNATIVE 2: PHYSICAL/HYDRAULIC CONTAINMENT AND MNA

Alternative 2 would provide physical/hydraulic containment for contaminated groundwater by (1) construction of a barrier wall around the most highly affected area, and (2) implementing a total fluids recovery program inside the barrier wall to recover LNAPL and establish hydraulic control. A groundwater recovery/treatment system would be employed to recover LNAPL and the most highly affected groundwater. LNAPL would be separated, and the affected groundwater would be treated to attain discharge criteria. MNA would address affected groundwater outside the containment area. A hanging, low-permeability barrier wall would be installed around the source area using conventional slurry wall methods. This alternative would combine physical containment with an LNAPL and groundwater recovery program.

10.2.1 Technical Criteria

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined on Table 10-1. Alternative 2 is evaluated against these technical criteria in the following subsections. The overall rating is shown on Table 10-2.

10.2.1.1 Performance

Alternative 2 relies on a hanging barrier wall and active groundwater pumping using the total fluids recovery concept to provide hydraulic containment and to recover LNAPL from the subsurface. MNA would limit the toxicity and mobility of site COCs within groundwater downgradient of the source area. The physical/hydraulic containment system could be effective, provided that active pumping is maintained. If pumping were to fail or stop, system warnings would indicate the malfunction; however, given the absence of an aquitard at a reasonable depth and the high hydraulic conductivity of the aquifer, the system would become ineffective shortly after a shutdown and affected groundwater inside the barrier wall would likely migrate beyond the wall. However, the hanging barrier wall would limit contaminant flow from the source area during shutdown of the

total fluids system; this alternative would provide improved performance over Alternative 1. MNA would remain active for degradation of many constituents in groundwater, but the rate of attenuation would be generally slow.

Biodegradation of COCs in the downgradient plume would permanently destroy the COCs, gradually reducing both the toxicity and volume of affected groundwater. COCs present in groundwater recovered at the facility would be removed from the groundwater and destroyed permanently; this would contribute to reduced toxicity and mobility within the source area. There would be a reduction in the volume of LNAPL due to recovery using the total fluids approach, although complete LNAPL removal would be unlikely. The mobility of COCs in the source area would be reduced, due to the physical and hydraulic containment system. Even if the groundwater recovery component failed, the hanging barrier wall would reduce mobility of the LNAPL somewhat. Mobility of the groundwater plume also would be moderately reduced by lengthening the flow path for affected groundwater and by limiting the flux of groundwater from the source area.

The engineering controls included in this alternative to recover LNAPL and provide containment are generally simple and proven reliable, provided that active pumping is maintained. The useful life for the barrier wall is very long, as it is constructed of earthen materials and would likely fail only if a major earthquake affected the facility. The useful life for the groundwater recovery and treatment components is not expected to be long; active pumping and treatment requires operator attention, periodic maintenance, and periodic replacement of wells and equipment. Since LNAPL recovery included in Alternative 2 would only address mobile LNAPL that readily flows to the collection facilities, LNAPL recovery would not be expected to have a long useful life. The estimated pumping rate, which is based on pumping performed during the pilot study described in Section 9.2.4, would need to be confirmed during detailed design studies. Because of the hydrological setting (i.e., high transmissivity and hanging wall not keyed into an aquitard), pumping inside the barrier would create an upward gradient with the pumping well acting as a partially penetrating well. Consequently, a hanging barrier wall may not provide a substantial reduction in the pumping rate required to achieve hydraulic control compared to hydraulic containment using extraction wells alone.

Based on these considerations, this alternative is rated moderately high for effectiveness and for reduction in toxicity, mobility, and volume, and moderately low for useful life.

10.2.1.2 Reliability

Alternative 2 incorporates a total fluids approach for groundwater and LNAPL recovery and treatment; this system relies upon mechanical systems and equipment. The system requires substantial long term operation and maintenance for most reliable performance; however, the barrier wall alone would provide a nominal level of containment in the absence of the total fluids

recovery component. Since both the groundwater recovery and treatment components include rotating and electronic equipment, regular maintenance is necessary. The groundwater treatment system would also require regular monitoring and maintenance, especially for the GAC units providing primary removal of groundwater COCs. Based on these considerations, this alternative is rated moderately low for long term operation and maintenance.

All components of this alternative have been proven appropriate and reliable for remediation of wood treating sites. Since the hanging barrier wall alone does not provide full physical containment, the alternative may provide only partial containment of the source area if the groundwater recovery and treatment system fails; such a failure would likely result in the loss of affected groundwater from the source area, potentially affecting downgradient groundwater. Given these considerations, Alternative 2 is rated moderately low for demonstrated and expected reliability.

10.2.1.3 Implementability

This alternative would require extensive and highly invasive construction to install the barrier wall using either conventional slurry wall or other applicable barrier wall installation techniques (e.g., vibrated beam barrier wall). This alternative would be difficult to implement. Excavation and containment wall construction would be complicated by the presence of existing structures, including buildings, drip pads, rail lines, underground lines or utilities, and the treated pole storage area. The Arlington facility is also an active industrial facility, and ongoing facility operations would be disrupted by required construction work. Additionally, the groundwater collection piping, the groundwater treatment system, and the treated water discharge piping must be installed. Significant permitting issues could be encountered if the Arlington POTW cannot commit to accepting treated groundwater for the long-term, and it is not feasible to transport the water to another POTW by truck or pipeline. It is expected that a RCRA Part B permit, a permit waiver, or a permit by rule determination would be needed to treat the groundwater; the RCRA permitting or waiver process is expected to be lengthy and complex. For purposes of the CMS, it is assumed that treated groundwater would be discharged to the subsurface through an infiltration gallery. Specifically, the existing infiltration trench would be rehabilitated following barrier wall installation. Constructability for this alternative is difficult. Due to difficult constructability and permitting requirements, the implementation time would be fairly long, likely in the range of 3 to 4 years.

The ICs included in this alternative would apply to the Arlington facility and affected downgradient groundwater and could be readily implemented. Significant beneficial results would accrue immediately upon completing construction of the barrier wall and groundwater recovery and treatment system. Beneficial results would continue as long as the groundwater recovery and treatment system remained in operation.

Based on the considerations presented above, Alternative 2 has been rated low for constructability, moderately low for implementation time, and moderately high for beneficial results time frame.

10.2.1.4 Safety

Significant safety concerns would result from implementation of Alternative 2. These concerns would affect remediation workers and on-site production workers. Safety concerns include potential exposure to affected soil during barrier wall construction, potential exposure to LNAPL or affected groundwater during excavation, and the normal construction safety concerns related to construction using heavy equipment. Additional safety concerns unique to slurry wall installation include potential trench failure due to the depth of the slurry trench and the potential effects of failure on adjacent structures, underground utilities, and rail lines. Safety issues due to trench failure would be less relevant in the case of vibrating beam technology. Minor safety concerns would also result from long term operation and maintenance of the groundwater recovery and treatment system; operation and maintenance could lead to exposure of workers to contaminated groundwater. This alternative is rated moderately low for safety.

10.2.2 Human Health Criteria

Alternative 2 is rated moderately low for minimizing short-term exposure to COCs at the facility because of the extensive, invasive construction typically associated with construction of barrier walls and recovery of contaminated groundwater and LNAPL. The alternative is rated moderately high for minimizing the potential for long-term exposure due to recovery of highly contaminated groundwater for hydraulic control and natural degradation/immobilization of COCs in the downgradient plume. There is some potential for human exposure due to recovery of LNAPL and to operation and maintenance activities needed for groundwater treatment.

10.2.3 Environmental Criteria

Alternative 2 is rated moderately high for this criterion due to the containment and recovery of affected groundwater combined with recovery of mobile LNAPL. Substantial short-term adverse effects could result from implementation of this alternative, but the potential for these effects can be minimized. Implementation of this alternative would achieve many remedial objectives within a short time, providing short-term beneficial effects. Long-term beneficial effects would accrue due to continued groundwater pumping; long-term adverse effects could result from failure of the groundwater recovery and treatment system. In the long term, not all LNAPL in the source area would be removed by the pump and treat system, and as a result the beneficial effects are roughly equivalent to the other containment strategies.

10.2.4 Institutional Criteria

Alternative 2 is rated low for institutional criteria because it requires extensive, invasive construction work for implementation and would adversely affect facility activities and operations during implementation. Excavation and containment wall construction would be complicated by the presence of existing structures, including buildings, drip pads, rail lines, and treated pole storage areas. Mitigation measures would be required to minimize the potential for short-term exposures during implementation. Significant permitting, including either a RCRA Part B permit, a permit waiver, or a permit by rule determination, would be required for implementation of this alternative, since the recovered groundwater would be a listed waste. The same institutional issues identified for Alternative 1 would apply to this alternative, even though the volume of recovered groundwater would be lower.

10.2.5 Cost

Assuming that treated groundwater could be disposed of via an on-site infiltration gallery, the estimated total net present value for this alternative is approximately $4,847,800. The cost would be significantly higher if treated groundwater could not be disposed of via infiltration or if pumping requirements to obtain plume capture are greater than anticipated. Business interruption and loss of lease income could also substantially increase the cost above the stated estimate. First-year costs associated with this alternative include costs to install a 1,500-foot-long containment wall, installation trench rehabilitation, three groundwater recovery wells, a groundwater treatment system, associated piping, and equipment; disposal costs for soil excavated for construction; plus implementation costs for the remediation program and ICs. Annual costs include maintenance of ICs, operation of the groundwater treatment system, maintenance of the containment wall and treatment system, and groundwater monitoring for a period of 100 years. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed cost estimate worksheets are included in Appendix C. This alternative is rated moderately low for cost, based on its moderately high net present value cost.

10.3 ALTERNATIVE 3: EXCAVATION, OFF-SITE DISPOSAL, AND MNA

Alternative 3 is based on the excavation and off-site treatment/disposal of the affected subsurface soil and LNAPL in the Main Treatment Area and MNA for the downgradient groundwater plume. In order to excavate and recover affected soil and LNAPL, it would be necessary to temporarily close the facility to operations, and demolish existing buildings, structures, and utilities in the Main Treatment Area. Upon completing excavation and shipment of excavated materials for off-site treatment and disposal, the facility would need to be rebuilt, and ICs would be implemented for the facility and off site areas impacted by affected groundwater.

10.3.1 Technical Criteria

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined on Table 10-1. Alternative 3 is evaluated against these technical criteria in the following subsections. The overall rating is shown on Table 10-2.

10.3.1.1 Performance

Under Alternative 3, practically all affected soil and LNAPL would be removed for off-site treatment and disposal. MNA would continue to degrade COCs present in groundwater beneath and downgradient from the source area; since the source would be eliminated, it is expected that MNA would cause the plume to contract over time after source area removal. This approach would be highly effective in removing COCs from the facility and in reducing contaminant loading to downgradient groundwater. Since this alternative does not rely on engineering controls to limit the mobility or toxicity of affected media and since it permanently removes most affected soil and LNAPL from the Arlington facility, the useful life of this alternative would be long.

Under applicable regulations, excavated soil and recovered LNAPL would be treated at a permitted facility to permanently destroy COCs. Residuals remaining after treatment would be disposed of in a secure, appropriately permitted landfill. This would substantially decrease the toxicity and mobility of the COCs present in soils at the facility. Biodegradation and immobilization of COCs in the plume beneath and downgradient from the source area would permanently destroy the constituents, gradually reducing both the toxicity and volume of affected groundwater. This alternative would essentially eliminate LNAPL and affected soil remaining on site. Based on these considerations, this alternative is rated high for effectiveness, useful life, and reduction in toxicity, mobility, and volume.

10.3.1.2 Reliability

Alternative 3 does not rely on engineering controls requiring active operation or maintenance. No mechanical equipment would be used for this alternative once excavated soil was removed, and off site treatment would be performed using facilities designed and permitted for waste materials and soil. Alternative 3 is rated high for both long-term operation and maintenance and for demonstrated and expected reliability.

10.3.1.3 Implementability

This alternative would require complete demolition of operational facilities in the Main Treatment Area, followed by extensive and highly invasive construction to excavate affected soil and LNAPL. For these reasons, excavation and disposal would be very difficult and extremely costly. The groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring for the MNA component. The ICs included in this alternative would

apply to the Arlington facility and affected downgradient groundwater and could be readily implemented.

Due to the complexities involved in demolishing existing facilities and excavating affected soil, it is expected that the implementation time for this alternative would be fairly long. However, beneficial results would be obtained immediately upon implementing the alternative.

Based on these considerations, Alternative 3 has been rated low for both constructability and implementation time and high for beneficial results time frame.

10.3.1.4 Safety

Alternative 3 would create substantial safety concerns for demolition and remediation workers. These concerns include potential exposure to dust and other materials during demolition; potential exposure to affected soil, LNAPL, and/or affected groundwater during excavation; and the normal construction safety concerns related to demolition and earthwork using heavy equipment. Additional safety concerns include potential slope failure due to the depth of the excavation (up to 35 feet below grade). Transportation of excavated soil and LNAPL to disposal facilities would raise safety concerns along transportation routes for other traffic and for affected communities. This alternative is rated low for safety.

10.3.2 Human Health Criteria

Alternative 3 is rated low for minimizing short-term exposure to COCs at the facility because of the extensive, invasive construction and long-distance transportation associated with excavation and off-site disposal of soil and LNAPL. The alternative is rated high for minimizing the potential for long-term exposure, since most of the COCs in excavated soil and recovered LNAPL would be destroyed during off-site treatment. Remaining COCs in excavated soil would be contained within a secure modern landfill. There would be some potential for long-term human exposure since some affected soils could remain; these potential risks would be addressed by ICs.

10.3.3 Environmental Criteria

Alternative 3 is rated moderately high for this criterion. While environmental benefits would be realized immediately upon completing implementation, the invasive construction and handling/shipping of contaminated soil and LNAPL could create adverse impacts during implementation. However, the potential for adverse impacts could be mitigated by careful planning and strict management. Long-term beneficial effects would result from the alternative due to removal of affected media from the facility and treatment to destroy COCs prior to disposal in a secure landfill. Since some affected soil could potentially remain beneath buildings and other

structures, there could be some residual environmental risks after implementation of the alternative.

10.3.4 Institutional Criteria

Alternative 3 is rated low for institutional criteria because it requires closure and demolition of the facility plus extensive and invasive construction for implementation. Demolition and excavation permits would be required to implement this alternative; appropriate designs and precautions would be needed to complete excavation to depths of up to 35 feet without creating unacceptable safety concerns. Mitigation measures would be required to minimize the potential for short-term exposures during implementation. It is expected that this alternative could be implemented in compliance with applicable regulations and standards.

10.3.5 Cost

The estimated total net present value for this alternative is $40,179,300. First-year costs incurred from implementation of this alternative include costs for demolition and reconstruction of the facility for the excavation work, disposal of excavated soil, and implementation of the remediation program and ICs. This alternative would also incur lost opportunity costs for Baxter's lost business because this alternative would most likely cause the loss of the lease term which has 13 more years due, resulting in a loss of business customers who will need to go elsewhere during the shutdown, and human resource costs for loss of employees; however, these opportunity costs have not been estimated and are not included in the total estimated cost or the net present value. Annual costs would include maintenance of ICs and groundwater monitoring for a period of 10 years. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed cost estimate worksheets are included in Appendix C. Due to the very high estimated cost, Alternative 3 is rated low for cost, since it has by far the highest estimated cost of any alternative.

10.4 ALTERNATIVE 4: ENHANCED BIODEGRADATION RECIRCULATION SYSTEM

This alternative combines in situ bioremediation through groundwater recirculation with passive recovery of LNAPL and MNA to provide a comprehensive contaminant containment program in the vicinity of the source area. The in situ bioremediation system was installed in early 2008 as a full scale pilot test and has been operating for five years. This system intercepts groundwater immediately downgradient of the main treatment area using groundwater extraction wells. The extraction wells recirculate the groundwater in situ to an aeration/infiltration trench, which mixes the collected groundwater and aerates it to promote in situ biological degradation of groundwater COCs. The water in the trench then re infiltrates, creating a recirculation cell to enhance aerobic biodegradation of groundwater COCs. Groundwater flowing from the recirculation cell undergoes

additional biodegradation and MNA in the area downgradient from the recirculation cell. Mobile LNAPL is being recovered using passive collection systems.

As discussed in Section 9.1.2, a long-term groundwater monitoring program would be conducted using 20 wells from the existing monitoring well network. The program would consist of semiannual groundwater elevation measurements and sampling with laboratory analysis for site COCs. In order to evaluate vertical plume capture and control, groundwater samples would be collected from existing nested well pairs along the main axis of the. Analytical results would be used to evaluate whether elevated COC concentrations are bypassing the enhanced bioremediation circulation system at depth and to assess the effectiveness of MNA for the groundwater plume beneath the Northwest Parcel and further downgradient. Groundwater elevations collected from these well pairs would also allow evaluation of vertical gradients across the facility, including immediately upgradient of the aeration trench. After approximately 15 years, the number of monitored wells would be reduced to 10 wells sampled annually.

10.4.1 Technical Criteria

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined on Table 10-1. Alternative 4 is evaluated against these technical criteria in the following subsections. The overall rating is shown on Table 10-2.

10.4.1.1 Performance

Alternative 4 incorporates an in situ bioremediation system to treat groundwater immediately downgradient of the source area with passive LNAPL recovery and MNA to limit the toxicity and mobility of COCs at and downgradient of the facility. Enhanced aerobic bioremediation has been proven effective for wood treating sites. Based on the data collected in five years of operation of this system as a full-scale pilot test, this bioremediation approach would be effective for the Arlington facility. Passive LNAPL recovery would be effective for removal of mobile LNAPL, but will not remove LNAPL that is not freely mobile. MNA would degrade COCs downgradient of the enhanced bioremediation system, but degradation rates would be slow, especially as distance from the bioremediation system increases.

Biodegradation of constituents due to the enhanced bioremediation system and due to MNA in the downgradient plume would permanently destroy the constituents, thereby reducing both the toxicity and volume of affected groundwater. The enhanced bioremediation system would also increase biodegradation rates downgradient of the extraction wells due to increased dissolved oxygen in groundwater exiting the recirculation zone. The mobility of COCs would decrease due to the hydraulic control and enhanced biodegradation created by the groundwater recirculation wells. There would be a moderate reduction in volume of LNAPL due to passive recovery. The pilot test

has shown that this alternative reduces the toxicity and volume of affected groundwater; it has minor effects on the mobility of COCs, but the groundwater recirculation system increases travel time for groundwater COCs due to the increased residence time in the recirculation cell.

The mechanical components included in this alternative to recover LNAPL and recirculate groundwater are simple, readily available, and proven reliable. The useful life for the wells and trench would be very long; the mechanical components would require operator attention, maintenance, and periodic replacement. Since LNAPL recovery included in Alternative 4 would only address readily mobile LNAPL by passive flow to the collection facilities, LNAPL recovery is not be expected to have a long useful life.

Based on these considerations, this alternative is rated moderately high for effectiveness, useful life, and reduction in toxicity, mobility, and volume.

10.4.1.2 Reliability

Alternative 4 would require long-term operation and maintenance for reliable operation of the enhanced bioremediation system and the LNAPL recovery system. However, operation and maintenance requirements have been shown in the pilot test to be nominal because the mechanical systems are simple and incorporate minimal rotating and electrical equipment. The only equipment expected to require routine checks and maintenance would be the groundwater recirculation pumps. Submersible well pumps have proven to be highly reliable, but they would require periodic maintenance and replacement after about 15 years of operation. Continued monitoring would be required to confirm the effectiveness of the alternative, but this element is common to all alternatives. Based on these considerations, this alternative is rated moderately high for long-term operation and maintenance.

The enhanced bioremediation system has been applied previously to wood-treating sites; the actual configuration has varied in previous applications due to site-specific design requirements. Aerobic bioremediation of groundwater has been used fairly widely and is known to be reliable at wood treating sites. Other components of this alternative also have been used reliably at wood treating sites.

No substantial adverse effects, other than reduction in the rate of biodegradation, would result from failure of the enhanced bioremediation recirculation system. If recirculation pumping fails or is stopped for short times, the effectiveness of the bioremediation system would not be significantly affected. If extraction wells stop operating, system warnings would indicate the shutdown, thereby limiting the duration of shutdowns; however, because of the high hydraulic conductivity of the aquifer, groundwater containing elevated COC concentrations could migrate downgradient following a shutdown. Long-term failure of all recirculation wells would result in reduced treatment

effectiveness. No significant adverse effects would result from failure of the LNAPL recovery system other than loss of recovery. The key components of this alternative are all compatible; enhanced bioremediation interfaces seamlessly with MNA. Alternative 4 is rated moderately high for demonstrated and expected reliability.

10.4.1.3 Implementability

This alternative does not require additional construction. As part of the pilot study, excavation was performed to construct the aeration trench, which was placed so that it is compatible with existing structures and utilities. Well construction was implemented for the recirculation wells and for LNAPL recovery. Limited, shallow trenching was performed to install recirculation lines from the wells to the aeration trench. Because the aeration trench is classified as a Class 5 injection well under Washington State regulations and the trench was registered with the state, no permitting was required.

Construction performed during the pilot study occurred in coordination with ongoing operations. The groundwater monitoring program described in Section 9.1.2 is sufficient to provide groundwater quality monitoring for this alternative.

The ICs included in the alternative would apply to the Arlington facility and affected downgradient groundwater and could be readily implemented. Data collected during the pilot study demonstrate that degradation of COCs began shortly after startup of the enhanced bioremediation recirculation system, indicating that beneficial results were attained in a short time frame. Enhanced biological activity occurred within a few weeks after system startup. For these reasons, Alternative 4 has been rated high for constructability and implementation time, and moderately low for beneficial results time frame.

10.4.1.4 Safety

Implementation of Alternative 4 presented minor safety concerns. The primary safety concerns occurred during construction of the aeration trench, which involved standard earthwork safety issues in addition to potential exposure to soil affected by COCs at the facility. Recovery of LNAPL presents some safety concerns for direct contact with the LNAPL and for fire. While there are minor safety concerns associated with maintenance of the recirculation wells and aeration trench, this work has been performed safely by trained workers using appropriate, proven procedures. This alternative is rated moderately high for safety.

10.4.2 Human Health Criteria

Alternative 4 is rated moderately high for minimizing short-term exposure to COCs at the facility based on the limited extent of invasive construction required for implementation. Operational

components of this alternative consist largely of wells, which present only a small potential for short-term exposure. The alternative rates moderately high for minimizing the potential for long-term exposure. Recirculated groundwater would not be pumped over long distances and would remain below grade, providing minimal potential for exposure. There would be some potential for human exposure due to recovery of LNAPL and maintenance of the recirculation system, but this potential would be limited to facility personnel and can be readily mitigated by using appropriate safety procedures. The active and fairly rapid degradation of COCs by enhanced bioremediation would limit the potential for long-term exposure to COCs at the facility.

10.4.3 Environmental Criteria

Alternative 4 is rated moderately high for this criterion since pilot study results have demonstrated that this alternative provides short-term beneficial effects and would provide long-term beneficial effects with minimal adverse effects. Furthermore, results of the pilot test have shown that the recirculation wells effectively intercept contaminated groundwater. Aeration of the recirculated groundwater has enhanced biological activity downgradient of the source area. Long-term adverse effects would be limited to non-recoverable LNAPL, affected soil, and affected groundwater remaining beneath the Main Treatment Area; these would not create any significant environmental impacts since the affected media are located beneath an active industrial facility.

10.4.4 Institutional Criteria

Alternative 4 is rated high for institutional criteria because it does not require extensive, invasive construction for implementation and had limited effects on site activities and facilities during implementation. Future construction, which would consist primarily of rehabilitation of the existing aeration trench or replacement of wells, could be readily coordinated with ongoing facility operations. This alternative has been designed to comply with applicable regulations, including the RCRA regulations. Standard excavation and building permits were needed, but no extensive or complex permitting was required to implement this alternative. The aeration trench is already registered as a Class 5 injection well under Washington regulations, and is exempt from permitting.

10.4.5 Cost

The estimated total net present value for this alternative is $2,684,700. This total net present value cost does not include approximately $967,000 in sunk costs incurred by Baxter between 2007 and 2012 for installation and operation of the pilot system. In the cost estimate presented in this CMS, first-year costs associated with this alternative include program implementation costs include modification of the existing infiltration gallery to facilitate future maintenance activities. Annual operation and maintenance costs include maintenance of ICs, LNAPL recovery and disposal, groundwater monitoring, and operation and maintenance of the recirculation system for a period of

100 years. There would be little or no business interruption costs associated with this alternative. A summary of total estimated costs for this alternative is included in Table 10-3. The detailed cost estimate for Alternative 4 is presented in Appendix C. This alternative is rated moderately high for cost.

10.5 ALTERNATIVE 5: ERH, TOTAL FLUIDS RECOVERY, AND ENHANCED BIODEGRADATION RECIRCULATION

This alternative combines ERH, total fluids recovery, enhanced biodegradation recirculation, and ICs to provide a comprehensive contaminant reduction program in the source area. ERH and total fluids recovery would be conducted in the source area (Figure 9-5). Total fluids extraction would recover LNAPL and would provide hydraulic containment of the source area. This potentially feasible combination of remediation technologies provides an aggressive approach to both LNAPL recovery and soil and groundwater remediation. As described above for Alternative 1, ICs to limit potential direct exposure to affected groundwater and/or soil would be implemented under this alternative. As described in Section 9.1.2, a long-term groundwater monitoring program would be conducted, including semiannual sampling with laboratory analysis for site COCs. The monitoring program would assess whether natural attenuation is actively degrading COCs and assess progress toward attainment of remediation objectives. A subset of the existing monitoring wells would be used for monitoring.

10.5.1 Technical Criteria

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined on Table 10-1. Alternative 5 is evaluated against these technical criteria in the following subsections. The overall rating is shown on Table 10-2.

10.5.1.1 Performance

Alternative 5 would provide a comparatively rapid reduction in the toxicity and volume of COCs, particularly in the source area. However, the woodwaste area would not be directly treated by ERH and therefore would only be indirectly treated (as some mass would be removed indirectly due to ERH vapor recovery systems). This alternative should reduce the contaminant loading to the downgradient portion of the plume, which would improve the rate of COC degradation. Potential risks to downgradient receptors would be minimal, based on the limited future mobility of COCs due to the combination of remediation technologies applied in this alternative.

Source control is included to remove LNAPL and highly contaminated groundwater, thereby reducing the toxicity, mobility, and volume of affected media and accelerating cleanup. Recovered groundwater would be treated to permanently destroy dissolved COCs.

Total fluids recovery is proven effective in recovering LNAPL and contaminated groundwater. Since groundwater is recovered in the immediate vicinity of the LNAPL, it is likely that more highly contaminated groundwater would be recovered compared to pumping downgradient of the source area, providing more contaminant mass recovery. Recovered COCs would be removed as a result of groundwater treatment and LNAPL disposal.

The engineering systems included to facilitate ERH and to recover vapor, LNAPL, and groundwater are proven technologies, but require periodic operator attention and maintenance to operate effectively. The useful life for the total fluids recovery system is typical for mechanical systems. Major mechanical components would likely require replacement after 3 to 5 years of operation; however, for ERH we estimate only six months of active treatment.

Mobility of COCs would be limited due to the ERH application producing steam and contaminant vapors and by the hydraulic containment created by the operation of the total fluids recovery wells. By inhibiting high-concentration COCs to migrate downgradient and using total fluids recovery to accelerate contaminant removal rates, this alternative is expected to result in the contraction of the groundwater plume's leading edge. If fluid recovery pumping were to fail, system warnings would indicate the malfunction; given the high hydraulic conductivity of the aquifer, system effectiveness would decrease shortly after a shutdown, and source area groundwater containing elevated COC concentrations could migrate downgradient of the remediation system.

In addition to total fluids extraction and treatment for an approximate one-year period, the existing enhanced groundwater recirculation system located downgradient from the source area would remain operational for a total of approximately five years from implementing the ERH treatment. This system would also capture any increase in COC concentrations in groundwater during and shortly after treatment that can occur. After the five-year period, the recirculation system would be turned off, and monitoring would continue for an additional 15 years to monitoring groundwater conditions.

Based on the above considerations, this alternative is rated both high for effectiveness and reduction in the toxicity, mobility, and/or volume of affected media, and moderately high for useful life, due to its relatively short time for treatment.

10.5.1.2 Reliability

Alternative 5 incorporates one mechanical system (the total fluids system) and one electrical system (ERH) for corrective action, with moderately high operational and maintenance requirements. The total fluids recovery and the groundwater treatment systems require periodic operator attention for proper operation. Since both systems include rotating equipment, regular maintenance is necessary. The groundwater treatment process required for operation of the total

fluids system also requires operator attention and regular monitoring so that requirements are attained and that the GAC units are replaced as needed. The ERH system requires periodic operator attention for proper operation and to ensure the temperature ranges are within acceptable operating parameters. However, since the ERH and total fluids recovery system is only planned to be in operation for six months, this alternative is rated high for long-term operation and maintenance.

Both thermal heating and total fluids recovery have been proven appropriate for remediation of wood treating sites. However, both components rely on mechanical and electrical equipment to provide remediation; equipment can fail, and failure of the equipment would render this alternative ineffective for short time periods. However, the relatively short operating time necessary for the system changes makes failure unlikely; thus, this alternative is rated moderately high for demonstrated and expected reliability.

10.5.1.3 Implementability

This alternative would require fairly extensive construction to install the ERH/fluid recovery wells and conveyance piping, but could possibly be completed without major disturbance of on-site operations. Construction would require detailed coordination with ongoing facility operations. For these reasons, construction would require careful planning and on-site management so that it is done safely and properly. Constructability for this alternative is moderate, and the implementation time would be fairly short, likely in the range of three to six months.

The long-term groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring for the ERH system.

Implementing this alternative would require disposal of treated groundwater in accordance with applicable regulations. For purposes of the CMS, it is assumed that treated groundwater would be discharged to the subsurface through the ERH/fluid recovery wells. Subsurface injection of the treated groundwater would require appropriate permitting and on-site treatment would require either a RCRA Part B permit, a permit waiver, or a permit by rule determination.

The ICs included in this alternative could be readily applied to the facility and affected downgradient groundwater. It is expected that beneficial results would be attained in a comparatively short time frame for Alternative 5. For these reasons, Alternative 5 has been rated moderately low for constructability, and high for both implementation time and beneficial results time frame.

10.5.1.4 Safety

Alternative 5 could be implemented with moderate concerns for safety. ERH could create some safety concerns, considering the reliance on electricity and electrodes for heating the subsurface. There is an area of wood debris/chips in the northern edge of the source area to depths ranging from 0 to 15 bgs. This area could create some safety concerns due to the potential for a fire; however, electrodes and heating is intended to be focused beneath this area and monitored by temperature monitoring points. Recovery of LNAPL could create some safety concerns as well for direct contact with the LNAPL and for fire. Safety concerns would result from operation of a groundwater treatment system with contaminated groundwater mixed with LNAPL in above-grade piping and vessels. This alternative is rated moderately low for safety.

10.5.2 Human Health Criteria

Alternative 5 is rated moderately low for minimizing short-term exposure to COCs at the facility, because minimal invasive construction work is needed for implementation. There is some potential for human exposure, due to recovery of LNAPL and the associated operation and maintenance activities for the total fluids recovery systems. This alternative is rated high for minimizing long-term exposure, since it contributes to active degradation of the majority of COCs and to aggressive recovery of LNAPL.

10.5.3 Environmental Criteria

Alternative 5 is rated high for this criterion since it rapidly reduces COCs near the source area, and aggressively recovers LNAPL. Minimal short-term effects (adverse or beneficial) would result from implementation of this alternative, because only minimally invasive construction is necessary within affected media. Additionally, containment systems for vapor and liquid minimize any chance of causing a spike in down gradient concentrations. Long-term beneficial effects would occur comparatively rapidly. This alternative would not produce any adverse long-term effects.

10.5.4 Institutional Criteria

Alternative 5 is rated moderately low for institutional criteria, because it may be very difficult to obtain necessary permissions for discharge of treated groundwater and to address RCRA permitting requirements. Discussions with the City of Arlington indicated that the local POTW may not have the capacity to accept the anticipated flow rate of treated groundwater on a short or long-term basis. There are also several permitting and administrative impediments related to the surface discharge. For the purposes of this CMS, it has been assumed that treated groundwater would be discharged to the subsurface through the ERH/fluid recovery wells. Additionally, construction of the electrodes/wells and systems needed for the total fluids groundwater/LNAPL

recovery and treatment system could interfere with ongoing facility operations, even with detailed planning and coordination with the facility.

10.5.5 Cost

The estimated total net present value for this alternative (based on the assumptions used for estimation) is $4,287,500. However, the cost could potentially be much higher if treated groundwater could not be disposed of via on-site infiltration or at the local POTW; if it is necessary to transport the treated water for disposal at another POTW it could increase annual costs by $1,000,000, which would substantially increase the net present value. First-year costs associated with this alternative include costs to install 103 electrodes/total fluid recovery wells, electrical infrastructure, six temperature monitoring points, a groundwater treatment system, and piping plus program costs and costs to implement ICs. Annual costs would include maintenance of ICs, and groundwater monitoring for a period of 20 years. Business interruption and loss of lease income could also substantially increase the cost over the stated estimate. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed estimate worksheets are included in Appendix C. This alternative is rated moderately high for cost, since the cost is higher than the lowest cost alternative, but considerably less than Alternative 3.

10.6 ALTERNATIVE 6: CHEMICAL OXIDATION AND ENHANCED BIODEGRADATION RECIRCULATION

Alternative 6 would provide a comprehensive contaminant reduction program in the source area with minimal disturbance to on-site operations. ICs would be enforced to limit potential exposure to any remaining COCs in the source area. Injection of oxidant would be performed via push probe drill rig for three separate events, as shown on Figure 9-6. Long term effectiveness would be monitored via a subset of groundwater monitoring wells.

10.6.1 Technical Criteria

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined on Table 10-1. Alternative 6 is evaluated against these technical criteria in the following subsections. The overall rating is shown on Table 10-2.

10.6.1.1 Performance

Alternative 6 relies on the ability of oxidant to make contact with COCs in the source area. If successful contact is made, COC concentrations will be significantly reduced. However, chemical oxidation will not be effective in places where background oxidant demand is high (in woodwaste backfill, high dissolved metals in groundwater, etc.) and cannot be injected too close to ground surface without risking surfacing of the oxidant. The soil matrix on-site has generally allowed push

probes to reach the target depths, but some probe locations have been limited to shallower depths. In addition, injection could be physically limited if chemical reactions occur and plug the pore space prior to complete injection of the required oxidant volume. Pilot testing is needed to confirm that oxidant injection volumes can be met, and additional groundwater data should be collected to verify that background oxidant demand is relatively low.

Based on the above considerations, this alternative is rated high for effectiveness, but pilot test results and additional sampling would be needed to confirm this effectiveness rating prior to implementing a full scale program. Alternative 6 is rated moderately high for useful life, due to its relatively short time for treatment, and high for reduction in the toxicity, mobility, and/or volume of affected media.

10.6.1.2 Implementability

This alternative would require fairly minor construction, with major equipment consisting of a drill rig and mix tank. Implementing this alternative would require disposal of small amounts of solid and liquid waste from push probe cores. Construction would minimally impact facility operations. The constructability rating for this alternative is moderately high, and the implementation time would be fairly short, likely in the range of three to seven months. This alternative also has a high degree of flexibility in implementation, as a phased approach for treatment could be used in conjunction with groundwater monitoring to verify effectiveness after individual treatments.

The long-term groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring after chemical oxidation treatment.

The ICs included in this alternative could be readily applied to the facility and affected downgradient groundwater. It is expected that beneficial results would be attained in a comparatively short time frame for Alternative 6. For these reasons, Alternative 6 has been rated high for both implementation time and beneficial results time frame.

10.6.1.3 Safety

Minor safety concerns would result from implementation of Alternative 6. These concerns would affect remediation workers and on-site production workers. Safety concerns include potential exposure to affected soil during drilling, potential exposure to LNAPL or affected groundwater during drilling, and the normal construction safety concerns related to construction using heavy equipment. Additional safety concerns unique to chemical oxidation include potential exposure to chemical oxidant. Safety issues due to oxidant exposure can be mitigated by choosing an oxidant that is safe to handle. Regenox requires mixing two inert ingredients to create the oxidant, and therefore handling risks are negligible. Risks of the oxidant surfacing have been minimized by limiting injection to 10 feet bgs. There is no long term operation and maintenance of any system;

the only long term item is groundwater monitoring. This alternative is rated moderately high for safety.

10.6.2 Human Health Criteria

Alternative 6 is rated moderately high for minimizing short-term exposure to COCs at the facility since push probe drilling is the major construction activity. The alternative is rated moderately high for minimizing the potential for long-term exposure, since the majority of the COC mass will be destroyed in situ in the short term and the remainder will be managed under MNA.

10.6.3 Environmental Criteria

Alternative 6 is rated moderately high for this criterion due to the destruction of the majority of the COC mass in a short time frame. Some short-term adverse effects could result from implementation of this alternative (such as mobilization of some COCs), but the potential for these effects is minimal. Implementation of this alternative would achieve many remedial objectives within a short time, providing short-term beneficial effects. Long-term beneficial effects would simply be a function of less COC mass being present. No long-term adverse effects are expected. In the long term, some of the COC mass in the source area would remain (woodwaste backfill areas would not be directly treated), and as a result the beneficial effects are roughly equivalent to ERH.

10.6.4 Institutional Criteria

Alternative 6 is rated moderately high for institutional criteria because it requires extensive, but minimally disruptive, construction work for implementation. Alternative 7 would not substantively affect facility activities and operations during implementation. Injection points would be minimally limited by the presence of existing structures, including buildings, drip pads, rail lines, and treated pole storage areas. Permitting concerns would be relatively minor, since very little waste would be generated by this method, and no waste would be treated ex situ on-site.

10.6.5 Cost

Assuming that the pilot test confirms design expectations, the estimated total net present value for this alternative is approximately $2,484,700. The cost would be significantly higher if the pilot test shows that even low COC mass areas require multiple injections for effective treatment, or if push probe drilling is slower than expected. Implementation costs associated with this alternative include costs for drilling, oxidant chemicals, mixing, disposal of drilling cores, and minor cost for implementation of ICs. Annual costs include maintenance of ICs and groundwater monitoring for a period of 20 years. Relatively minor impacts on business operations would occur with this alternative. A summary of total estimated costs for this alternative is included in Table 10-3.

Detailed cost estimate worksheets are included in Appendix C. This alternative is rated moderately high for cost, based on the fact that it is one of the least expensive alternatives as measured by net present value cost.

11.0 COMPARATIVE EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

This section compares the corrective measures alternatives that have been developed and evaluated for the Arlington facility. This comparative analysis will then be used to select the preferred corrective measures alternative for the facility.

As discussed in Section 10, EPA guidance (EPA, 1994, 1996) describes two sets of criteria for evaluating corrective measures alternatives: (1) threshold criteria that must be attained by the corrective measures selected for implementation; and (2) balancing criteria that are used for detailed evaluation and screening of alternatives.

Section 10 defined the balancing criteria used in this CMS and evaluated each alternative was for its performance relative to the balancing criteria. All corrective measures were designed to attain the threshold criteria; however, the alternatives may differ in how well they achieve these threshold criteria.

Section 11 presents a comparative evaluation of the corrective measures alternatives described in Section 9, consistent with the AOC (EPA, 2001). Separate comparative evaluations are presented for the threshold criteria (Section 11.1) and the balancing criteria (Section 11.2). These comparative analyses are combined to develop a preferred corrective measures alternative in Section 11.3.

11.1 COMPARATIVE EVALUATION: THRESHOLD CRITERIA

EPA CMS guidance has established four threshold criteria that must be attained by a selected remedy:

1. Protect human health and the environment;
2. Attain media cleanup standards;
3. Control source areas to reduce or eliminate, to the extent practicable, further releases of hazardous constituents that may pose a threat to human health and the environment; and
4. Comply with applicable standards for waste management.

All six corrective measures alternatives considered would attain the threshold criteria. However, some alternatives may require a longer time period to attain the criteria than others. Table 11-1 rates the alternatives from 1 (low) to 4 (high) for relative effectiveness in attaining each of the

threshold criteria. Equal weighting was used for the threshold criteria... Table 11-1 also shows the total scores and rankings.

Alternative 3, including excavation and off-site disposal, would provide the most complete and rapid removal of COCs, eliminate the majority of the source area and future releases, and is ranked highest overall. It scored high for the first three criteria but moderately low for criteria 4, compliance with waste management standards, due to the large quantity of waste generated and requirement for treatment to achieve compliance.

Alternative 6 is ranked second highest and Alternative 5 is ranked third highest. Alternatives 5 and 6 are likely to relatively quickly remove contaminant mass effectively and include source area treatment, and don't rely on active systems for long term operations. However, both of these alternatives will not immediately treat all the source area and will rely on enhanced biodegradation recirculation for treatment of any remaining COCs. Alternative 6 is rated slightly higher, since it produces minimal waste to manage.

Alternatives 1, 2 and 4 received close to the same overall threshold criteria score. These alternatives all use active measures that will require significant long term O&M. However, the maintenance is fairly straightforward and none of the measures are technically or regulatorially challenging to implement. Alternatives 1 and 2 are the lowest ranked alternatives, since compliance with waste management standards is uncertain due to the high level of difficulty in treating and disposing of recovered groundwater. Alternative 4 is rated higher than Alternatives 1 and 2, as minimal amounts of wastes are created as the majority of the treatment is accomplished by in situ bioremediation.

Table 11-1 shows the ranking of the alternatives based on the total threshold criteria scores from 1 (best) to 6 (worst). The rankings are as follows:

1. Alternative 3 (Excavation, Off-Site Disposal, and MNA)
2. Alternative 6 (Chemical Oxidation and Enhanced Biodegradation Recirculation)
3. Alternative 5 (ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation)
4. Alternative 4 (Enhanced Biodegradation Recirculation System)
5. Alternative 1 (Total Fluids Recovery, Air Sparging, and MNA)
6. Alternative 2 (Physical/Hydraulic Containment and MNA).

11.2 COMPARATIVE EVALUATION: BALANCING CRITERIA

This section compares the six corrective measures alternatives for the balancing criteria. The balancing criteria identified in the AOC have been separated into technical criteria, human health criteria, environmental criteria, institutional criteria, and cost. The technical criteria have been further subdivided into criteria related to performance, reliability, implementability, and safety. All of the balancing criteria used in this CMS are defined in Table 10-1 and in the CMS guidance (EPA, 1996). EPA's AOC (EPA, 2001) has established a slightly different and more detailed set of balancing criteria that must be followed for this CMS, as described in Section 10.

Each alternative was evaluated against the balancing criteria and assigned a numerical rating in Section 10 (Table 10-2). A total score was calculated from these numerical ratings and used to rank the six corrective measures alternatives from 1 (highest) to 6 (lowest) (Table 11-2).

The ranking is based on the total scores shown on Table 10-2 and Table 11-1. The overall relative ranking of the six alternatives based on the balancing criteria is presented in Table 11-2. The highest ranked alternative is Alternative 6, and the lowest ranked alternative is Alternative 2.

11.3 SUMMARY OF ALTERNATIVES

The relative rankings for the threshold criteria and the balancing criteria are summarized in Table 11-2. The final column in Table 11-2 shows the rankings based on the total of scores for threshold and balancing criteria, assigning equal weighting to the two sets of criteria. In Table 11-2, the lowest total score results in the highest ranking. This equal weight approach is consistent with requirements set forth in EPA guidance documents for Corrective Measures studies (EPA, 1994, 1996).

The combined ranking for the alternatives, including both threshold and balancing criteria is shown on Table 11-2. The four highest ranked alternatives are:

- Alternative 6 (Chemical Oxidation and Enhanced Biodegradation Recirculation) is ranked highest.
- Alternative 5 (ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation) and Alternative 4 (Enhanced Biodegradation Recirculation System) are tied for second highest.
- Alternative 3 (Excavation, Off-Site Disposal, and MNA) is ranked as the fourth highest.

As shown on Table 11-2, for the threshold criteria Alternative 3 is ranked highest, and Alternative 6 is ranked second. For the balancing criteria, Alternative 6 is ranked highest and Alternative 5 is ranked second.

Of the four highest ranked alternatives, Alternative 3 is the most rapid and most reliably effective option for removing COC mass, but has a disproportionately high cost relative to the other alternatives considered in this CMS. In addition, Alternative 3 has the most severe impact on facility operations and is the least implementable of the alternatives.

Alternative 4 controls and treats COCs released from residual LNAPL and affected soil in the source area, but does not actively treat the source area other than by passive mobile LNAPL removal and natural degradation of COCs in the subsurface. This alternative is currently active at the facility as part of the pilot remediation system, and monitoring data indicate that the existing plume is decreasing in area and concentration with time, although the restoration time frame is uncertain. The overall cost of this alternative is similar to Alternative 6, primarily due to the long-term costs associated with monitoring and maintenance of the treatment system. The initial installation and operations and maintenance costs for this alternative of approximately $967,000, which have already been incurred (not including monitoring costs), are not included in the cost estimates presented in Table10-3 and Appendix C.

Alternative 5 would rapidly remove COC mass in the source area, but is more costly than Alternatives 4 and 6. For Alternative 5, additional investigations would be required to delineate the edges of residual NAPL in the treatment area to optimize the number and configuration of electrodes in the subsurface, and bench-scale tests on soils from the source areas would be required to establish optimal heating times and COC destruction efficiencies. Additional risks are associated with this alternative due to possible mobilization of COCs off-site.

The combined ranking for Alternative 6 is the highest of all six alternatives. The evaluations and rankings developed in this CMS are based upon EPA guidance and the AOC. Alternative 6 would require additional investigations to characterize subsurface soil conditions and oxidant requirements, as well as pilot testing to evaluate effectiveness of the technology. Of the three alternatives that actively address source area COCs through removal or treatment (Alternatives 3, 5, and 6), this alternative is the least disruptive to ongoing operations, and can be designed to perform treatment with multiple injections in a phased approach that could range from months to several years. Based on the analysis presented in this CMS, Alternative 6 is Baxter's preferred remedy.

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13.0 LIMITATIONS

This report was prepared exclusively for J.H. Baxter & Co. and the EPA by AMEC Environment & Infrastructure, Inc. (AMEC). The quality of information, conclusions, and estimates contained herein is consistent with the level of effort involved in AMEC services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions, and qualifications set forth in this report. This Corrective Measures Study, Revision 3, is intended to be used by J.H. Baxter & Co. and the EPA for the former wood treating facility in Arlington, Washington only. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

TABLES

TABLE 3-1

PROPOSED CLEANUP LEVELS FOR GROUNDWATER [1, 2]

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

	MTCA Method A	MTCA Method B		Maximum Contaminant Level	EPA RSL, Tap Water	Proposed Cleanup Level
		Carcinogen	Non-Carcinogen			
Metals						
Arsenic	5	0.058	4.8	10	0.045	**10**
Barium	--	--	3,200	2,000	2,900	**2,000**
Cadmium	5	--	16	5	6.9	**5**
Calcium	--	--	--	--	--	--
Chromium	50	--	--	100	--	**100**
Copper	--	--	640	1,300	620	**1,300**
Iron	--	--	--	--	11,000	**11,000**
Lead	15	--	--	15	--	**15**
Magnesium	--	--	--	--	--	--
Manganese	--	--	2,240	--	320	**2,240**
Nickel	--	--	320	--	300	**320**
Potassium	--	--	--	--	--	--
Selenium	--	--	80	50	78	**50**
Sodium	--	--	--	--	--	--
Zinc	--	--	4,800	--	4,700	**4,800**
Total Petroleum Hydrocarbons						
Diesel Range Organics (DRO)	500	--	--	--	--	**500**
Residual Range Organics (RRO)	500	--	--	--	--	**500**
Phenols						
2,4,6-Trichlorophenol	--	4.0	--	--	3.5	**4.0**
2,3,4,5-Tetrachlorophenol	--	--	--	--	--	--
2,3,5,6-Tetrachlorophenol	--	--	480	--	170	**480**
Pentachlorophenol	--	0.22	80	1.0	0.035	**1.0**
Polycyclic Aromatic Hydrocarbons						
2-Methylnaphthalene	--	--	32	--	27	**32**
Acenaphthene	--	--	960	--	400	**960**
Acenaphthylene	--	--	--	--	--	--
Anthracene	--	--	4,800	--	1,300	**4,800**
Benzo(a)anthracene	--	-- [3]	--	--	0.029	-- [3]
Benzo(a)pyrene	0.1	0.012	--	0.2	0.0029	**0.2**
Benzo(b)fluoranthene	--	-- [3]	--	--	0.029	-- [3]
Benzo(g,h,i)perylene	--	--	--	--	--	--
Benzo(k)fluoranthene	--	-- [3]	--	--	0.29	-- [3]
Chrysene	--	-- [3]	--	--	2.9	-- [3]
Dibenz(a,h)anthracene	--	-- [3]	--	--	0.0029	-- [3]
Fluoranthene	--	--	640	--	630	**640**
Fluorene	--	--	640	--	220	**640**
Indeno(1,2,3-cd)pyrene	--	-- [3]	--	--	0.029	-- [3]

TABLE 3-1

PROPOSED CLEANUP LEVELS FOR GROUNDWATER [1, 2]

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

	MTCA Method A	MTCA Method B		Maximum Contaminant Level	EPA RSL, Tap Water	Proposed Cleanup Level
		Carcinogen	Non-Carcinogen			
Polycyclic Aromatic Hydrocarbons (continued)						
Naphthalene	160	--	160	--	0.14	**160**
Phenanthrene	--	--	--	--	--	**--**
Pyrene	--	--	480	--	87	**480**
Volatile Organic Compounds						
m,p-xylenes	1,000	--	1,600	10,000	190	**10,000**
o-xylene	--	--	16,000	10,000	190	**10,000**
Trichlorofluoromethane	--	--	2,400	--	1,100	**2,400**
Dioxins/Furans						
Dioxins/Furans as 2,3,7,8-TCDD TEQ	--	-- [4]	--	3.00E-05	5.20E-07	**3.00E-05**

Notes

1. Includes all constituents detected at least once based on Table 8-5 of the Site Investigation Report (Baxter, 2005a).
2. -- = No cleanup level available.
3. Value is calculated using TEF as total cPAHs and compared to the value for benzo(a)pyrene according to WAC 173-340-708(8)(e).
4. Value is calculated using TEF as total dioxins/furans and compared to the value for 2,3,7,8-TCDD according to WAC 173-340.

Abbreviations

2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
EPA = U.S. Environmental Protection Agency
MTCA = Model Toxics Control Act
RSL = Regional Screening Level (2012)
TEF = toxicity equivalent factor
TEQ = toxicity equivalent
WAC = Washington Administrative Code

TABLE 4-1

GROUNDWATER DETECTIONS ABOVE PROPOSED CLEANUP LEVELS [1,2]

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

Constituent	Proposed Cleanup Level	Highest Detected Concentration			
		Parcel A and Affected Groundwater		Parcel B	
Metals					
Arsenic	10	**BXS-3**	**21.9**	BXS-4	5.4
Barium	2,000	BXS-3	71.2	BXS-4	32
Cadmium	5	ND		ND	
Calcium	--	BXS-3	112,000	BXS-4	20300
Chromium	100	--		--	
Copper	1,300	BXS-2	5.2	ND	
Iron	11,000	**BXS-3**	**21,900**	MW-14	2050
Lead	15	--		--	
Magnesium	--	BXS-2	71,200	BXS-4	8490
Manganese	2,240	**BXS-3**	**17,900**	BXS-4	127
Nickel	320	BXS-2	41	ND	
Potassium	--	BXS-2	12,300	BXS-4	3000
Selenium	50	--		--	
Sodium	--	MW-10	62,100	BXS-4	7270
Zinc	4,800	BXS-3	20	ND	
TPH					
Diesel Range Organics	500	**MW-13**	**3,700**	BXS-4	87
Residual Range Organics	500	MW-13	66	ND	
Phenols					
2,4,6-Trichlorophenol	4	ND		ND	
2,3,4,5-Tetrachlorophenol	--	ND		--	
2,3,5,6-Tetrachlorophenol	480	MW-3	110	--	
Pentachlorophenol	1	**MW-13**	**19,000**	BXS-4	0.62
PAHs					
2-Methylnaphthalene	32	MW-3	1.3	MW-14	0.02
Acenaphthene	960	MW-13	9.6	ND	
Acenaphthylene	--	MW-13	0.5	ND	
Anthracene	4,800	MW-13	1.2	MW-14	0.0018
Benzo(a)anthracene	--	**MW-13**	**0.1**	MW-14	0.0082
Benzo(a)pyrene	0.2	MW-15	0.025	MW-14	0.0031
Benzo(b)fluoranthene	--	**MW-15**	**0.056**	MW-14	0.0042
Benzo(g,h,i)perylene	--	MW-3	0.017	MW-14	0.0072
Benzo(k)fluoranthene	--	**MW-13**	**0.018**	MW-14	0.0033
Chrysene	--	**MW-13**	**0.1**	MW-14	0.0057
Dibenz(a,h)anthracene	--	**MW-3**	**0.015**	MW-14	0.0058
Fluoranthene	640	MW-13	0.77	MW-14	0.0031

TABLE 4-1

GROUNDWATER DETECTIONS ABOVE PROPOSED CLEANUP LEVELS [1,2]

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

Constituent	Proposed Cleanup Level	Highest Detected Concentration			
		Parcel A and Affected Groundwater		Parcel B	
PAHs (continued)					
Fluorene	640	MW-13	8.7	MW-14	0.0044
Indeno(1,2,3-cd)pyrene	--	MW-3	0.012	MW-14	0.0057
Naphthalene	160	MW-3	5.4	MW-14	0.0037
Phenanthrene	--	MW-3	0.035	ND	
Pyrene	480	MW-13	0.61	MW-14	0.0036
VOCs					
m,p-xylenes	10,000	--		--	
o-xylene	10,000	--		--	
Trichlorofluoromethane	2,400	--		--	
Dioxins/Furans					
Dioxins/Furans as 2,3,7,8-TCDD TEQ	3.00E-05	MW-1	2.40E-05	ND	

Notes

1. Table is based on data collected since 2001.
2. -- = No data available.
   ND = Not detected.
   Bold = Concentration is greater than proposed cleanup level.

Abbreviations

PAHs = polycyclic aromatic hydrocarbons
TEQ = toxicity equivalent
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds

TABLE 3-2

PROPOSED CLEANUP LEVELS FOR SOIL [1, 2, 3]

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

concentrations shown in milligrams per kilogram (mg/kg)

Constituent	MTCA Method A		MTCA C		2012 EPA RSLs				Parcel A Proposed Cleanup Level	Parcel B Proposed Cleanup Level
	Industrial	Unrestricted	Direct Contact	Protection of Groundwater	Industrial	Residential	Risk-Based SSL	MCL-Based SSL		
1,2,4-Trimethylbenzene	--	--	175,000	23.48	260	62	0.021	--	**23.48**	**175,000**
1,3,5-Trimethylbenzene	--	--	35,000	7.147	10,000	780	0.12	--	**7.147**	**35,000**
2,4,5-Trichlorophenol	--	--	350,000	28.8	62,000	6,100	3.3	--	**28.8**	**350,000**
2,4,6-Trichlorophenol	--	--	11,931	0.0464	160	44	0.013	--	**0.0464**	**11,931**
2-Methylnaphthalene	--	--	14,000	5.569	2,200	230	0.14	--	**5.569**	**14,000**
3,4-Dichlorophenol*	--	--	10,500	0.168	1,800	180	0.041	--	**0.168**	**10,500**
Acenaphthene	--	--	210,000	97.93	33,000	3,400	4.1	--	**97.93**	**210,000**
Acenaphthylene	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	1,050,000	2,227	170,000	17,000	42	--	**2,227**	**1,050,000**
Benz(a)anthracene	--	--	--[1]	0.2089	2.1	0.15	0.01	--	**0.2089**	**2.1**
Benzene	0.03	0.03	2,386	0.02819	5.4	1.1	0.0002	0.0026	**0.02819**	**2,386**
Benzo(a)pyrene	2	0.1	18	3.881	0.21	0.015	0.0035	0.24	**3.881**	**18**
Benzo(b)fluoranthene	--	--	--[1]	0.6961	2.1	0.15	0.035	--	**0.6961**	**2.1**
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--[1]	6.961	21	1.5	0.35	--	**6.961**	**21**
Chrysene	--	--	--[1]	23.21	210	15	1.1	--	**23.21**	**210**
Dibenz(a,h)anthracene	--	--	--[1]	0.1044	0.21	0.015	0.011	--	**0.1044**	**0.21**
Dibenzofuran	--	--	3,500	11.66	--	--	--	--	**11.66**	**3,500**
Fluoranthene	--	--	140,000	629	22,000	2,300	70	--	**629**	**140,000**
Fluorene	--	--	140,000	101.1	22,000	2,300	4	--	**101.1**	**140,000**
Indeno(1,2,3-cd)pyrene	--	--	--[1]	2.03	2.1	0.15	0.2	--	**2.03**	**2.1**
Naphthalene	5	5	70,000	4.486	18	3.6	0.00047	--	**4.486**	**70,000**
Pentachlorophenol	--	--	328	0.0158	2.7	0.89	0.00036	0.01	**0.0158**	**328**
Phenanthrene	--	--	--	--	--	--	--	--	--	--
Pyrene	--	--	105,000	654.7	17,000	1,700	9.5	--	**654.7**	**105,000**
Diesel (DRO)	2,000	2,000	--	--	--	--	--	--	**2,000**	**2,000**
Residual Oil (RRO)	2,000	2,000	--	--	--	--	--	--	**2,000**	**2,000**
Dioxins/Furans (2,3,7,8-TCDD TEQ)	--	--	1.46E-03	2.39E-03	1.80E-05	4.50E-06	2.60E-07	1.50E-05	**1.46E-03**	**1.46E-03**

Notes

1. Since groundwater cleanup levels for cPAHs are calculated as a total toxic equivalent, the individual cPAH RSLs were used in the protection of groundwater calculations where an individual MTCA cleanupvalue was not available.
2. -- = No cleanup level available.
3. * = cleanup level for 2,4-dichlorophenol was used.

Abbreviations

cPAH = carcinogenic polycyclic aromatic hydrocarbons
EPA = U.S. Environmental Protection Agency
MCL = maximum containment level
MTCA = Model Toxics Control Act
RSL = Regional Screening Level (2012)
SSL = soil screening level
TEQ = toxicity equivalent

TABLE 4-2

SOIL DETECTIONS ABOVE PROPOSED CLEANUP LEVELS [1,2]

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

concentrations shown in milligrams per kilogram (mg/kg)

Constituent	Parcel A					Parcel B				
	Proposed Cleanup Level	Highest Surface Soil Concentration		Highest Subsurface Soil Concentration[3]		Proposed Cleanup Level	Highest Surface Soil Concentration		Highest Subsurface Soil Concentration[3]	
1,2,4-Trimethylbenzene	23.48	--		--		175,000	--		--	
1,3,5-Trimethylbenzene	7.147	--		--		175,000	--		--	
2,4,5-Trichlorophenol	28.8	ND		ND		350,000	ND		ND	
2,4,6-Trichlorophenol	0.464	ND		ND		11,931	ND		ND	
2-Methylnaphthalene	5.569	SS25	0.0049	**SB-39 (10-12)**	**170**	14,000	SS18A	0.00056	SB-59 (4-6)	0.0003
3,4-Dichlorophenol[4]	0.168		ND	SB-36 (14-16)	0.0047	10,500	ND		ND	
Acenaphthene	97.93	SS24	0.00038	**SB-39 (10-12)**	**210**	210,000	ND		ND	
Acenaphthylene	--	SS02	0.00066	SB-39 (10-12)	2.9	--	SS18A	0.014	ND	
Anthracene	2,227	SS24	0.003	SB-39 (10-12)	95	1,050,000	SS18A	0.026	ND	
Benz(a)anthracene	0.2089	SS14	0.0083	**SB-39 (10-12)**	**29**	2	SS18A	0.065	SB-59 (4-6)	0.00022
Benzene	0.02819	--		--		2,386	--		--	
Benzo(a)pyrene	3.881	SS14	0.017	**SB-39 (10-12)**	**14**	18	SS18A	0.13	SB-59 (4-6)	0.00026
Benzo(b)fluoranthene	0.6961	SS24	0.021	**SB-39 (10-12)**	**12**	2.1	SS18A	0.24	SB-59 (4-6)	0.0013
Benzo(g,h,i)perylene	--	SS24	0.025	SB-39 (10-12)	3.9	--	SS18A	0.11	SB-59 (4-6)	0.00076
Benzo(k)fluoranthene	6.961	SS14	0.013	**SB-39 (10-12)**	**14**	21	SS18A	0.17	SB-59 (4-6)	0.00055
Chrysene	23.21	SS14	0.049	**SB-39 (10-12)**	**29**	210	SS18A	0.12	SB-59 (4-6)	0.00064
Dibenz(a,h)anthracene	0.1044	SS05	0.005	**SB-39 (10-12)**	**1.2**	0.21	SS18A	0.022	ND	
Dibenzofuran	11.66	--		--		3,500	--		--	
Fluoranthene	629	SS14	0.018	SB-39 (10-12)	180	140,000	SS18A	0.0092	ND	
Fluorene	101.1	SS25	0.0011	**SB-39 (10-12)**	**190**	140,000	ND		ND	
Indeno(1,2,3-cd)pyrene	2.03	SS24	0.021	**SB-39 (10-12)**	**5.8**	2.1	SS18A	0.12	SB-59 (4-6)	0.00083
Naphthalene	4.486	SS02	0.0072	**MW-13 (32-34)**	**35**	70,000	SS18A	0.00043	ND	
Pentachlorophenol	0.0158	**SS05**	**4.7**	**SB-39 (10-12)**	**1,300**	328	SS16	0.41	SB-52 (4-6)	0.14
Phenanthrene	--	SS25	0.0085	SB-39 (10-12)	450	--	SS18A	0.0018	ND	
Pyrene	654.7	SS14	0.03	SB-39 (10-12)	130	105,000	SS18A	0.015	SB-59 (4-6)	0.00053
Diesel (DRO)	2,000	**SS10**	**2,100**	**MW-13 (32-34)**	**45,000**	2,000	SS18A	140	MW-14 (4-6)	15
Residual Oil (RRO)	2,000	SS10	1,500	**MW-13 (32-34)**	**3,100**	2,000	SS20	1,200	**SB-57 (4-6)**	**5,300**
Dioxins/Furans (2,3,7,8-TCDD TEQ)	2.388E-03	**SS11**	6.450E-04	--		1.460E-03	SS21	1.14E-04	--	

Notes

1. Soil results from Tables 8-1 and 8-2 in the Site Investigation Report (Baxter, 2005a).
2. **Bold** = Concentration is greater than proposed cleanup level.
   ND = not detected.
   -- = No sample analyzed or no cleanup level established.
3. Sample depth in feet is shown in parentheses.
4. Cleanup level for 2,4-dichlorophenol was used.

TABLE 9-1

CORRECTIVE MEASURES ALTERNATIVES

Former J.H. Baxter Co. Wood Treating Facility
Arlington, Washington

Alternative 1	Total Fluids Recovery, Air Sparging, and MNA
Alternative 2	Physical/Hydraulic Containment and MNA
Alternative 3	Excavation, Off-Site Disposal, and MNA
Alternative 4	Enhanced Biodegradation Recirculation System
Alternative 5	ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation
Alternative 6	Chemical Oxidation and Enhanced Biodegradation Recirculation

TABLE 10-1

CORRECTIVE MEASURES SCREENING CRITERIA

Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Screening Criteria	Definition
Technical Criteria	
Performance	
Effectiveness	Capability for the alternative to perform the intended functions, such as containment or constituent destruction. This criterion must be evaluated through design specification or performance evaluation. Site-specific characteristics that affect the effectiveness of the alternative must be considered.
Useful Life	The length of time that the alternative can achieve its effectiveness. Specific components of an alternative may require replacement at the end of its useful life in order to continue to achieve the desired objective. The availability of resources in the future as well as the appropriateness of the technology must be considered to assess the useful life.
Toxicity, Mobility, and Volume Reduction	Capability of the alternative to remove the constituents from interaction with the environment through treatment. The reductions can be achieved by treatment to destroy COCs, treatment to immobilize the COCs, or treatment to reduce the volume of affected media.
Reliablility	
Long-Term Operation & Maintenance Requirements	The frequency and complexity of operations and maintenance procedures and availability of qualified labor. Alternatives requiring frequent or complex procedures would be less reliable than those requiring less frequent or simpler procedures.
Demonstrated and Expected Reliability	Assessment of the risk and potential effects due to failure of the alternative. Factors to assess include success of the technology in previous similar applications, demonstrated compatibility of multiple technologies, effects of failure of one component on other components, and the flexibility of the alternative to deal with uncontrollable changes.
Implementability	
Constructability	Relative ease of implementation for the alternative, considering factors specific to the site and external factors. Site factors could include heterogeneity, utilities or buildings, adjacent properties, natural conditions, etc. External factors could include availability of qualified contractors, permitting requirements, etc.
Implementation Time	Time needed to implement the alternative. Alternatives that can be implemented in a short time would be preferred over those that require longer implementation times.
Beneficial Results Time Frame	Time required to achieve the full effectiveness than others. Alternatives that achieve beneficial results in a shorter time would be preferred over alternatives requiring more time.
Safety	
Risk of Fire, Explosion, or Exposure to Hazardous Substances	Risks posed to workers implementing the corrective measure as well as to nearby businesses and communities. Factors to be assessed for safety include fire, explosion, traffic accidents, potential for exposure to site constituents, and injuries associated with implementation.

TABLE 10-1

CORRECTIVE MEASURES SCREENING CRITERIA

Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Screening Criteria	Definition
Human Health Criteria	
Minimization of Short- and Long-Term Exposure	The extent to which the alternative mitigates both short-term and long-term exposure to site constituents, including protection of workers and the public during implementation of the alternative. Potential exposure routes, the nature and location of site constituents, and the locations of potentially exposed populations are assessed.
Environmental Criteria	
Short- and Long-Term Beneficial Versus Adverse Effects	The short- and long-term beneficial and adverse effects associated with the alternative owing to site conditions and pathways, including measures taken to mitigate these effects. In addition, the beneficial or adverse effects on environmentally sensitive areas that could be affected by the corrective measure alternative are considered.
Institutional Criteria	
Relative Ease of Addressing Institutional Issues	Compliance with applicable federal, state, and local environmental, safety, or public health standards, guidance, or regulations on the design, operation, or implementation time for the alternative. Community issues that may affect the design, operation, or implementation time of the alternative. For the Arlington facility, which is an active production facility, institutional issues that must be addressed include compatibility with ongoing facility operations and with existing facilities.
Cost	
Relative Cost	The estimated costs for construction and for operation and maintenance of the alternative, including associated monitoring and inspection costs. Total costs in current dollars will be estimated for a project life up to 100 years. All net present value costs based on 2 percent discount factor.

Abbreviations

COCs = constituents of concern

TABLE 10-2

CORRECTIVE MEASURES COMPARATIVE EVALUATION: BALANCING CRITERIA [1]

Former J.H. Baxter Co. Wood Treating Facility
Arlington, Washington

Alternative	Technical									Human Health		Environmental	Institutional	Cost	Total Score	Ranking
	Performance			Reliability		Implementability			Safety							
	Effectiveness	Useful Life	Toxicity, Mobility, and Volume Reduction	Long-term Operation and Maintenance	Demonstrated and Expected Reliability	Constructability	Implementation Time	Beneficial Results Time Frame	Risk of Fire, Explosion, or Exposure to Hazardous Substances	Minimization of Short-Term Exposure	Minimization of Long-Term Exposure	Short- and Long-Term Beneficial vs. Adverse Effects	Relative Ease of Addressing Institutional Issues	Relative Cost		
1 Total Fluids Recovery, Air Sparging, and MNA	3	1	3	1	1	2	2	3	2	3	3	3	2	2	**31**	**5**
2 Physical/Hydraulic Containment and MNA	3	2	3	2	2	1	2	3	2	2	3	3	1	2	**31**	**5**
3 Excavation, Off-Site Disposal, and MNA	4	4	4	4	4	1	1	4	1	1	4	3	1	1	**37**	**4**
4 Enhanced Biodegradation Recirculation System	3	3	3	3	3	4	4	2	4	3	3	3	4	3	**45**	**2**
5 ERH, Total Fluids Recovery, and Enhanced Biodegradation	4	3	4	4	3	2	4	4	2	2	4	4	2	2	**44**	**3**
6 Chemical Oxidation and Enhanced Biodegradation	4	3	4	4	3	3	4	4	3	3	4	3	3	3	**48**	**1**

Notes

1. Alternatives are rated for relative effectiveness as High (4), Moderately High (3), Moderately Low (2), or Low (1). Higher scores indicate better performance or effectiveness. Higher scores also indicate lower overall costs. Total score is based on equal weighting for each criterion.

TA[illegible] 10-3

ESTIMATED COSTS FOR CORRECTIVE MEASURES ALTERNATIVES

Former J.H. Baxter Co. Wood Treating Facility
Arlington, Washington

Alternative	Initial Cost[1]	Total Cost[2]	Net Present Value[3]
1 Total Fluids Recovery, Air Sparging, and MNA	$606,400	$8,492,000	$4,309,600
2 Physical/Hydraulic Containment and MNA	$1,526,100	$8,285,000	$4,847,800
3 Excavation, Off-site Disposal, and MNA	$32,541,600	$41,010,000	$40,179,300
4 Enhanced Biodegradation Recirculation System	$102,000	$5,487,000	$2,684,700
5 Electric Resistance Heating, Recirculation, and MNA	$2,924,600	$4,475,000	$4,287,500
6 Chemical Oxidation, Recirculation, and MNA	$1,488,840	$2,635,000	$2,484,700

Notes

1. First year costs for implementation (assumed to be 2014) in 2012 dollars.
2. Total cost for project in 2012 dollars.
3. Net present value based on a 2% discount factor.
4. Initial costs for Alternative 4 do not include costs already incurred by Baxter of approximately $967,000 (installation and operations and maintenance).

TABLE 11-1

CORRECTIVE MEASURES COMPARATIVE EVALUATION: THRESHOLD CRITERIA [1]

Former J.H. Baxter Co. Wood Treating Facility
Arlington, Washington

Alternative	Protect Human Health and the Environment	Attain Cleanup Standards	Control Future Hazardous Constituent Releases	Comply with Waste Management Standards	Total Score	Ranking
1 Total Fluids Recovery, Air Sparging, and MNA	2	3	2	2	9	5
2 Physical/Hydraulic Containment and MNA	2	2	2	2	8	6
3 Excavation, Off-Site Disposal, and MNA	4	4	4	2	14	1
4 Enhanced Biodegradation Recirculation System	2	2	2	4	10	4
5 ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation	3	3	3	3	12	3
6 Chemical Oxidation and Enhanced Biodegradation Recirculation	3	3	3	4	13	2

Notes

1. Alternatives are rated for relative effectiveness as high (4), moderately high (3), moderately low (2), or low (1). Higher scores indicate better performance or effectiveness. Total score is based on equal weighting for each criterion.

TABLE 11-2

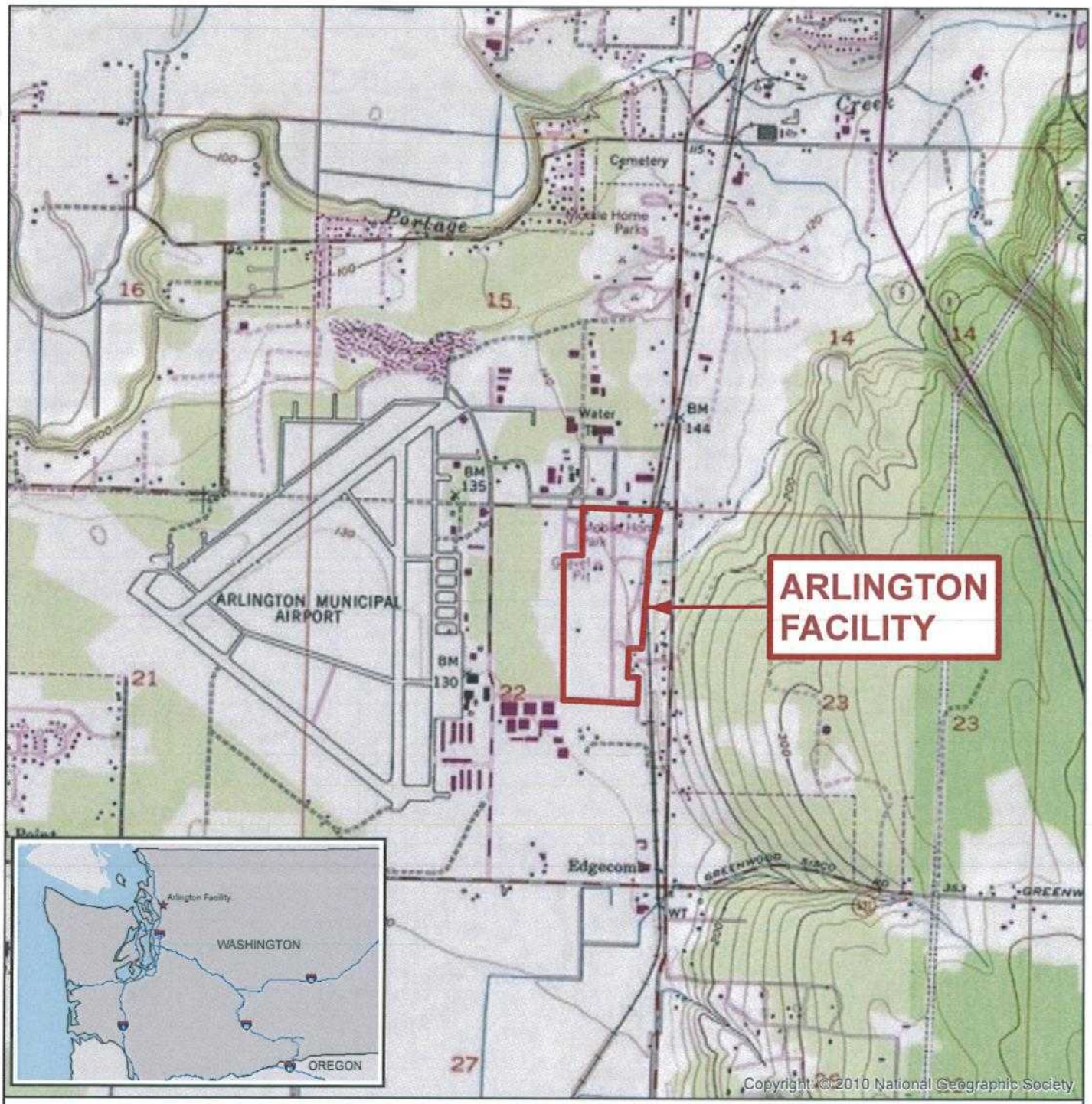
RANKING OF CORRECTIVE MEASURES ALTERNATIVES [1]

Former J.H. Baxter Co. Wood Treating Facility
Arlington, Washington

Alternative	Threshold Criteria Ranking	Balancing Criteria Ranking	Combined Score	Combined Ranking
1 Total Fluids Recovery, Air Sparging, and MNA	5	5	10	5
2 Physical/Hydraulic Containment and MNA	6	5	11	5
3 Excavation, Off-Site Disposal, and MNA	1	4	5	4
4 Enhanced Biodegradation Recirculation System	4	2	6	2
5 ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation	3	3	6	2
6 Chemical Oxidation and Enhanced Biodegradation Recirculation	2	1	3	1

1. The ranking in this table is based on 1 being the highest and 6 the lowest.
The combined score is the sum of the rankings for individual criteria, and is the basis for combined ranking.
The lowest total score for the combined ranking represents the best overall performance.

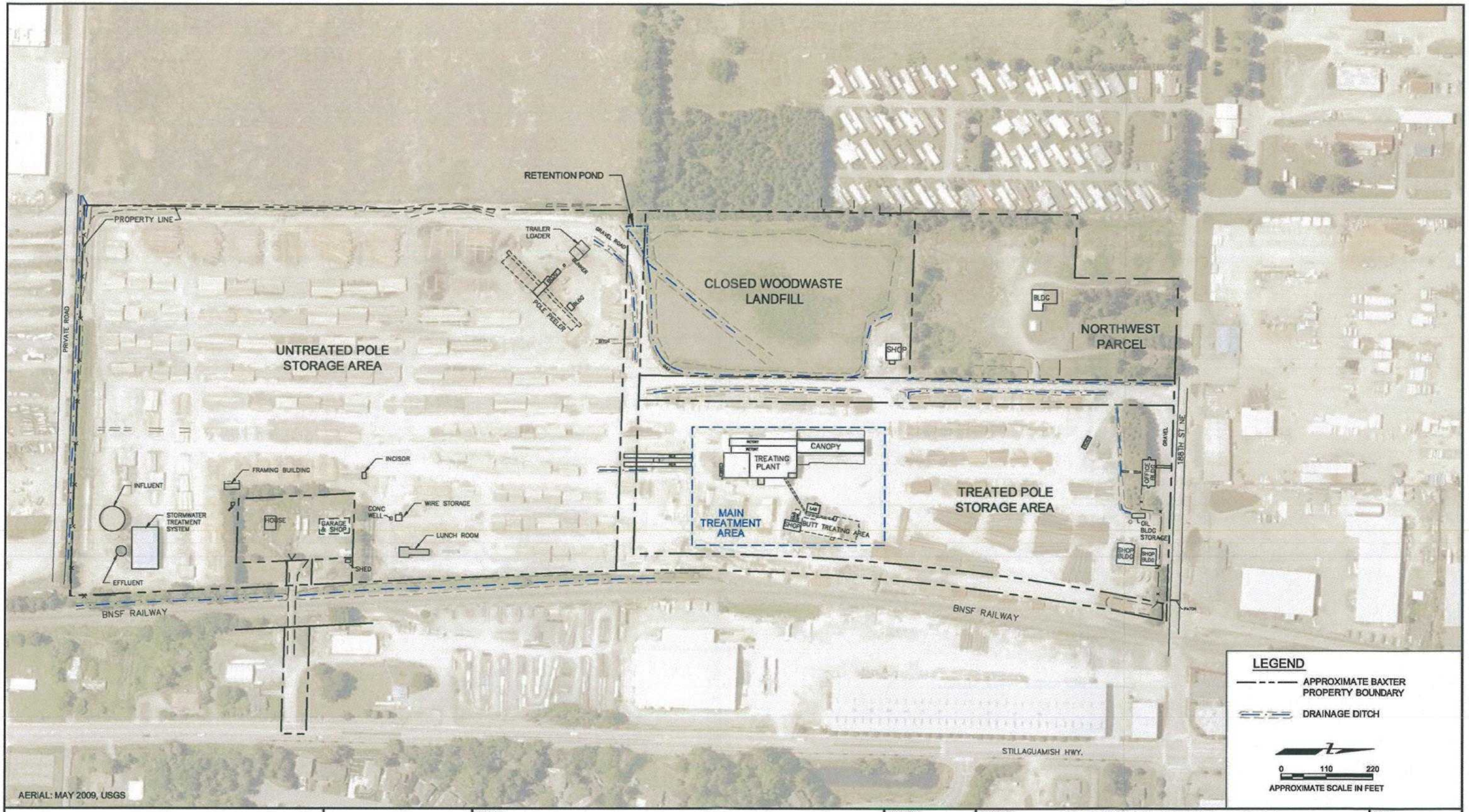
FIGURES



0 1,000 2,000 4,000 Feet

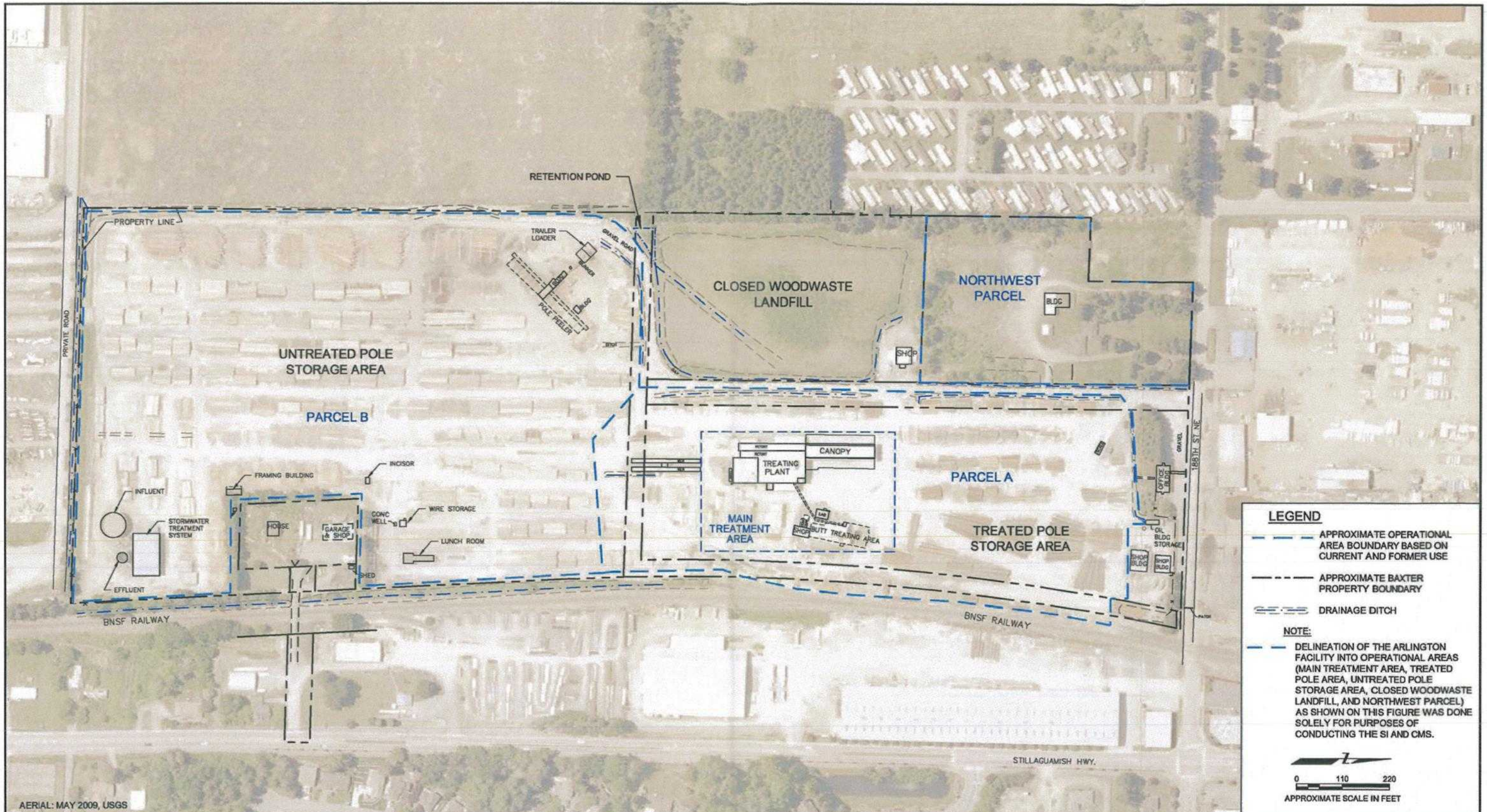
AMEC 7376 SW Durham Road Portland, OR, U.S.A. 97224	amec	J.H. Baxter	CLIENT: J.H. BAXTER
TITLE: SITE VICINITY MAP	DWN BY: PM	DATUM: NAD83	DATE: MARCH 2013
PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	CHK'D BY: SB	REV. NO.: 1	PROJECT NO.: 161M125611.0001.3
	PROJECTION: WA SP N. Ft	SCALE: 1 inch = 2,000 feet	FIGURE No.: 1-1

K:\12000\12500\12561\125611\CMS Revision 3\Figures\Figures for Patrick to Update into new frames\Figure 1-1 - Site Vicinity Map.mxd - patrick.mccarthy - 3/19/2013 - 8:40:46 AM



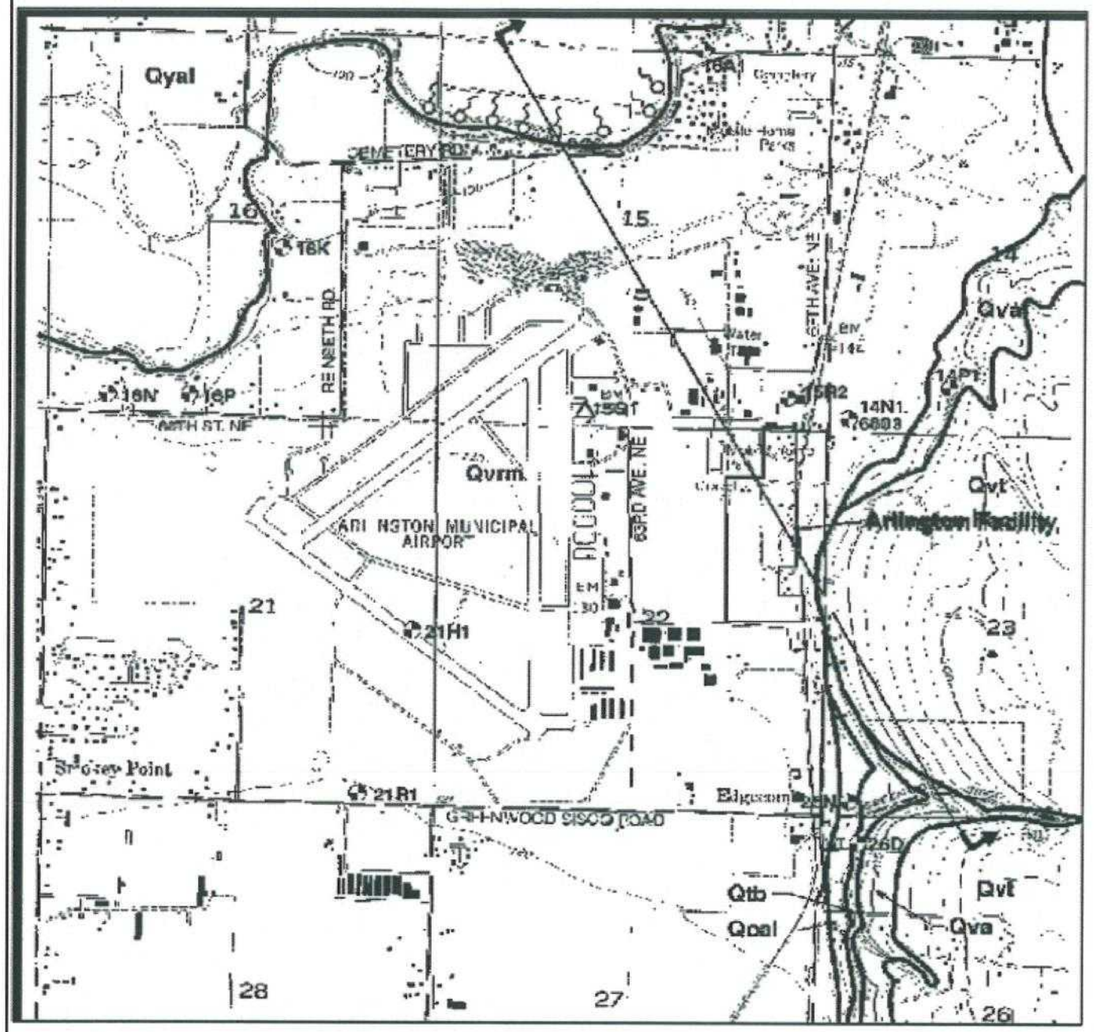
JH Baxter	CLIENT: J.H. BAXTER	DWN BY: APS CHK'D BY: SB DATUM: - PROJECTION: - SCALE: AS SHOWN	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013 PROJECT NO: 3-61M-125611
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	amec	TITLE: SITE PLAN	REV. NO.: FIGURE No. 2-1

S:\125611\018_ChemicalOxidationTreatmentAreas\CAD\JH Baxter_Alternatives_032112.dwg – Figure 2-1 SitePlan – Mar. 27, 2013 3:01pm – adam.stenberg



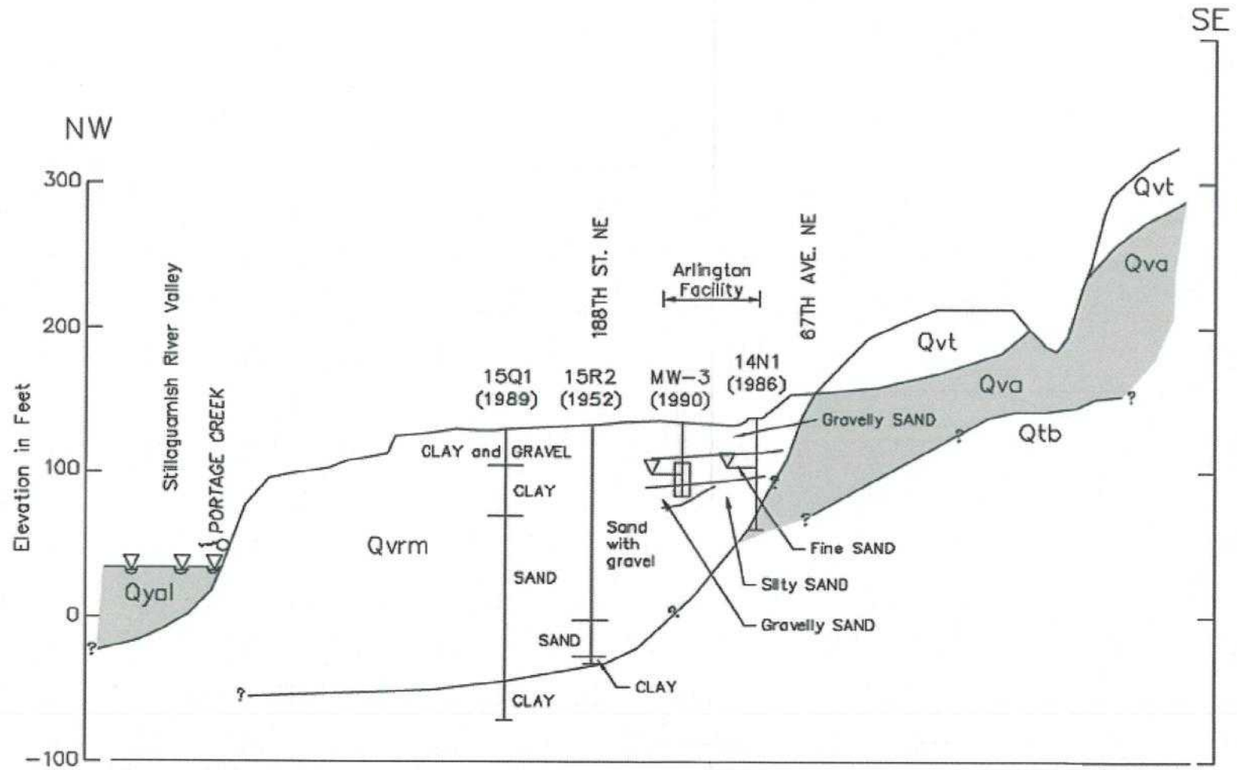
JH Baxter	CLIENT: J.H. BAXTER	DWN BY: APS CHK'D BY: SB DATUM: - PROJECTION: - SCALE: AS SHOWN	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013 PROJECT NO: 3-61M-125611
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	amec	TITLE: AREAS OF INVESTIGATION	REV. NO.: FIGURE No. 2-2

S:\125611\018_ChemicalOxidationTreatmentAreas\CAD\JH Baxter_Alternatives_032112.dwg – Figure 2-2 AOI – Mar. 27, 2013 3:03pm – adam.stenberg



16A1 Well Log Available from Dept. of Ecology or Newcomb (1952)

△ 15Q1 Ecology Log for Anode Well



Note: Contacts between soil units are based upon interpolation between borings.

Horizontal Scale in Feet
0 2000 4000

0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

15R2 (1952) Exploration Number (Date of Log or Data Source)

Exploration Location

Water Level

Screened Interval (When available)

Seep

Geologic Units from Minard (1985)

Qyal	Younger Alluvium
Qvrm	Recessional Outwash – Marysville Member
Qvt	Till
Qva	Advance Outwash
Qtb	Transitional Beds Silt

CLIENT: J.H. BAXTER	DWN BY: PM	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
	CHK'D BY: SB		PROJECT NO: 361M 125611.0001.3
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	DATUM: -	TITLE: REGIONAL GEOLOGIC MAP AND CROSS SECTION	REV. NO.: A
	PROJECTION: -		FIGURE No. 2-3
	SCALE: AS SHOWN		

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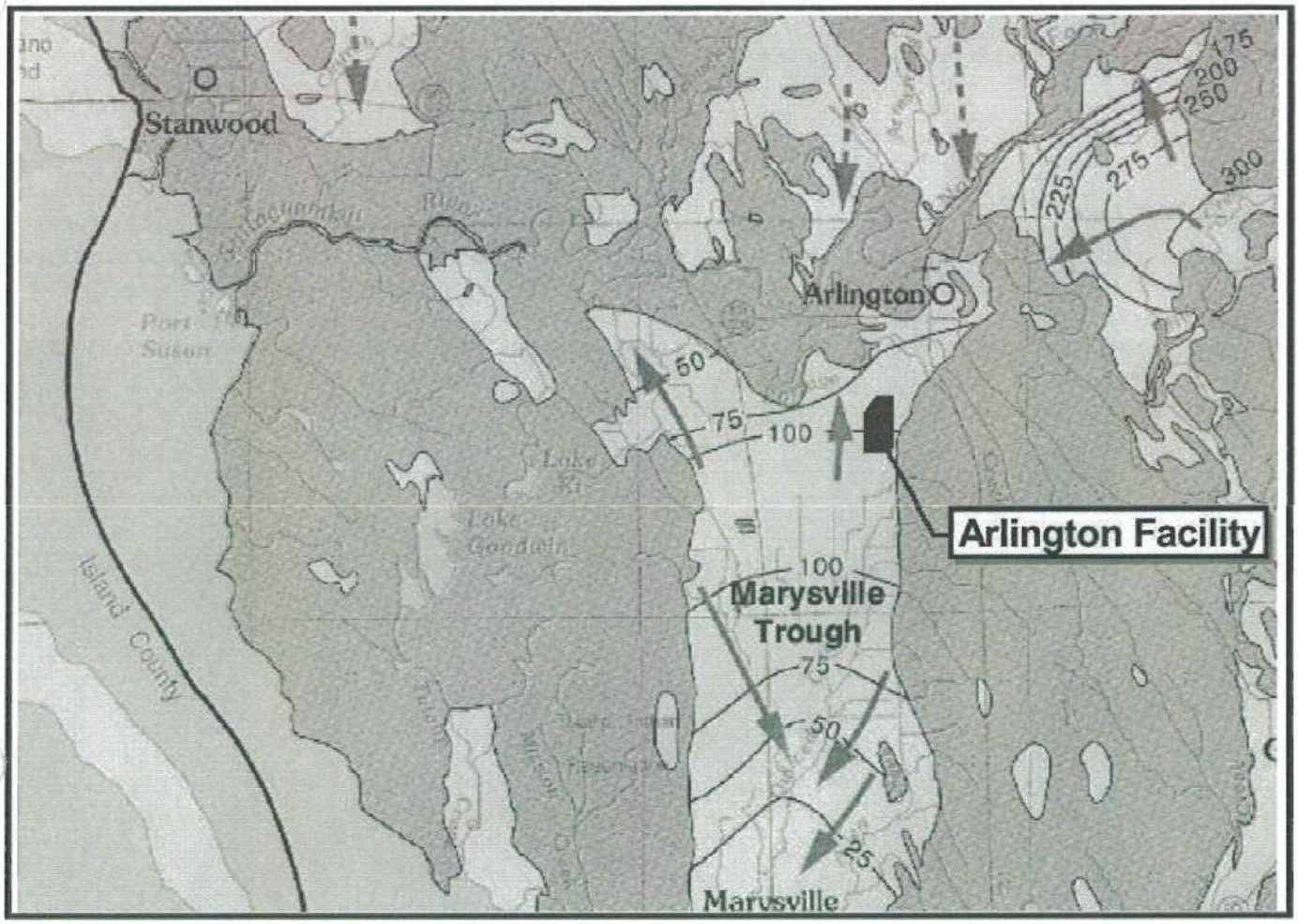

Note:
Map created by base map by B.E. Thomas, J.M. Wilkinson, and S.S. Embrey, entitled "Plate 6. Areal Recharge From Precipitation and Potentiometric Surfaces of Prinicpal Aquifers, Western Snohomish County, Washington," dated 1997

0 4 8 Miles

LEGEND

50 Groundwater Elevation
Groundwater Elevation Contour
Inferred Groundwater Flow Direction

AMEC 7376 S.W. Durham Road Portland OR. U.S.A. 97224	amec		CLIENT J.H. BAXTER	
TITLE: REGIONAL GROUNDWATER FLOW DIRECTION		DWN BY: PM	DATUM: -	DATE: MARCH 2013
PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATMENT FACILITY ARLINGTON, WA		CHK'D BY: SB	REV. NO.: A	PROJECT NO: 361M 125611.0001.3
		PROJECTION: -	SCALE: -	FIGURE No. 2-4

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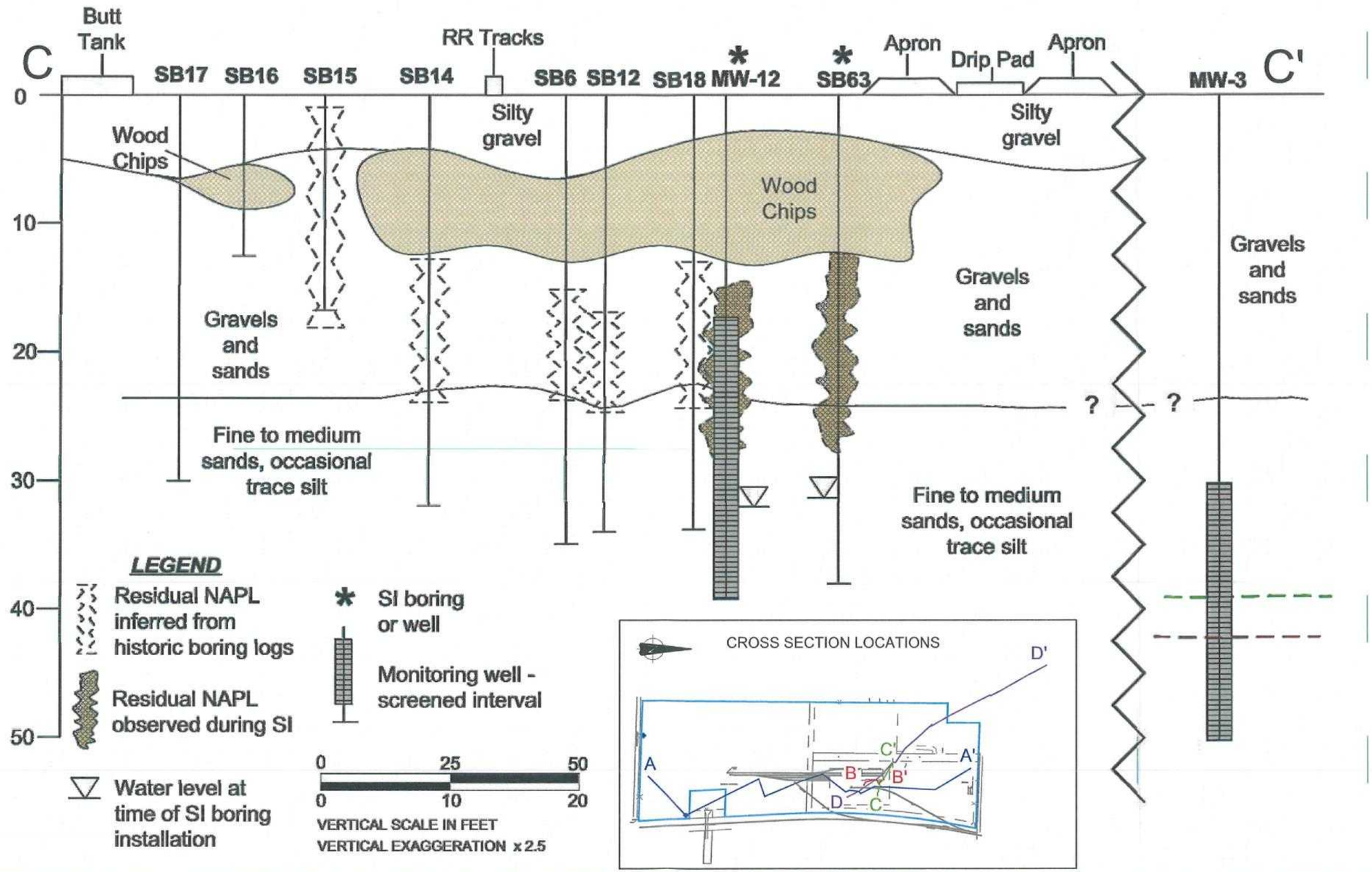

JH Baxter	CLIENT: J.H. BAXTER	DWN BY: PM	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
		CHK'D BY: SB		PROJECT NO: 361M 125611.0001.3
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	DATUM: -	TITLE: CROSS SECTION C-C'	REV. NO.: A
	amec	PROJECTION: -		FIGURE No. 2-7
		SCALE: AS SHOWN		

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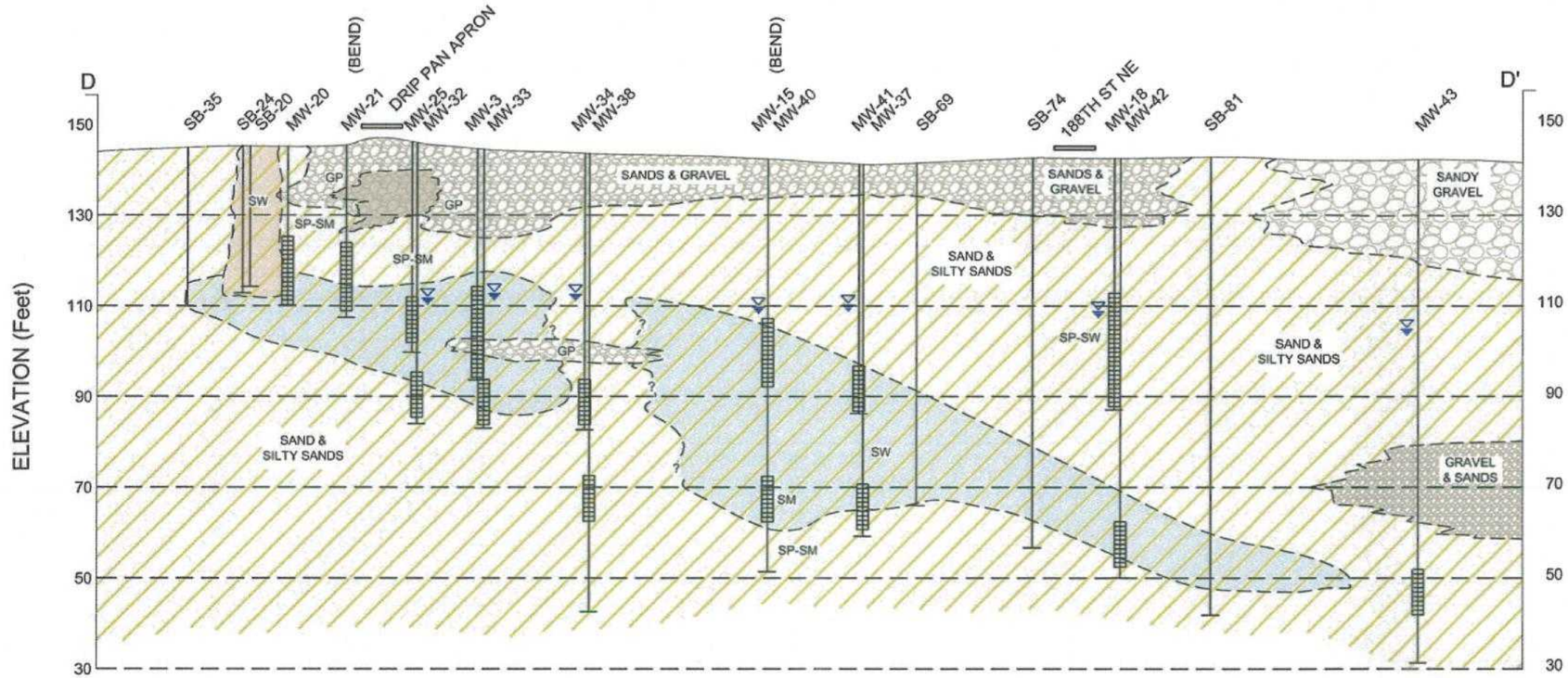


VERTICAL SCALE: 1" = 30'

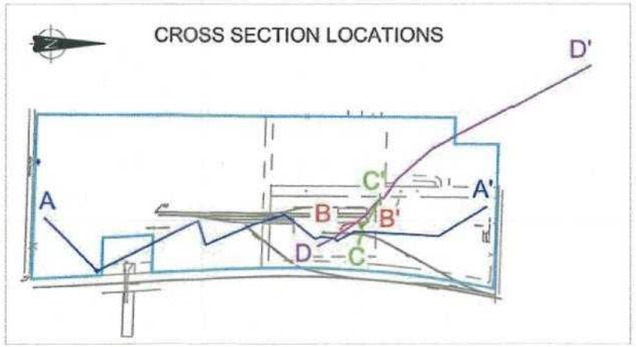
0' 15' 30' 45'
1" = 30'

HORIZONTAL SCALE: 1" = 225'
EXAGGERATION 7.5x

0' 112.5' 225' 337.5'
1" = 225'

LEGEND

- SOIL BORING AND IDENTIFIER
- MONITORING WELL CLUSTER, IDENTIFIER, AND SCREEN INTERVAL
- INFERRED LITHOLOGIC CONTACT
- APPROXIMATE WATER LEVEL ON AUGUST 19, 2012
- RESIDUAL LNAPL
- WOOD DEBRIS
- AREA OF PCP IN GROUNDWATER



J.H. Baxter	CLIENT: J.H. BAXTER	DWN BY: PM CHK'D BY: SB DATUM: - PROJECTION: - SCALE: AS SHOWN	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013 PROJECT NO. 361M0125611.0001.3
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224 amec		TITLE: CROSS SECTION D-D'	REV. NO.: A FIGURE No. 2-8

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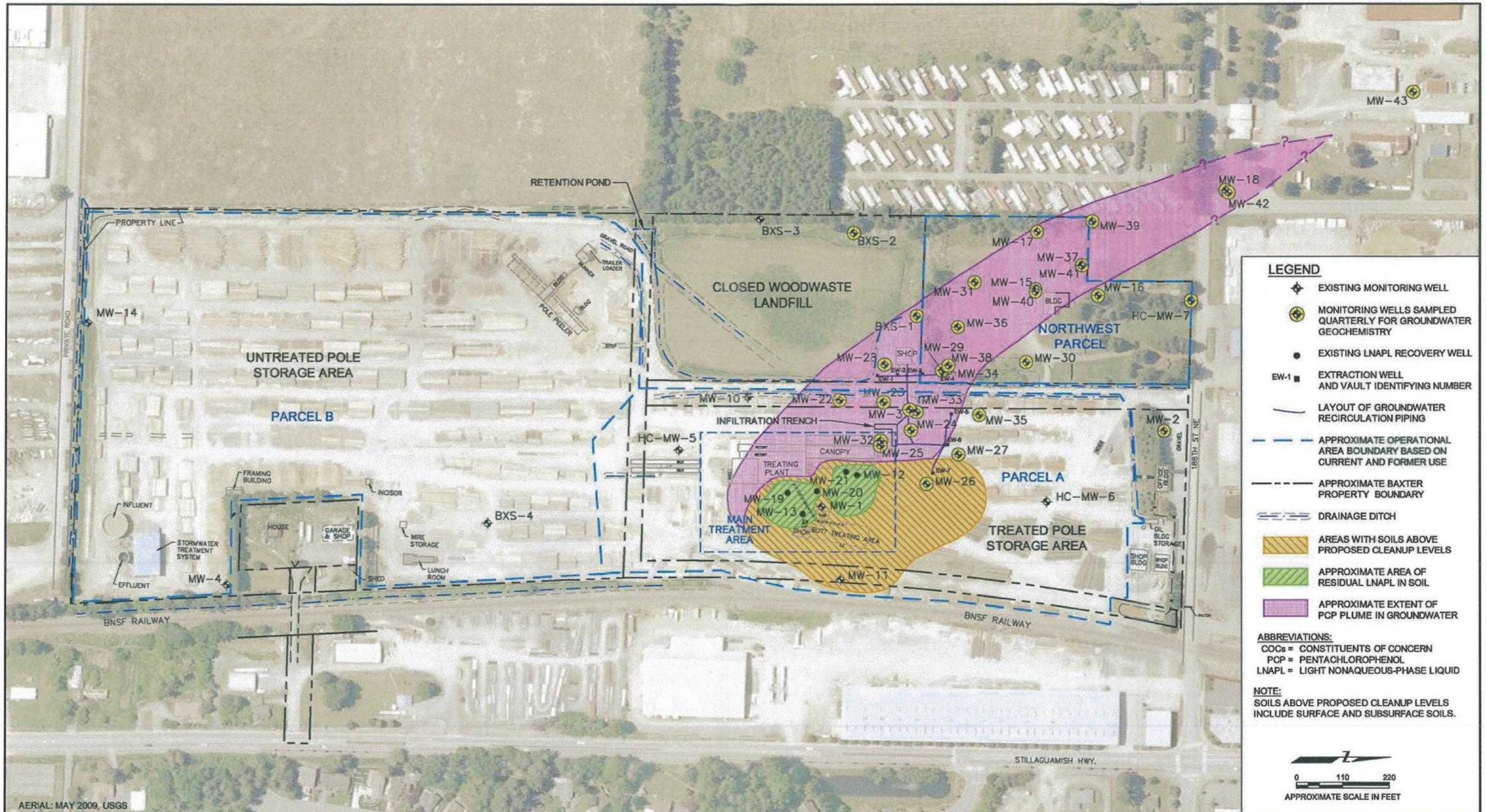

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	CHK'D BY: SB		PROJECT NO: 3-61M-125611
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	DATUM: -	TITLE: AREAS OF CONCERN	REV. NO.: A
	PROJECTION: -		FIGURE No. 4-1
	SCALE: AS SHOWN		

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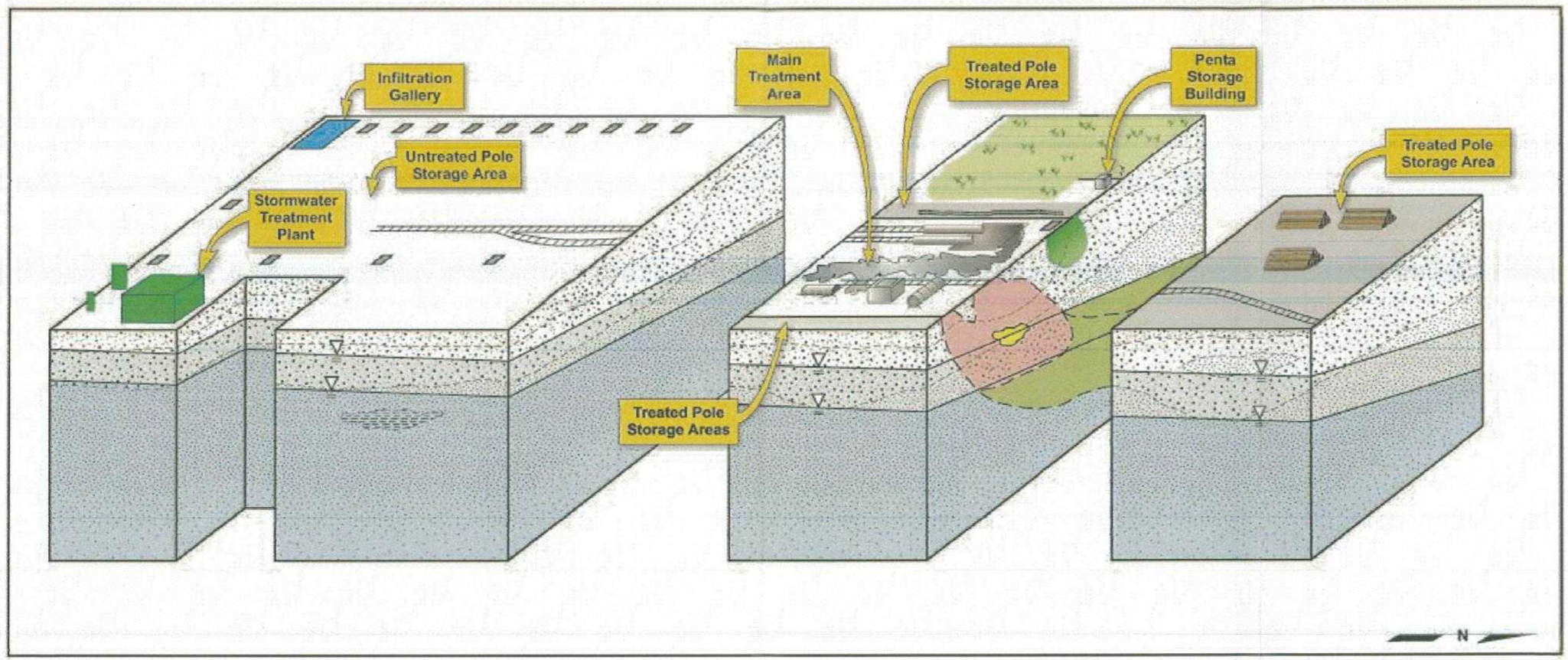

Legend:

- Railroad Tracks
- Groundwater Seasonal High
- Groundwater Seasonal Low
- Former Catch Basin
- Historical Surface Spill
- Old Butt Tank
- Old Thermal Retort
- Old Thermal Tank
- Drainage Ditch
- Retorts and Drip Apron
- Closed Wood Waste Landfill
- Potential Residual NAPL
- Approximate Area of LNAPL Occurrence
- Estimated Area of PCP Plume in Groundwater
- Potential Infiltration of CoPCs to Soil and Groundwater

Soil Types

- FILL (Silty SAND with Gravel)
- Fine SAND
- Gravelly SAND
- Silty CLAY

Note: Surface features shown larger than actual size.

Horizontal Scale in Feet: 0 300 600

Vertical Scale in Feet: 0 30 60

Vertical Exaggeration x10

	CLIENT: J.H. BAXTER	DWN BY: PM	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
		CHK'D BY: SB		PROJECT NO: 361M 125611.0001.3
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	DATUM: -	TITLE: CONCEPTUAL SITE MODEL	REV. NO.: A
		PROJECTION: -		FIGURE No. 5-1
		SCALE: AS SHOWN		

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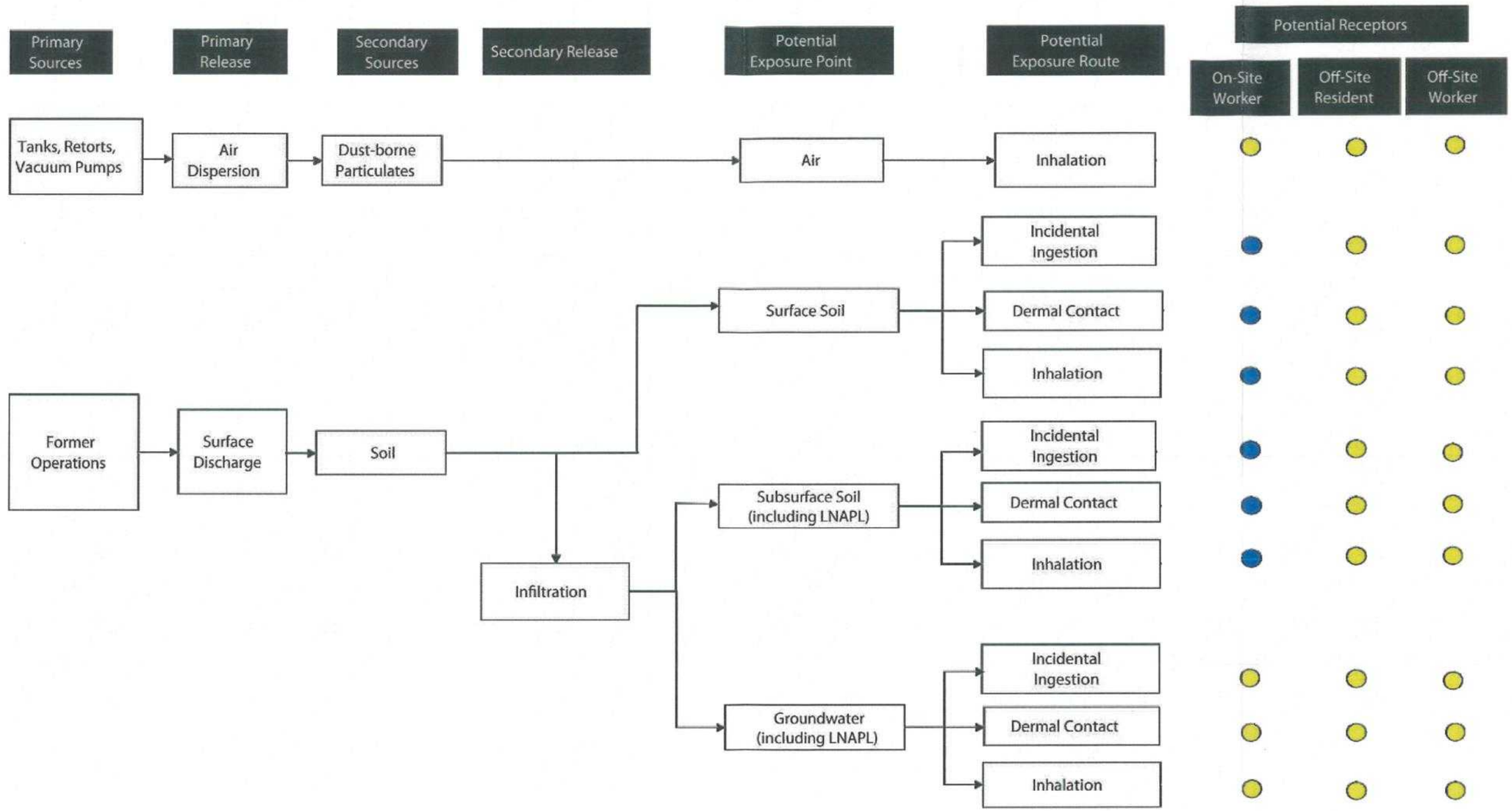

Potentially incomplete exposure pathway

Potentially complete exposure pathway

JHBaxter	CLIENT: J.H. BAXTER	DWN BY: PM CHK'D BY: SB DATUM: - PROJECTION: - SCALE: AS SHOWN	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013 PROJECT NO: 361M 125611.0001.3	
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224 amec		TITLE: CONCEPTUAL SITE MODEL OF POTENTIAL EXPOSURE PATHWAYS	REV. NO.: A FIGURE No. 5-2	

K:\12000\12500\12561\125611\CMS Revision 3\Figures\Figure 5-2 – Conceptual Site Model of Potential Exposure Pathways.dwg – Layout1 – Mar. 27, 2013 2:09pm – patrick.mccarthy

JH Baxter	CLIENT: J.H. BAXTER	DWN BY: APS	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
		CHK'D BY: SB		PROJECT NO: 3-61M-125611
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	DATUM: -	TITLE: ALTERNATIVE 1 TOTAL FLUIDS RECOVERY, AIR SPARGING, AND MNA	REV. NO.:
	amec	PROJECTION: -		FIGURE No. 9-1
		SCALE: AS SHOWN		

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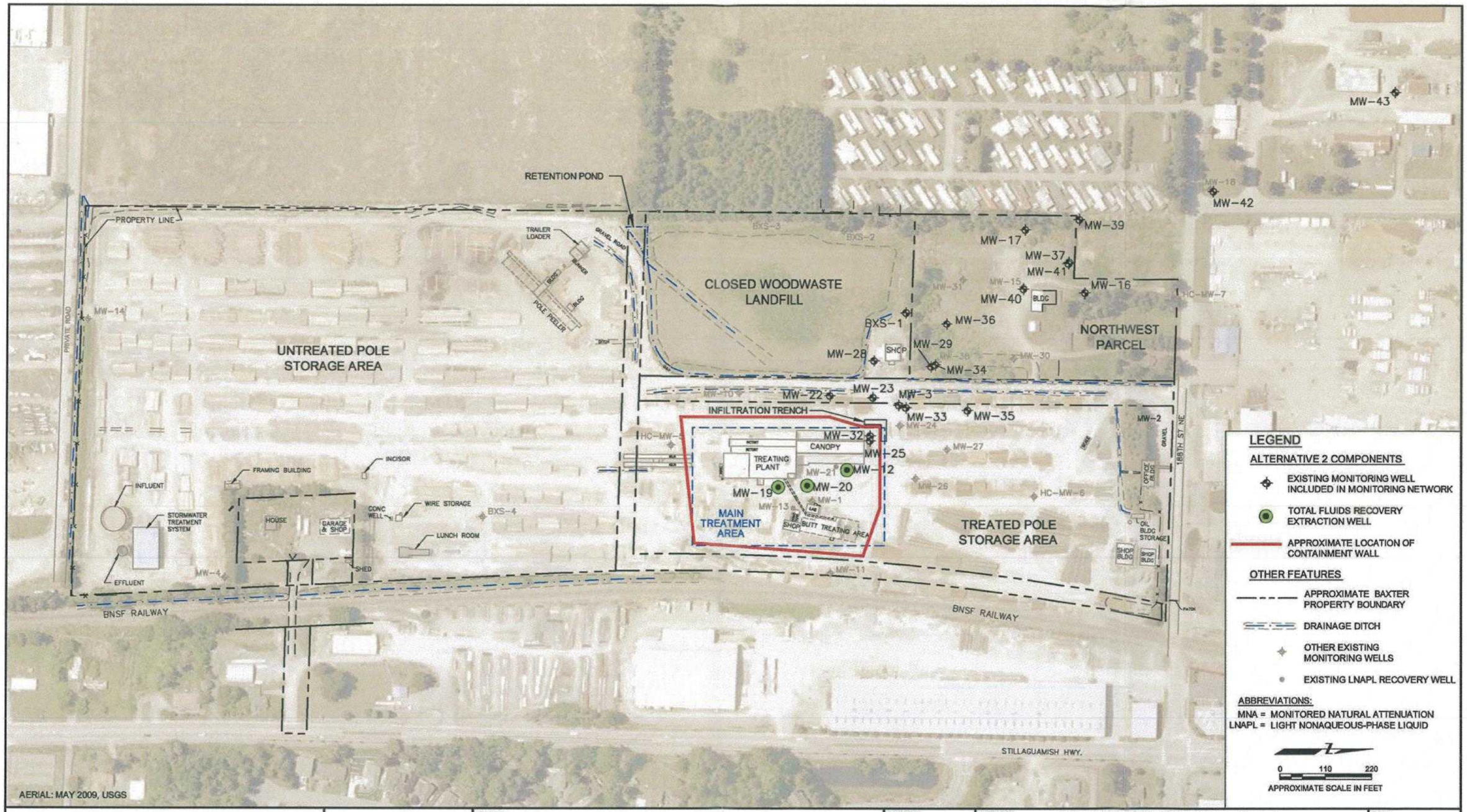

CLIENT: J.H. BAXTER	DWN BY: APS	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
	CHK'D BY: SB		PROJECT NO: 3-61M-125611
	DATUM: -	TITLE: ALTERNATIVE 2 PHYSICAL/HYDRAULIC CONTAINMENT AND MNA	REV. NO.:
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	PROJECTION: -		FIGURE No. 9-2
	SCALE: AS SHOWN		

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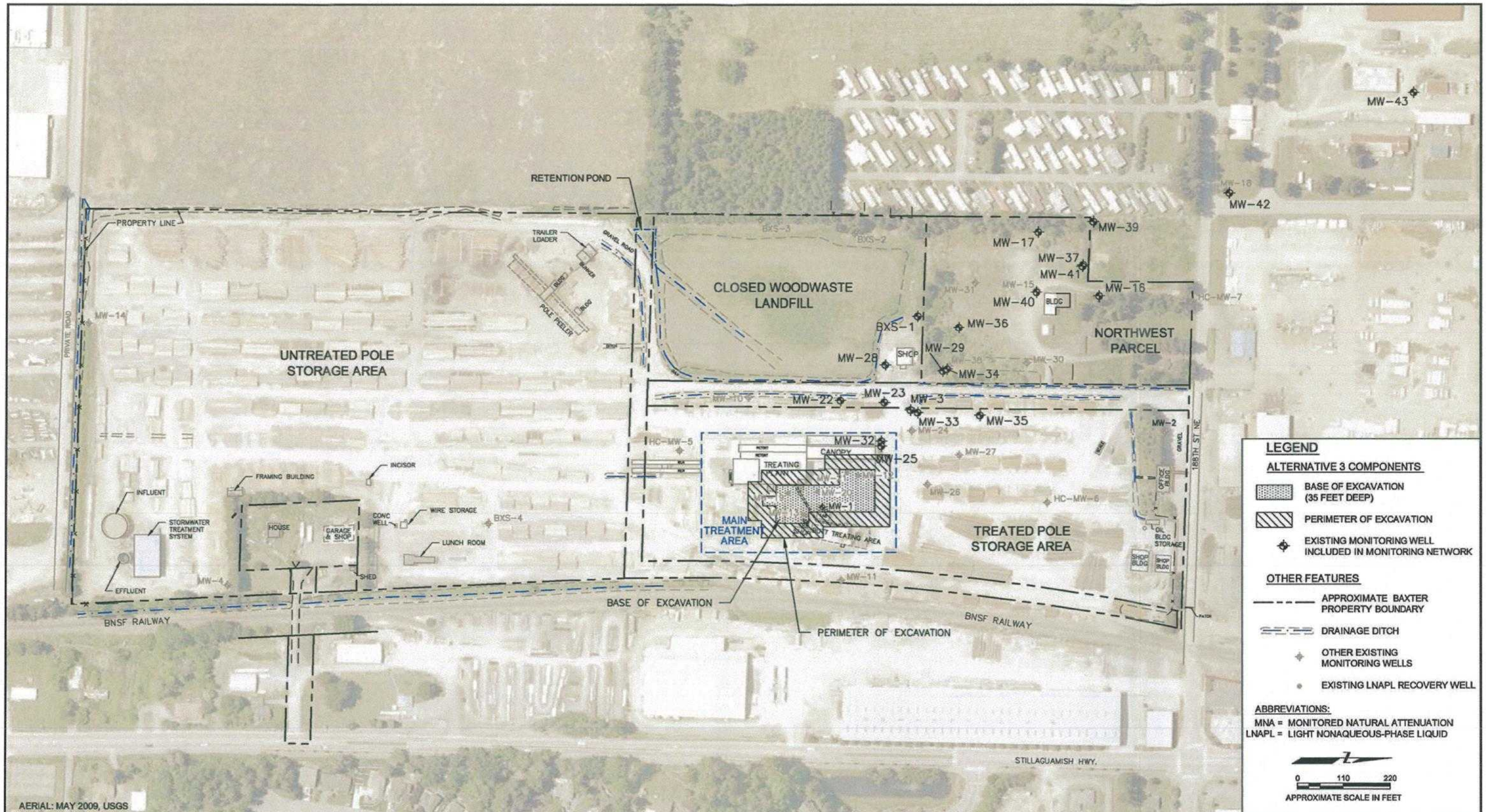

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		CHK'D BY: SB		PROJECT NO: 3-61M-125611
		DATUM: -	TITLE: ALTERNATIVE 3 EXCAVATION, OFF-SITE DISPOSAL, AND MNA	REV. NO.:
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	PROJECTION: -		FIGURE No. 9-3
		SCALE: AS SHOWN		

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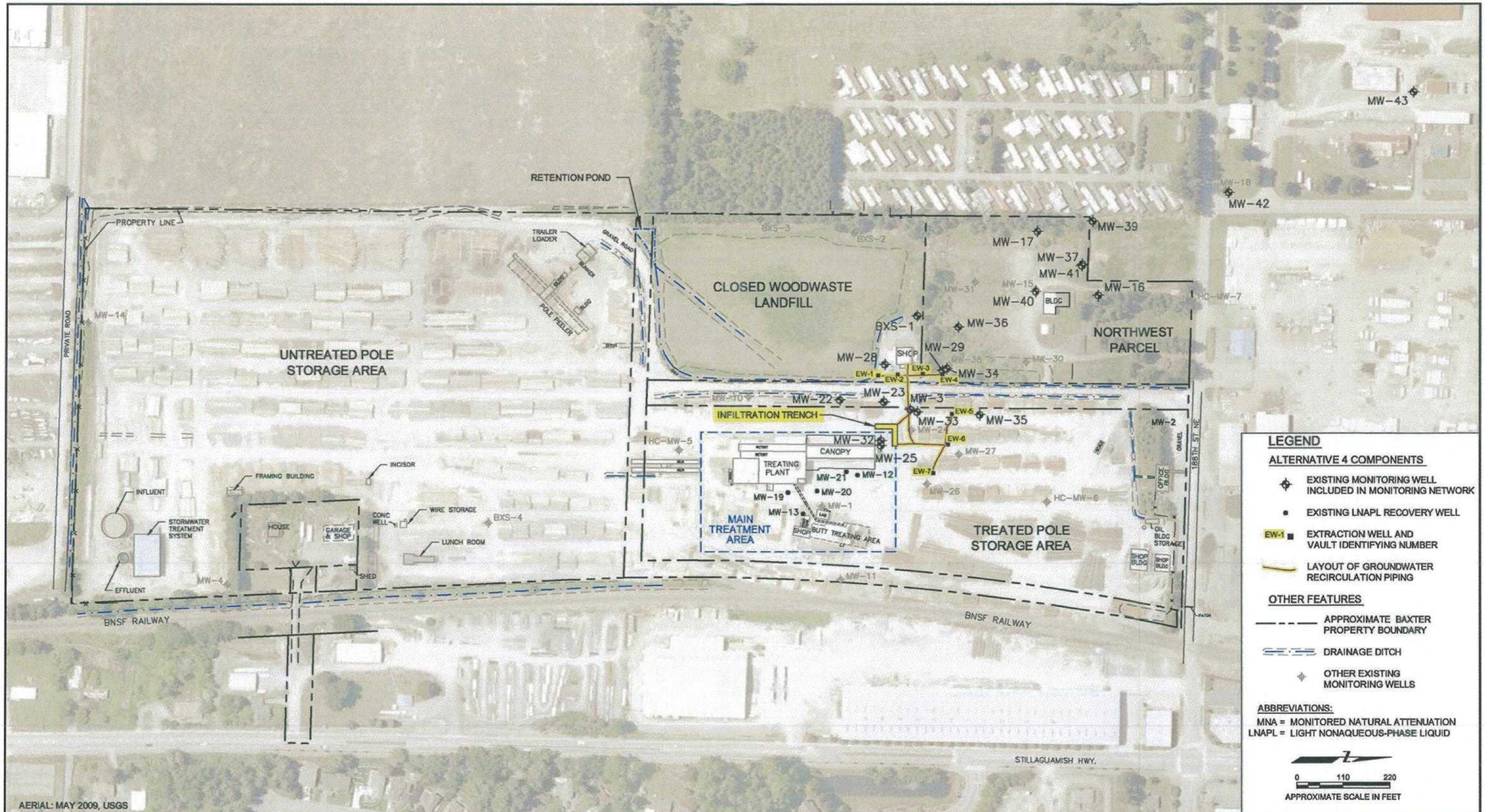

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		CHK'D BY: SB		PROJECT NO: 3-61M-125611
		DATUM: -	TITLE: ALTERNATIVE 4 ENHANCED BIODEGRADATION RECIRCULATION SYSTEM	REV. NO.:
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	PROJECTION: -		FIGURE No. 9-4
		SCALE: AS SHOWN		

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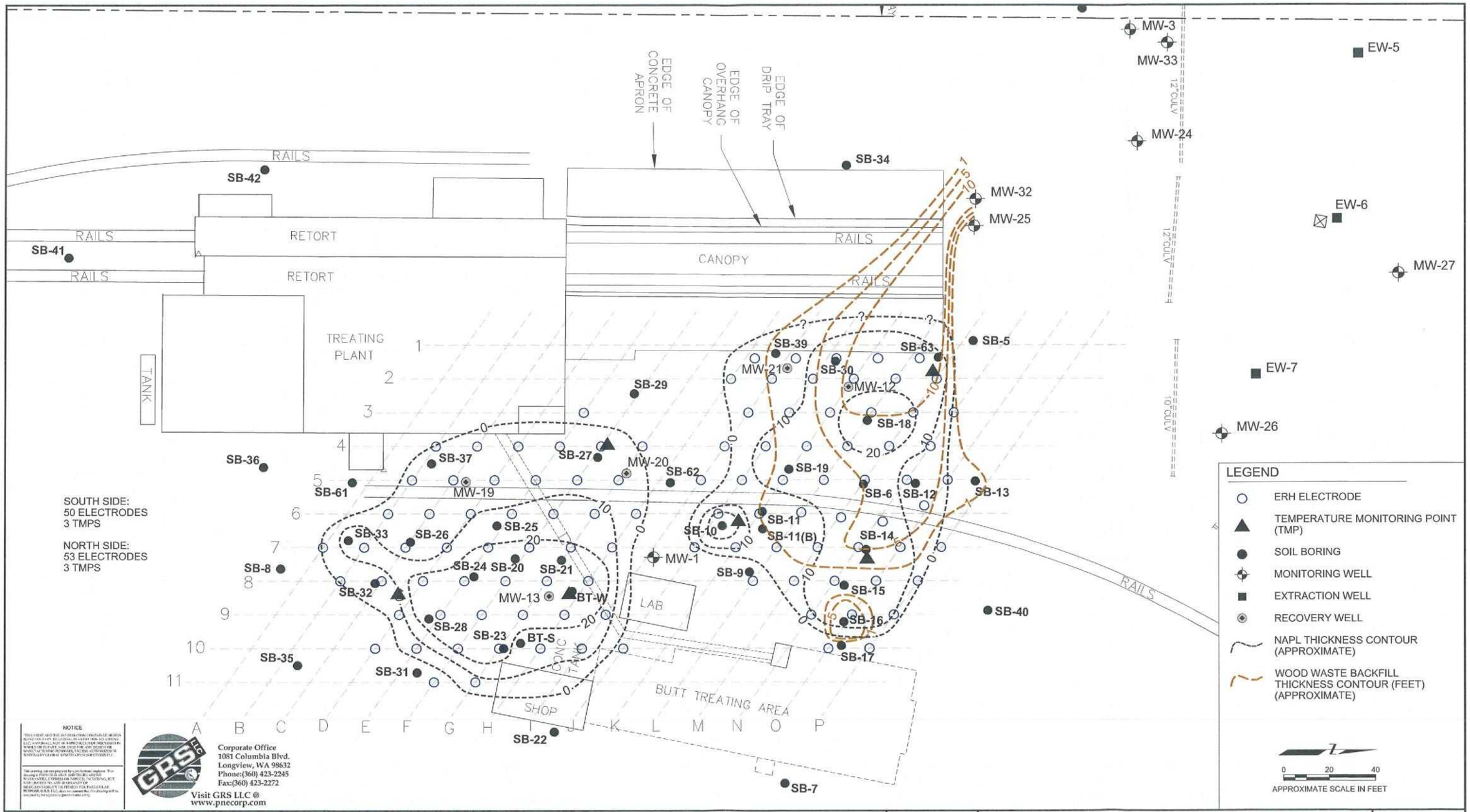

NOTICE

Corporate Office
1081 Columbia Blvd.
Longview, WA 98632
Phone:(360) 423-2245
Fax:(360) 423-2272
Visit GRS LLC @
www.pnecorp.com

CLIENT: J.H. BAXTER	DWN BY: APS	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
	CHK'D BY: SB		PROJECT NO: 3-61M-125611
	DATUM: -	TITLE: ALTERNATIVE 5 ERH, TOTAL FLUIDS RECOVERY, AND ENHANCED BIODEGRADATION RECIRCULATION	REV. NO.: A
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	PROJECTION: -		FIGURE No. 9-5
	SCALE: AS SHOWN		

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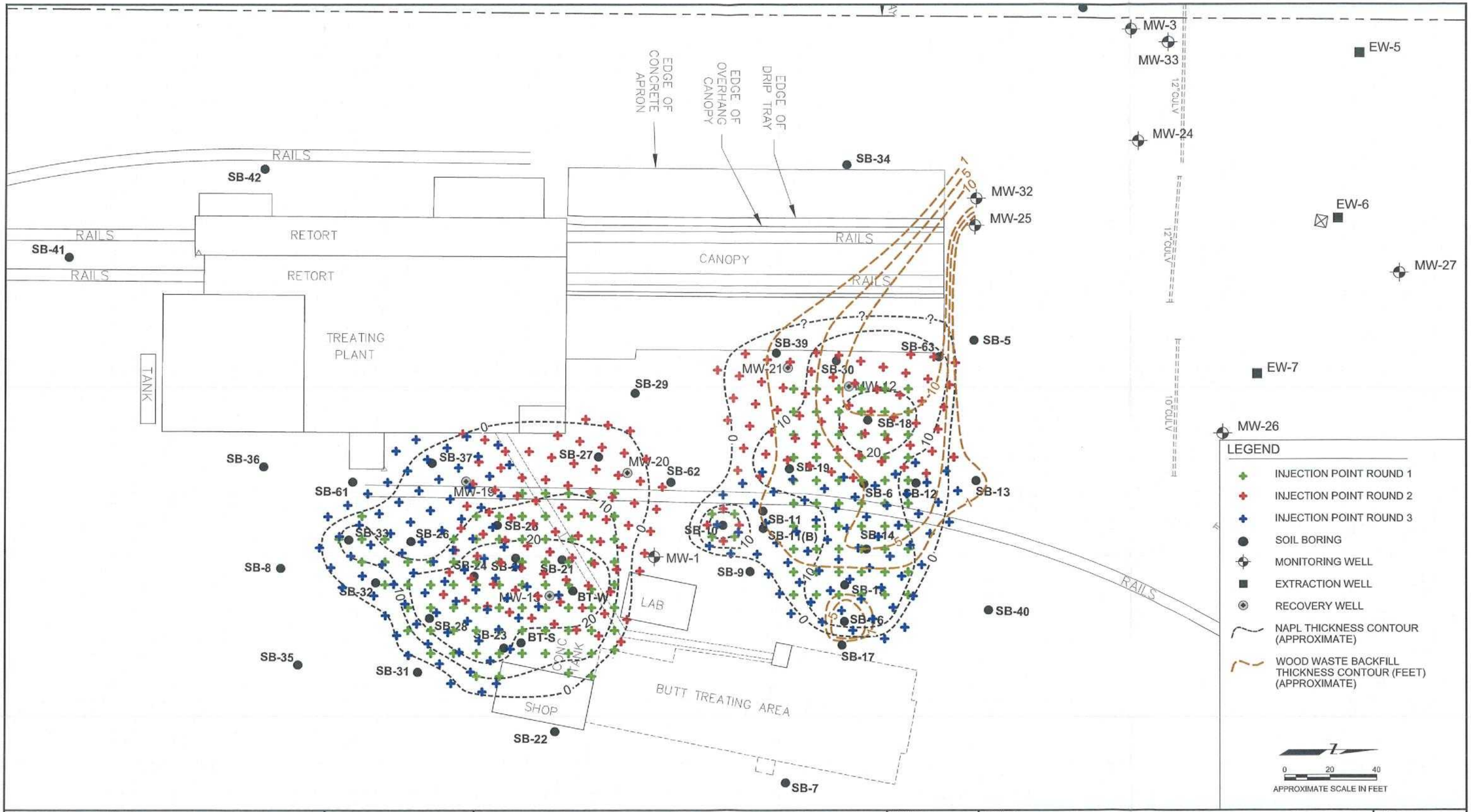

JH Baxter	CLIENT: J.H. BAXTER	DWN BY: APS CHK'D BY: SB DATUM: - PROJECTION: - SCALE: AS SHOWN	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013 PROJECT NO: 3-61M-125611
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224		TITLE: ALTERNATIVE 6 CHEMICAL OXIDATION AND ENHANCED BIODEGRADATION RECIRCULATION	REV. NO.: A FIGURE No. 9-6

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APPENDIX A

Data Tables (electronic version only)

APPENDIX B

Model Toxics Control Act Worksheets

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 4/5/2013
Site Name: JH Baxter Method C
Evaluator: JSB

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		1,2,4-Trimethylbenzene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.05	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i	0.002	mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	2.712E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.623E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*6.160E-03*	atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*2.623E-01*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	5.700E+01	mg/l
5. Target Ground Water Cleanup Level			
Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**4.00E+02**	ug/l
6. Site-Specific Hydrogeological Characteristics			
Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless
7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms			
** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*			
Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 1,2,4-Trimethylbenzene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.348E+01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.348E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.673E+02	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	10.5	unitless	contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	4.000E+03	2.778E+03	1.750E+05	3.333E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		4.000E+02			
	Target Soil CUL? mg/kg		2.348E+01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	3.200E+00		7.000E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	#DIV/0!		0.000E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 4/5/2013
Site Name: JH Baxter Method C
Evaluator: JSB

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		1,3,5-Trimethylbenzene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.01	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i	0.0017	mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.610E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	3.735E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*8.770E-03*	atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*3.735E-01*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	4.820E+01	mg/l
5. Target Ground Water Cleanup Level			
Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**4.00E+02**	ug/l
6. Site-Specific Hydrogeological Characteristics			
Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless
7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms			
** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*			
Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 1,3,5-Trimethylbenzene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	7.147E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	7.147E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	4.306E+01	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	3.3	unitless	contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	8.000E+02	5.556E+02	3.500E+04	6.667E+03
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		4.000E+02			
	Target Soil CUL? mg/kg		7.147E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	2.720E+00		5.950E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	#DIV/0!		0.000E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		2,4-dichlorophenol	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.003	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.500E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	1.300E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*7.920E-05*	atm.m^3/mol
**Converted unitless form of H_{cc} @13 °C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*3.373E-03*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	4.500E+03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w 2.40E+01 ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 2,4-dichlorophenol

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.680E-01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.680E-01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.575E+03	mg/kg
Retardation Factor, R:	1.5	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	2.400E+02	1.667E+02	1.050E+04	2.000E+03
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		2.400E+01			
	Target Soil CUL? mg/kg		1.680E-01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/3/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		2-methylnapthalene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.004	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	8.500E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.206E-02	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*5.180E-04*	atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*2.206E-02*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	2.460E+01	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **3.20E+01** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 2-methylnapthalene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	5.569E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	5.569E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	2.141E+02	mg/kg
Retardation Factor, R:	30.7	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	3.200E+02	2.222E+02	1.400E+04	2.667E+03
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		3.200E+01			
	Target Soil CUL? mg/kg		5.569E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Acenaphthene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.06	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	4.900E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	6.400E-03	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13 °C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	4.200E+00	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **9.60E+02** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Acenaphthene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	9.793E+01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	9.793E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	2.142E+01	mg/kg
Retardation Factor, R:	18.1	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	4.800E+03	3.333E+03	2.100E+05	4.000E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		9.600E+02			
	Target Soil CUL? mg/kg		9.793E+01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Anthracene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.3	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	2.300E+04	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.700E-03	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13 °C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	4.300E-02	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation:

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

C_w	**4.80E+03**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Anthracene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.227E+03	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.227E+03	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	9.976E-01	mg/kg
Retardation Factor, R:	81.2	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	2.400E+04	1.667E+04	1.050E+06	2.000E+05
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		4.800E+03			
	Target Soil CUL? mg/kg		2.227E+03			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Benzene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.004	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	0.055	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i	0.0086	mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i	0.0272	kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	2	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.200E+01	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.300E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*8.770E-03*	atm.m^3/mol
**Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*3.735E-01*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.800E+03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **5.00E+00** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Benzene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.819E-02	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.819E-02	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	5.075E+02	mg/kg
Retardation Factor, R:	1.2	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	3.200E+02	2.222E+02	1.400E+04	2.667E+03
		@RISK =1.0E-6 or 1.0E-5	1.818E+01	1.263E+01	2.386E+03	4.545E+02
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		5.000E+00			
	Target Soil CUL? mg/kg		2.819E-02			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	1.376E+01		3.010E+01	
		@ RISK=1.0E-6 or 1.0E-5	3.217E-01		3.217E+00	
	Target Soil CUL? mg/kg	@ HQ=1.0	#DIV/0!		0.000E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Benz(a)anthracene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	3.600E+05	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	1.400E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	9.400E-03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **2.90E-02** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Benz(a)anthracene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.089E-01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.089E-01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	3.386E+00	mg/kg
Retardation Factor, R:	1,256.8	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		2.900E-02			
	Target Soil CUL? mg/kg		2.089E-01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/29/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Benzo(a)pyrene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i	6.1	kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	9.700E+05	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	4.600E-05	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.600E-03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation:

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

	C_w	**2.00E-01**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Benzo(a)pyrene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	3.425E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	3.425E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.552E+00	mg/kg
Retardation Factor, R:	3,384.7	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		2.000E-01			
	Target Soil CUL? mg/kg		3.881E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	1.434E-03		1.434E-02	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Benzo(b)fluoranthene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1,3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1,3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1,2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.200E+06	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	4.600E-03	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.500E-03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **1.20E-01** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Benzo(b)fluoranthene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.880E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.880E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.800E+00	mg/kg
Retardation Factor, R:	4,187.0	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.200E-01			
	Target Soil CUL? mg/kg		2.880E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Benzo(k)fluoranthene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.200E+06	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	3.400E-05	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	8.000E-04	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **1.20E-01** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Benzo(k)fluoranthene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.880E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.880E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	9.602E-01	mg/kg
Retardation Factor, R:	4,187.0	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.200E-01			
	Target Soil CUL? mg/kg		2.880E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Chrysene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	4.000E+05	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	3.900E-03	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.600E-03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation:
**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

	C_w	**1.20E-01**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Chrysene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	9.605E-01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	9.605E-01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	6.403E-01	mg/kg
Retardation Factor, R:	1,396.3	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.200E-01			
	Target Soil CUL? mg/kg		9.605E-01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Dibenz(a,h)anthracene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.800E+06	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	6.000E-07	unitless
*If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:	H		atm.m^3/mol
*Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)	H_{cc}	0.000E+00	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	2.500E-03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **1.20E-01** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Dibenz(a,h)anthracene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	3.425E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	3.425E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	4.501E+00	mg/kg
Retardation Factor, R:	6,280.1	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.200E-01			
	Target Soil CUL? mg/kg		4.320E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 4/5/2013
Site Name: JH Baxter Method C
Evaluator: JSB

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Dibenzofuran	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.001	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	8.128E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	5.366E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*1.260E-05*	atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*5.366E-04*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	3.100E+00	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**7.00E+01**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Dibenzofuran

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.166E+01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.166E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	2.582E+01	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	29.4	unitless	contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	8.000E+01	5.556E+01	3.500E+03	6.667E+02
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		7.000E+01			
	Target Soil CUL? mg/kg		1.166E+01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Fluoranthene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.04	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	4.900E+04	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	6.600E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13 ^{o} C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	2.100E-01	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation:

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

	C_w	**1.40E+03**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Fluoranthene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.378E+03	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.378E+03	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.033E+01	mg/kg
Retardation Factor, R:	171.9	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	3.200E+03	2.222E+03	1.400E+05	2.667E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.400E+03			
	Target Soil CUL? mg/kg		1.378E+03			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Fluorene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.04	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	7.700E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.600E-03	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13° C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	2.000E+00	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation:

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

	C_w	1.40E+03	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Fluorene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.212E+02	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.212E+02	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.580E+01	mg/kg
Retardation Factor, R:	27.9	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	3.200E+03	2.222E+03	1.400E+05	2.667E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.400E+03			
	Target Soil CUL? mg/kg		2.212E+02			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Indeno(1,2,3-cd)pyrene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.3	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	3.500E+06	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	6.600E-05	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	2.200E-05	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **1.20E-01** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Indeno(1,2,3-cd)pyrene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	3.425E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	3.425E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	7.700E-02	mg/kg
Retardation Factor, R:	12,210.3	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.200E-01			
	Target Soil CUL? mg/kg		8.400E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/3/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Napthalene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.02	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i	0.00086	mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.200E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.000E-02	unitless
*If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:	H	5.180E-04	atm.m^3/mol
*Converted unitless form of H_{cc} @13 ^{o}C: (Enter this converted value into "H_{cc} input Box" above for a calculation)	H_{cc}	2.206E-02	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	3.100E+01	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **3.50E+02** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Napthalene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	9.812E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	9.812E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	4.345E+01	mg/kg
Retardation Factor, R:	5.2	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	1.600E+03	1.111E+03	7.000E+04	1.333E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		3.500E+02			
	Target Soil CUL? mg/kg		9.812E+00			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	1.376E+00		3.010E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	#DIV/0!		0.000E+00	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 4/5/2013
Site Name: JH Baxter Method C
Evaluator: JSB

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Pentachlorophenol	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.005	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	0.4	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	5.900E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	1.000E-06	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	2.000E+03	mg/l
5. Target Ground Water Cleanup Level			
Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**1.00E+00**	ug/l
6. Site-Specific Hydrogeological Characteristics			
Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless
7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms			
** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*			
Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Pentachlorophenol

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.580E-02	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.580E-02	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	1.580E+03	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	3.1	unitless	contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	4.000E+02	2.778E+02	1.750E+04	3.333E+03
		@RISK =1.0E-6 or 1.0E-5	2.500E+00	1.736E+00	3.281E+02	6.250E+01
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.000E+00			
	Target Soil CUL? mg/kg		1.580E-02			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		Pyrene	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.03	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.800E+04	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	4.500E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13°C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.400E-01	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **1.10E+03** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Pyrene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.500E+03	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.500E+03	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	9.548E+00	mg/kg
Retardation Factor, R:	238.2	unitless

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	2.400E+03	1.667E+03	1.050E+05	2.000E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.100E+03			
	Target Soil CUL? mg/kg		1.500E+03			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/29/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		2,3,7,8-TCDD	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	150000	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i	150000	kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	3.980E+06	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	3.730E-03	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*7.920E-05*	atm.m^3/mol
**Converted unitless form of H_{cc} @13 ^{o}C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*3.373E-03*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	7.970E-06	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w 3.00E-05 ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 2,3,7,8-TCDD

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.667E-04	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.667E-04	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	3.172E-02	mg/kg
Retardation Factor, R:	13,884.7	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	6.667E-06	4.630E-06	8.750E-04	1.667E-04
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		3.000E-05			
	Target Soil CUL? mg/kg		2.388E-03			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	5.833E-08		5.833E-07	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/6/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		2,4,5-Trichlorophenol	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	0.1	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.600E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	1.800E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13 °C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.200E+03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation:

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

	C_w	**8.00E+02**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 2,4,5-Trichlorophenol

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.880E+01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.880E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	2.160E+03	mg/kg
Retardation Factor, R:	6.6	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	8.000E+03	5.556E+03	3.500E+05	6.667E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		8.000E+02			
	Target Soil CUL? mg/kg		2.880E+01			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 11/29/2006
Site Name: JH Baxter Method C
Evaluator: Tasya Gray, Geomatrix

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		2,4,6-Trichlorophenol	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for AF, ABS_d, GI:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	0.011	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i	0.011	kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	3.800E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	3.200E-04	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H		atm.m^3/mol
**Converted unitless form of H_{cc} @13 °C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless
Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	8.000E+02	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: C_w **4.00E+00** ug/l

**Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_a	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.001	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway VAF [ ] unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: 2,4,6-Trichlorophenol

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☑

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	4.640E-02	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	4.640E-02	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	4.640E+02	mg/kg
Retardation Factor, R:	2.3	unitless

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	9.091E+01	6.313E+01	1.193E+04	2.273E+03
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		4.000E+00			
	Target Soil CUL? mg/kg		4.640E-02			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	7.955E-01		7.955E+00	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

APPENDIX C

Cost Worksheets

TABLE C-1

ESTIMATED COSTS FOR CORRECTIVE MEASURES ALTERNATIVES

Former J.H. Baxter Co. Wood Treating Facility
Arlington, Washington

Alternative	Initial Cost[1]	Total Cost[2]	Net Present Value[3]
1 Total Fluids Recovery, Air Sparging, and MNA	$606,400	$8,492,000	$4,309,600
2 Physical/Hydraulic Containment and MNA	$1,526,100	$8,285,000	$4,847,800
3 Excavation, Off-site Disposal, and MNA	$32,541,600	$41,010,000	$40,179,300
4 Enhanced Biodegradation Recirculation System and MNA	$102,000	$5,487,000	$2,684,700
5 Electric Resistance Heating, Recirculation, and MNA	$2,924,600	$4,475,000	$4,287,500
6 Chemical Oxidation, Recirculation, and MNA	$1,488,840	$2,635,000	$2,484,700

Notes

1. First year costs for implementation (assumed to be 2014) in 2012 dollars.
2. Total cost for project in 2012 dollars.
3. Net present value based on a 2% discount factor.
4. Initial costs for Alternative 4 do not include costs already incurred by Baxter of approximately $967,000 (installation and operations and maintenance).

TABLE C-2

COST ESTIMATE
ALTERNATIVE 1 - TOTAL FLUIDS RECOVERY, AIR SPARGING, AND MONITORED NATURAL ATTENUATION

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Item	Quantity	Unit	Rate/ Percentage	Total	Years	Total
Construction Costs						
Mobilization	1	LS	$15,000	$15,000		
Air Sparge Wells Installation	15	Ea	$4,000	$60,000		
Air Sparge System Installation and Startup	1	LS	$100,000	$100,000		
Groundwater Treatment System	1	LS	$100,000	$100,000		
Surveying	3	Day	$1,500	$4,500		
Pilot Test	1	LS	$25,000	$25,000		
			Construction Subtotal	**$304,500**		
Consultant Costs						
Design and Permitting	1	LS	$200,000	$200,000		
Consultant	1	LS	$16,000	$16,000		
Implement Institutional Controls	1	LS	$10,000	$10,000		
Pilot Test	1	LS	$15,000	$15,000		
Construction Management			20%	$60,900		
			Consultant Subtotal	**$301,900**		
			Total Initial Construction and Consultant Costs	**$606,400**		
Annual Long Term Costs						
Annual Costs, Years 1 through 100						
Maintain Institutional Controls	1	LS	$1,000	$1,000	100	$100,000
Annual Cost for Years 1 through 15						
Groundwater Sampling & Reporting	2	Ea	$17,730	$35,460	15	$531,900
Fluid Disposal	1	Ea	$5,000	$5,000	15	$75,000
Air & Groundwater Treatment System O&M	1	Ea	$38,000	$38,000	15	$570,000
Annual Costs for Years 16 through 100						
Groundwater Sampling & Reporting	1	Ea	$14,000	$14,000	85	$1,190,000
Fluid Disposal	1	Ea	$5,000	$5,000	15	$75,000
Air & Groundwater Treatment System O&M	1	Ea	$38,000	$38,000	85	$3,230,000
One Time Construction Cost						
Pump/blower replacement allowance (yr 10, 20...)	1	LS	$15,000	$15,000	9	$135,000
Replace 16 wells (yr 25, 50, 75)	1	LS	$50,000	$50,000	3	$150,000
Replace treatment system (yr 31, 61)	1	Ea	$50,000	$50,000	2	$100,000
Abandon 20 wells in year 16	20	Ea	$1,500	$30,000	1	$30,000
				Long-Term Costs Subtotal		$6,186,900
				Total Initial Construction and Consultant Costs		$606,400
				Total Construction/Consultant and Long-Term Costs		$6,793,300
				Contingency	25%	$1,698,325
TOTAL PROJECT COST						**$8,492,000**
TOTAL NET PRESENT VALUE COST						**$4,309,600**

Notes and Assumptions

1. Cost includes institutional controls and monitored natural attenuation.
2. The net present value is based on a net discount rate of 2% (Interest rate of 4.5% and inflation of 2.5%).
3. Average well depths are assumed to be 40 feet.
4. Fluids disposal assumed to occur for 30 years.
5. Assumes for the initial 15 years, the monitoring will be semiannual, limited to 20 wells for pentachlorophenol and 7 wells for polyaromatic hydrocarbons and MNA.
6. Assumes after 15 years, the monitoring will be annual, limited to 10 wells for pentachlorophenol and 4 wells polycyclic aromatic hydrocarbons and MNA
7. Assumes average well operational lifetime of 25 years. Allowance for pump/blower replacement of $15000 every 10 yrs.

Abbreviations

LS = lump sum
O&M = operations and maintenance

NET PRESENT VALUE CALCULATION

Year	Const./Consult	Annual	Contingency	Total	Year	Const./Consult	Annual	Contingency	Total
1	$606,400	$79,460	$171,470	$857,330	51		$53,000	$13,250	$66,250
2		$79,460	$19,870	$99,330	52		$53,000	$13,250	$66,250
3		$79,460	$19,870	$99,330	53		$53,000	$13,250	$66,250
4		$79,460	$19,870	$99,330	54		$53,000	$13,250	$66,250
5		$79,460	$19,870	$99,330	55		$53,000	$13,250	$66,250
6		$79,460	$19,870	$99,330	56		$53,000	$13,250	$66,250
7		$79,460	$19,870	$99,330	57		$53,000	$13,250	$66,250
8		$79,460	$19,870	$99,330	58		$53,000	$13,250	$66,250
9		$79,460	$19,870	$99,330	59		$53,000	$13,250	$66,250
10		$94,460	$23,620	$118,080	60		$68,000	$17,000	$85,000
11		$79,460	$19,870	$99,330	61		$103,000	$25,750	$128,750
12		$79,460	$19,870	$99,330	62		$53,000	$13,250	$66,250
13		$79,460	$19,870	$99,330	63		$53,000	$13,250	$66,250
14		$79,460	$19,870	$99,330	64		$53,000	$13,250	$66,250
15		$79,460	$19,870	$99,330	65		$53,000	$13,250	$66,250
16		$88,000	$22,000	$110,000	66		$53,000	$13,250	$66,250
17		$58,000	$14,500	$72,500	67		$53,000	$13,250	$66,250
18		$58,000	$14,500	$72,500	68		$53,000	$13,250	$66,250
19		$58,000	$14,500	$72,500	69		$53,000	$13,250	$66,250
20		$73,000	$18,250	$91,250	70		$68,000	$17,000	$85,000
21		$58,000	$14,500	$72,500	71		$53,000	$13,250	$66,250
22		$58,000	$14,500	$72,500	72		$53,000	$13,250	$66,250
23		$58,000	$14,500	$72,500	73		$53,000	$13,250	$66,250
24		$58,000	$14,500	$72,500	74		$53,000	$13,250	$66,250
25		$108,000	$27,000	$135,000	75		$103,000	$25,750	$128,750
26		$58,000	$14,500	$72,500	76		$53,000	$13,250	$66,250
27		$58,000	$14,500	$72,500	77		$53,000	$13,250	$66,250
28		$58,000	$14,500	$72,500	78		$53,000	$13,250	$66,250
29		$58,000	$14,500	$72,500	79		$53,000	$13,250	$66,250
30		$73,000	$18,250	$91,250	80		$68,000	$17,000	$85,000
31		$103,000	$25,750	$128,750	81		$53,000	$13,250	$66,250
32		$53,000	$13,250	$66,250	82		$53,000	$13,250	$66,250
33		$53,000	$13,250	$66,250	83		$53,000	$13,250	$66,250
34		$53,000	$13,250	$66,250	84		$53,000	$13,250	$66,250
35		$53,000	$13,250	$66,250	85		$53,000	$13,250	$66,250
36		$53,000	$13,250	$66,250	86		$53,000	$13,250	$66,250
37		$53,000	$13,250	$66,250	87		$53,000	$13,250	$66,250
38		$53,000	$13,250	$66,250	88		$53,000	$13,250	$66,250
39		$53,000	$13,250	$66,250	89		$53,000	$13,250	$66,250
40		$68,000	$17,000	$85,000	90		$68,000	$17,000	$85,000
41		$53,000	$13,250	$66,250	91		$53,000	$13,250	$66,250
42		$53,000	$13,250	$66,250	92		$53,000	$13,250	$66,250
43		$53,000	$13,250	$66,250	93		$53,000	$13,250	$66,250
44		$53,000	$13,250	$66,250	94		$53,000	$13,250	$66,250
45		$53,000	$13,250	$66,250	95		$53,000	$13,250	$66,250
46		$53,000	$13,250	$66,250	96		$53,000	$13,250	$66,250
47		$53,000	$13,250	$66,250	97		$53,000	$13,250	$66,250
48		$53,000	$13,250	$66,250	98		$53,000	$13,250	$66,250
49		$53,000	$13,250	$66,250	99		$53,000	$13,250	$66,250
50		$118,000	$29,500	$147,500	100		$53,000	$13,250	$66,250
					TOTAL	$606,400	$6,186,900	$1,698,400	$8,491,700

NET PRESENT VALUE **$4,309,600**

TABLE C-3

COST ESTIMATE
ALTERNATIVE 2 - PHYSICAL/HYDRAULIC CONTAINMENT AND MONITORED NATURAL ATTENUATION

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Item	Quantity	Unit	Rate/ Percentage	Total	Years	Total
Construction Costs						
Mobilization	1	LS	$150,000	$150,000		
Install Hanging Barrier Wall	60,000	SF	$12	$720,000		
Soil Disposal	2,500	Tons	$55	$137,500		
Groundwater Treatment System	1	LS	$50,000	$50,000		
Surveying	3	Day	$1,500	$4,500		
Infiltration Trench Rehabilitation	1	LS	$25,000	$25,000		
Construction Subtotal				$1,087,000		
Consultant Costs						
Design and Permitting	1	LS	$215,000	$215,000		
Consultant	1	LS	$16,000	$16,000		
Implement Institutional Controls	1	LS	$10,000	$10,000		
Field Investigation	1	LS	$35,000	$35,000		
Construction Management			15%	$163,100		
Consultant Subtotal				$439,100		
Total Initial Construction and Consultant Costs				**$1,526,100**		
Annual Long Term Costs						
Annual Costs, Years 1 through 100						
Maintain Institutional Controls	1	LS	$1,000	$1,000	100	$100,000
Annual Cost for Years 1 through 15						
Groundwater Sampling & Reporting	2	Ea	$17,730	$35,460	15	$531,900
Fluid Disposal	1	Ea	$5,000	$5,000	15	$75,000
Groundwater Treatment System O&M	1	Ea	$24,000	$24,000	15	$360,000
Annual Costs for Years 16 through 100						
Groundwater Sampling & Reporting	1	Ea	$14,000	$14,000	85	$1,190,000
Fluid Disposal	1	Ea	$5,000	$5,000	15	$75,000
Groundwater Treatment System O&M	1	Ea	$24,000	$24,000	85	$2,040,000
One Time Construction Cost						
Repair Barrier Wall (25% of wall)(yr 31, 61)	15,000	SF	$12	$180,000	2	$360,000
Pump replacement allowance (yr 10, 20...)	1	LS	$10,000	$10,000	9	$90,000
Replace 16 wells (yr 25, 50, 75)	1	LS	$50,000	$50,000	3	$150,000
Replace groundwater treatment system (yr 31, 61)	1	Ea	$50,000	$50,000	2	$100,000
Abandon 20 wells in year 16	20	Ea	$1,500	$30,000	1	$30,000
Long-Term Costs Subtotal						$5,101,900
Total Initial Construction and Consultant Costs						$1,526,100
Total Construction/Consultant and Long-Term Costs						$6,628,000
Contingency					25%	$1,657,000
TOTAL PROJECT COST						**$8,285,000**
TOTAL NET PRESENT VALUE COST						**$4,847,800**

Notes and Assumptions

1. Cost includes institutional controls and monitoring natural attenuation.
2. The net present value is based on a net discount rate of 2% (Interest rate of 4.5% and inflation of 2.5%).
3. Average well depths are assumed to be 40 feet.
4. Fluids disposal assumed to occur for 30 years.
5. Assumes for the initial 15 years, the monitoring will be semiannual, limited to 20 wells for pentachlorophenol and 7 wells for polycyclic aromatic hydrocarbons and MNA.
6. Assumes after 15 years, the monitoring will be annual, limited to 10 wells for pentachlorophenol and 4 wells for polycyclic aromatic hydrocarbons and MNA.
7. Assumes average well operational lifetime of 25 years. Allowance for pump replacement of $10000 every 10 yrs.

Abbreviations

LS = lump sum
O&M = operations and maintenance
SF = square feet

NET PRESENT VALUE CALCULATION

Year	Const./Consult	Annual	Contingency	Total	Year	Const./Consult	Annual	Contingency	Total
1	$1,526,100	$65,460	$397,890	$1,989,450	51		$39,000	$9,750	$48,750
2		$65,460	$16,370	$81,830	52		$39,000	$9,750	$48,750
3		$65,460	$16,370	$81,830	53		$39,000	$9,750	$48,750
4		$65,460	$16,370	$81,830	54		$39,000	$9,750	$48,750
5		$65,460	$16,370	$81,830	55		$39,000	$9,750	$48,750
6		$65,460	$16,370	$81,830	56		$39,000	$9,750	$48,750
7		$65,460	$16,370	$81,830	57		$39,000	$9,750	$48,750
8		$65,460	$16,370	$81,830	58		$39,000	$9,750	$48,750
9		$65,460	$16,370	$81,830	59		$39,000	$9,750	$48,750
10		$75,460	$18,870	$94,330	60		$49,000	$12,250	$61,250
11		$65,460	$16,370	$81,830	61		$269,000	$67,250	$336,250
12		$65,460	$16,370	$81,830	62		$39,000	$9,750	$48,750
13		$65,460	$16,370	$81,830	63		$39,000	$9,750	$48,750
14		$65,460	$16,370	$81,830	64		$39,000	$9,750	$48,750
15		$65,460	$16,370	$81,830	65		$39,000	$9,750	$48,750
16		$74,000	$18,500	$92,500	66		$39,000	$9,750	$48,750
17		$44,000	$11,000	$55,000	67		$39,000	$9,750	$48,750
18		$44,000	$11,000	$55,000	68		$39,000	$9,750	$48,750
19		$44,000	$11,000	$55,000	69		$39,000	$9,750	$48,750
20		$54,000	$13,500	$67,500	70		$49,000	$12,250	$61,250
21		$44,000	$11,000	$55,000	71		$39,000	$9,750	$48,750
22		$44,000	$11,000	$55,000	72		$39,000	$9,750	$48,750
23		$44,000	$11,000	$55,000	73		$39,000	$9,750	$48,750
24		$44,000	$11,000	$55,000	74		$39,000	$9,750	$48,750
25		$94,000	$23,500	$117,500	75		$89,000	$22,250	$111,250
26		$44,000	$11,000	$55,000	76		$39,000	$9,750	$48,750
27		$44,000	$11,000	$55,000	77		$39,000	$9,750	$48,750
28		$44,000	$11,000	$55,000	78		$39,000	$9,750	$48,750
29		$44,000	$11,000	$55,000	79		$39,000	$9,750	$48,750
30		$54,000	$13,500	$67,500	80		$49,000	$12,250	$61,250
31		$269,000	$67,250	$336,250	81		$39,000	$9,750	$48,750
32		$39,000	$9,750	$48,750	82		$39,000	$9,750	$48,750
33		$39,000	$9,750	$48,750	83		$39,000	$9,750	$48,750
34		$39,000	$9,750	$48,750	84		$39,000	$9,750	$48,750
35		$39,000	$9,750	$48,750	85		$39,000	$9,750	$48,750
36		$39,000	$9,750	$48,750	86		$39,000	$9,750	$48,750
37		$39,000	$9,750	$48,750	87		$39,000	$9,750	$48,750
38		$39,000	$9,750	$48,750	88		$39,000	$9,750	$48,750
39		$39,000	$9,750	$48,750	89		$39,000	$9,750	$48,750
40		$49,000	$12,250	$61,250	90		$49,000	$12,250	$61,250
41		$39,000	$9,750	$48,750	91		$39,000	$9,750	$48,750
42		$39,000	$9,750	$48,750	92		$39,000	$9,750	$48,750
43		$39,000	$9,750	$48,750	93		$39,000	$9,750	$48,750
44		$39,000	$9,750	$48,750	94		$39,000	$9,750	$48,750
45		$39,000	$9,750	$48,750	95		$39,000	$9,750	$48,750
46		$39,000	$9,750	$48,750	96		$39,000	$9,750	$48,750
47		$39,000	$9,750	$48,750	97		$39,000	$9,750	$48,750
48		$39,000	$9,750	$48,750	98		$39,000	$9,750	$48,750
49		$39,000	$9,750	$48,750	99		$39,000	$9,750	$48,750
50		$99,000	$24,750	$123,750	100		$39,000	$9,750	$48,750
					TOTAL	$1,526,100	$5,101,900	$1,657,100	$8,285,100

NET PRESENT VALUE $4,847,800

TABLE C-4

COST ESTIMATE
ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL AND MONITORED NATURAL ATTENUATION

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Item	Quantity	Unit	Rate/ Percentage	Total	Years	Total
Construction Costs						
Mobilization	1	LS	$200,000	$200,000		
Excavation	84,000	Tons	$12	$1,008,000		
Offsite Transportation and Disposal (hazardous)	84,000	Tons	$300	$25,200,000		
Backfill and Grading	84,000	Tons	$15	$1,260,000		
Facility Demolition	1	LS	$250,000	$250,000		
Facility Construction	1	LS	$3,000,000	$3,000,000		
Surveying	30	Day	$1,500	$45,000		
			Construction Subtotal	$30,963,000		
Consultant Costs						
Design and Permitting	1	LS	$300,000	$300,000		
Consultant	1	LS	$16,000	$16,000		
Implement Institutional Controls	1	LS	$10,000	$10,000		
Field Investigation	1	LS	$100,000	$100,000		
Construction Management			20%	$1,152,600		
			Consultant Subtotal	$1,578,600		
			Total Initial Construction and Consultant Costs	**$32,541,600**		
Annual Long Term Costs						
Annual Costs, Years 1 through 10						
Maintain Institutional Controls	1	LS	$1,000	$1,000	10	$10,000
Annual Costs, Years 1 through 5						
Groundwater Sampling & Reporting	2	Ea	$15,600	$31,200	5	$156,000
Annual Costs for Years 6 through 10						
Groundwater Sampling & Reporting	1	Ea	$14,000	$14,000	5	$70,000
One Time Construction Cost						
Abandon 20 wells in year 11	20	LS	$1,500	$30,000	1	$30,000
				Long-Term Costs Subtotal		$266,000
				Total Initial Construction and Consultant Costs		$32,541,600
				Total Construction/Consultant and Long-Term Costs		$32,807,600
				Contingency	25%	$8,201,900
TOTAL PROJECT COST						**$41,010,000**
TOTAL NET PRESENT VALUE COST						**$40,179,300**

Notes and Assumptions

1. Cost includes institutional controls and monitoring natural attenuation.
2. The net present value is based on discount rate of 2% (Interest rate of 4.5% and inflation of 2.5%).
3. Average well depths are assumed to be 40 feet.
4. Assumes for the initial 5 years, the monitoring will be semiannual, limited to 10 wells for pentachlorophenol and 4 wells for polycyclic aromatic hydrocarbons.
5. Assumes after 5 years, the monitoring will be annual, limited to 10 wells for pentachlorophenol and 4 wells for polycyclic aromatic hydrocarbons.
6. Excavation costs include removal of existing groundwater remediation system.

NET PRESENT VALUE CALCULATION

Year	Const./Consult	Annual	Contingency	Total	Year	Const./Consult	Annual	Contingency	Total
1	$32,541,600	$32,200	$8,143,450	$40,717,250	51		$0	$0	$0
2		$32,200	$8,050	$40,250	52		$0	$0	$0
3		$32,200	$8,050	$40,250	53		$0	$0	$0
4		$32,200	$8,050	$40,250	54		$0	$0	$0
5		$32,200	$8,050	$40,250	55		$0	$0	$0
6		$15,000	$3,750	$18,750	56		$0	$0	$0
7		$15,000	$3,750	$18,750	57		$0	$0	$0
8		$15,000	$3,750	$18,750	58		$0	$0	$0
9		$15,000	$3,750	$18,750	59		$0	$0	$0
10		$15,000	$3,750	$18,750	60		$0	$0	$0
11		$30,000	$7,500	$37,500	61		$0	$0	$0
12		$0	$0	$0	62		$0	$0	$0
13		$0	$0	$0	63		$0	$0	$0
14		$0	$0	$0	64		$0	$0	$0
15		$0	$0	$0	65		$0	$0	$0
16		$0	$0	$0	66		$0	$0	$0
17		$0	$0	$0	67		$0	$0	$0
18		$0	$0	$0	68		$0	$0	$0
19		$0	$0	$0	69		$0	$0	$0
20		$0	$0	$0	70		$0	$0	$0
21		$0	$0	$0	71		$0	$0	$0
22		$0	$0	$0	72		$0	$0	$0
23		$0	$0	$0	73		$0	$0	$0
24		$0	$0	$0	74		$0	$0	$0
25		$0	$0	$0	75		$0	$0	$0
26		$0	$0	$0	76		$0	$0	$0
27		$0	$0	$0	77		$0	$0	$0
28		$0	$0	$0	78		$0	$0	$0
29		$0	$0	$0	79		$0	$0	$0
30		$0	$0	$0	80		$0	$0	$0
31		$0	$0	$0	81		$0	$0	$0
32		$0	$0	$0	82		$0	$0	$0
33		$0	$0	$0	83		$0	$0	$0
34		$0	$0	$0	84		$0	$0	$0
35		$0	$0	$0	85		$0	$0	$0
36		$0	$0	$0	86		$0	$0	$0
37		$0	$0	$0	87		$0	$0	$0
38		$0	$0	$0	88		$0	$0	$0
39		$0	$0	$0	89		$0	$0	$0
40		$0	$0	$0	90		$0	$0	$0
41		$0	$0	$0	91		$0	$0	$0
42		$0	$0	$0	92		$0	$0	$0
43		$0	$0	$0	93		$0	$0	$0
44		$0	$0	$0	94		$0	$0	$0
45		$0	$0	$0	95		$0	$0	$0
46		$0	$0	$0	96		$0	$0	$0
47		$0	$0	$0	97		$0	$0	$0
48		$0	$0	$0	98		$0	$0	$0
49		$0	$0	$0	99		$0	$0	$0
50		$0	$0	$0	100		$0	$0	$0
					TOTAL	$32,541,600	266,000	8,201,900	$41,009,500

NET PRESENT VALUE **$40,179,300**

TABLE C-5

COST ESTIMATE
ALTERNATIVE 4 - ENHANCED BIODEGRADATION RECIRCULATION SYSTEM

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Item	Quantity	Unit	Rate/ Percentage	Total	Years	Total
Construction Costs						
Existing System	0	LS	$0	$0		
Replace & upgrade infiltration gallery	1	LS	$85,000	$85,000		
	0	LS	$0	$0		
	0	LS	$0	$0		
	0	LS	$0	$0		
	0	LS	$0	$0		
	0	LS	$0	$0		
	3	LS	$0	$0		
	1	LS	$0	$0		
			Construction Subtotal	$85,000		
Consultant Costs						
Design and Permitting	0	LS	$0	$0		
Consultant	0	LS	$0	$0		
Implement ICs & Indoor Air Monitoring	0	LS	$0	$0		
Field Investigation	0	LS	$0	$0		
Construction Management	0		20%	$17,000		
			Consultant Subtotal	$17,000		
Total Initial Construction and Consultant Costs				**$102,000**		
Annual Long Term Costs						
Annual Costs, Years 1 through 100						
Maintain Institutional Controls	1	LS	$1,000	$1,000	100	$100,000
Annual Cost for Years 1 through 15						
Groundwater Sampling & Reporting	2	Ea	$17,730	$35,460	15	$531,900
LNAPL Disposal	1	Ea	$5,000	$5,000	15	$75,000
Recirc. System O&M	1	Ea	$19,560	$19,560	15	$293,400
Annual Costs for Years 16 through 100						
Groundwater Sampling & Reporting	1	Ea	$14,000	$14,000	85	$1,190,000
LNAPL Disposal	1	Ea	$5,000	$5,000	15	$75,000
Recirc. System O&M	0	Ea	$0	$17,260	85	$1,467,100
One Time Construction Cost						
Pump replacement allowance (yr 10, 20...)	1	LS	$10,000	$10,000	9	$90,000
Replace 16 wells (yr 25, 50, 75)	1	LS	$50,000	$50,000	3	$150,000
Gallery maintenance (yr 6, 11, 15, 21...)	1	Ea	$15,000	$15,000	19	$285,000
Abandon 20 wells in year 16	20	Ea	$1,500	$30,000	1	$30,000
					Long-Term Costs Subtotal	$4,287,400
					Total Initial Construction and Consultant Costs	$102,000
					Total Construction/Consultant and Long-Term Costs	$4,389,400
					Contingency 25%	$1,097,400
TOTAL PROJECT COST						**$5,487,000**
TOTAL NET PRESENT VALUE COST						**$2,684,700**

Notes and Assumptions

1. Cost includes institutional controls and monitoring natural attenuation.
2. The net present value is based on a net discount rate of 2% (Interest rate of 4.5% and inflation of 2.5%).
3. Average well depths are assumed to be 40 feet.
4. Abandon 20 existing wells in year 16
5. Assumes for the initial 15 years, the monitoring will be semiannual, limited to 20 wells for pentachlorophenol and 7 wells for polycyclic aromatic hydrocarbons, plus 5 wells for MNA.
6. Assumes from years 16 to 100, the monitoring will be annual, limited to 10 wells for pentachlorophenol and 4 wells for polycyclic aromatic hydrocarbons and MNA
7. Assumes average well operational lifetime of 25 years. Allowance for pump replacement of $10000 every 10 yrs.
8. Initial costs for Alternative 4 do not include costs already incurred by Baxter of approximately $967,000 (installation and operations and maintenance).

LF= linear feet
LS = lump sum
O&M = operations and maintenance
SF = square feet

NET PRESENT VALUE CALCULATION

Year	Const./Consult	Annual	Contingency	Total	Year	Const./Consult	Annual	Contingency	Total
1	$102,000	$61,020	$40,760	$203,780	51		$47,260	$11,820	$59,080
2		$61,020	$15,260	$76,280	52		$32,260	$8,070	$40,330
3		$61,020	$15,260	$76,280	53		$32,260	$8,070	$40,330
4		$61,020	$15,260	$76,280	54		$32,260	$8,070	$40,330
5		$61,020	$15,260	$76,280	55		$32,260	$8,070	$40,330
6		$76,020	$19,010	$95,030	56		$47,260	$11,820	$59,080
7		$61,020	$15,260	$76,280	57		$32,260	$8,070	$40,330
8		$61,020	$15,260	$76,280	58		$32,260	$8,070	$40,330
9		$61,020	$15,260	$76,280	59		$32,260	$8,070	$40,330
10		$71,020	$17,760	$88,780	60		$42,260	$10,570	$52,830
11		$76,020	$19,010	$95,030	61		$47,260	$11,820	$59,080
12		$61,020	$15,260	$76,280	62		$32,260	$8,070	$40,330
13		$61,020	$15,260	$76,280	63		$32,260	$8,070	$40,330
14		$61,020	$15,260	$76,280	64		$32,260	$8,070	$40,330
15		$61,020	$15,260	$76,280	65		$32,260	$8,070	$40,330
16		$82,260	$20,570	$102,830	66		$47,260	$11,820	$59,080
17		$37,260	$9,320	$46,580	67		$32,260	$8,070	$40,330
18		$37,260	$9,320	$46,580	68		$32,260	$8,070	$40,330
19		$37,260	$9,320	$46,580	69		$32,260	$8,070	$40,330
20		$47,260	$11,820	$59,080	70		$42,260	$10,570	$52,830
21		$52,260	$13,070	$65,330	71		$47,260	$11,820	$59,080
22		$37,260	$9,320	$46,580	72		$32,260	$8,070	$40,330
23		$37,260	$9,320	$46,580	73		$32,260	$8,070	$40,330
24		$37,260	$9,320	$46,580	74		$32,260	$8,070	$40,330
25		$87,260	$21,820	$109,080	75		$82,260	$20,570	$102,830
26		$52,260	$13,070	$65,330	76		$47,260	$11,820	$59,080
27		$37,260	$9,320	$46,580	77		$32,260	$8,070	$40,330
28		$37,260	$9,320	$46,580	78		$32,260	$8,070	$40,330
29		$37,260	$9,320	$46,580	79		$32,260	$8,070	$40,330
30		$47,260	$11,820	$59,080	80		$42,260	$10,570	$52,830
31		$47,260	$11,820	$59,080	81		$47,260	$11,820	$59,080
32		$32,260	$8,070	$40,330	82		$32,260	$8,070	$40,330
33		$32,260	$8,070	$40,330	83		$32,260	$8,070	$40,330
34		$32,260	$8,070	$40,330	84		$32,260	$8,070	$40,330
35		$32,260	$8,070	$40,330	85		$32,260	$8,070	$40,330
36		$47,260	$11,820	$59,080	86		$47,260	$11,820	$59,080
37		$32,260	$8,070	$40,330	87		$32,260	$8,070	$40,330
38		$32,260	$8,070	$40,330	88		$32,260	$8,070	$40,330
39		$32,260	$8,070	$40,330	89		$32,260	$8,070	$40,330
40		$42,260	$10,570	$52,830	90		$42,260	$10,570	$52,830
41		$47,260	$11,820	$59,080	91		$47,260	$11,820	$59,080
42		$32,260	$8,070	$40,330	92		$32,260	$8,070	$40,330
43		$32,260	$8,070	$40,330	93		$32,260	$8,070	$40,330
44		$32,260	$8,070	$40,330	94		$32,260	$8,070	$40,330
45		$32,260	$8,070	$40,330	95		$32,260	$8,070	$40,330
46		$47,260	$11,820	$59,080	96		$47,260	$11,820	$59,080
47		$32,260	$8,070	$40,330	97		$32,260	$8,070	$40,330
48		$32,260	$8,070	$40,330	98		$32,260	$8,070	$40,330
49		$32,260	$8,070	$40,330	99		$32,260	$8,070	$40,330
50		$92,260	$23,070	$115,330	100		$32,260	$8,070	$40,330
					TOTAL	$102,000	$4,287,400	$1,097,900	$5,487,300

NET PRESENT VALUE $2,684,700

TABLE C-6

COST ESTIMATE

ALTERNATIVE 5 - ELECTRIC RESISTANCE HEATING AND ENHANCED BIODEGRADATION RECIRCULATION

Former J.H. Baxter & Co. Wood Treating Facility

Arlington, Washington

Item	Quantity	Unit	Rate/ Percentage	Total	Years	Total
Construction Costs						
Mobilization	1	LS	$425,000	$425,000		
Electrode Well Installation	4,500	LF	$57	$256,500		
Offsite Transportation and Disposal (hazardous)	170	Ton	$300	$51,000		
Fludis Disposal	20	Drum	$800	$16,000		
Trenching, Piping, Vaults, GAC	1	LS	$120,000	$120,000		
ERH System Install & Operation	1	LS	$600,000	$600,000		
Electricty Usage (130 days)	3,200,000	kWh	$0.08	$256,000		
Heating beyond 130 days	3	Month	$122,000	$366,000		
Electrical Power Drop	1	LS	$50,000	$50,000		
			Construction Subtotal	$2,140,500		
Consultant Costs						
Design and Permitting	1	LS	$150,000	$150,000		
Consultant	1	LS	$16,000	$16,000		
Implement ICs & Indoor Air Monitoring	1	LS	$40,000	$40,000		
Pilot test/Supplemental Field Investigation	1	LS	$150,000	$150,000		
Construction Management			20%	$428,100		
			Consultant Subtotal	$784,100		
Total Initial Construction and Consultant Costs				**$2,924,600**		
Annual Long Term Costs						
Annual Costs, Years 1 through 20						
Maintain Institutional Controls	1	LS	$1,000	$1,000	20	$20,000
Annual Cost for Years 1 through 5						
Groundwater Sampling & Reporting	2	Ea	$17,730	$35,460	5	$177,300
LNAPL Disposal	1	Ea	$1,980	$1,980	5	$9,900
Recirc. System O&M	1	Ea	$19,560	$19,560	5	$97,800
Annual Costs for Years 6 through 20						
Groundwater Sampling & Reporting	1	Ea	$14,000	$14,000	15	$210,000
LNAPL Disposal	0	Ea	$0	$0	0	$0
Recirc. System O&M	0	Ea	$0	$0	0	$0
One Time Construction Cost in Years 2, 6 and 21						
Abandon Electrode Wells - *Year 2*	4500	LF	$8	$36,000	1	$36,000
Remove Groundwater Treatment System - *Year 11*	1	LS	$50,000	$50,000	1	$50,000
Well Abandonment - *Year 11*	20	Ea	$1,500	$30,000	1	$30,000
Well Abandonment - *Year 21*	16	Ea	$1,500	$24,000	1	$24,000
				Long-Term Costs Subtotal		$655,000
				Total Initial Construction and Consultant Costs		$2,924,600
				Total Construction/Consultant and Long-Term Costs		$3,579,600
				Contingency	25%	$894,900
TOTAL PROJECT COST						**$4,475,000**
TOTAL NET PRESENT VALUE COST						**$4,287,500**

Notes and Assumptions

1. Cost includes institutional controls and monitoring natural attenuation.
2. The net present value is based on a net discount rate of 2% (Interest rate of 4.5% and inflation of 2.5%).
3. Average well depths are assumed to be 40 feet.
4. Abandon 20 existing wells in year 6, and abandon 16 wells in year 21
5. Assumes for the initial 5 years, the monitoring will be semiannual, limited to 20 wells for pentachlorophenol and 7 wells for polycyclic aromatic hydrocarbons, plus 5 wells for MNA.
6. Assumes from years 6 to 20, the monitoring will be annual, limited to 10 wells for pentachlorophenol and 4 wells for polycyclic aromatic hydrocarbons and MNA.
7. Assumes average well operational lifetime of 25 years.
8. Assumes 70% of waste (cuttings) can be taked to Haz-landfill, the other 30% will listed as hazardous waste F032.
9. IC's - $10,000, indoor air monitoring - $30,000 (equipment rental, analytical, staff time)

Abbreviations

LF= linear feet

LS = lump sum

O&M = operations and maintenance

SF = square feet

NET PRESENT VALUE CALCULATION

Year	Const./Consult	Annual	Contingency	Total	Year	Const./Consult	Annual	Contingency	Total
1	$2,924,600	$58,000	$745,650	$3,728,250	51		$0	$0	$0
2		$94,000	$23,500	$117,500	52		$0	$0	$0
3		$58,000	$14,500	$72,500	53		$0	$0	$0
4		$58,000	$14,500	$72,500	54		$0	$0	$0
5		$58,000	$14,500	$72,500	55		$0	$0	$0
6		$15,000	$3,750	$18,750	56		$0	$0	$0
7		$15,000	$3,750	$18,750	57		$0	$0	$0
8		$15,000	$3,750	$18,750	58		$0	$0	$0
9		$15,000	$3,750	$18,750	59		$0	$0	$0
10		$15,000	$3,750	$18,750	60		$0	$0	$0
11		$95,000	$23,750	$118,750	61		$0	$0	$0
12		$15,000	$3,750	$18,750	62		$0	$0	$0
13		$15,000	$3,750	$18,750	63		$0	$0	$0
14		$15,000	$3,750	$18,750	64		$0	$0	$0
15		$15,000	$3,750	$18,750	65		$0	$0	$0
16		$15,000	$3,750	$18,750	66		$0	$0	$0
17		$15,000	$3,750	$18,750	67		$0	$0	$0
18		$15,000	$3,750	$18,750	68		$0	$0	$0
19		$15,000	$3,750	$18,750	69		$0	$0	$0
20		$15,000	$3,750	$18,750	70		$0	$0	$0
21		$24,000	$6,000	$30,000	71		$0	$0	$0
22		$0	$0	$0	72		$0	$0	$0
23		$0	$0	$0	73		$0	$0	$0
24		$0	$0	$0	74		$0	$0	$0
25		$0	$0	$0	75		$0	$0	$0
26		$0	$0	$0	76		$0	$0	$0
27		$0	$0	$0	77		$0	$0	$0
28		$0	$0	$0	78		$0	$0	$0
29		$0	$0	$0	79		$0	$0	$0
30		$0	$0	$0	80		$0	$0	$0
31		$0	$0	$0	81		$0	$0	$0
32		$0	$0	$0	82		$0	$0	$0
33		$0	$0	$0	83		$0	$0	$0
34		$0	$0	$0	84		$0	$0	$0
35		$0	$0	$0	85		$0	$0	$0
36		$0	$0	$0	86		$0	$0	$0
37		$0	$0	$0	87		$0	$0	$0
38		$0	$0	$0	88		$0	$0	$0
39		$0	$0	$0	89		$0	$0	$0
40		$0	$0	$0	90		$0	$0	$0
41		$0	$0	$0	91		$0	$0	$0
42		$0	$0	$0	92		$0	$0	$0
43		$0	$0	$0	93		$0	$0	$0
44		$0	$0	$0	94		$0	$0	$0
45		$0	$0	$0	95		$0	$0	$0
46		$0	$0	$0	96		$0	$0	$0
47		$0	$0	$0	97		$0	$0	$0
48		$0	$0	$0	98		$0	$0	$0
49		$0	$0	$0	99		$0	$0	$0
50		$0	$0	$0	100		$0	$0	$0
					TOTAL	$2,924,600	$655,000	$894,900	$4,474,500

NET PRESENT VALUE **$4,287,500**

TABLE C-7

COST ESTIMATE
ALTERNATIVE 6 - CHEMICAL OXIDATION, RECIRCULATION, AND MONITORED NATURAL ATTENUATION

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Item	Quantity	Unit	Rate/ Percentage	Total	Years	Total
Construction Costs						
Mobilization	1	LS	$100,000	$100,000		
Chemical Oxidation Push Probe Injection (per point)	420	Ea	$1,500	$630,000		
Regenox Cost	120,000	LBS	$1.80	$216,000		
Fluids Disposal	20	Drum	$800	$16,000		
Water	300	CCF	$4.00	$1,200		
Offsite Transportation and Disposal (hazardous)	25	Tons	$300	$7,500		
Surveying	10	Day	$1,500	$15,000		
Pilot Test	1	LS	$50,000	$50,000		
Construction Subtotal				**$1,035,700**		
Consultant Costs						
Design and Permitting	1	LS	$120,000	$120,000		
Consultant	1	LS	$16,000	$16,000		
Implement Institutional Controls	1	LS	$10,000	$10,000		
Pilot Test Evaluation/Supplemental Field Investigatior	1	LS	$100,000	$100,000		
Construction Management			20%	$207,140		
Consultant Subtotal				**$453,140**		
Total Initial Construction and Consultant Costs				**$1,488,840**		
Annual Long Term Costs						
Annual Costs, Years 1 through 20						
Maintain Institutional Controls	1	LS	$1,000	$1,000	20	$20,000
Annual Cost for Years 1 through 5						
Groundwater Sampling & Reporting	2	Ea	$17,730	$35,460	5	$177,300
LNAPL Disposal	1	Ea	$1,980	$1,980	5	$9,900
Recirc. System O&M	1	Ea	$19,560	$19,560	5	$97,800
Annual Costs for Years 6 through 20						
Groundwater Sampling & Reporting	1	Ea	$14,000	$14,000	15	$210,000
LNAPL Disposal	0	Ea	$0	$0	0	$0
Recirc. System O&M	0	Ea	$0	$0	0	$0
One Time Construction Cost						
Remove Recirculation System - *Year 11*	1	LS	$50,000	$50,000	1	$50,000
Well Abandonment - *Year 11*	20	Ea	$1,500	$30,000	1	$30,000
Well Abandonment - *Year 21*	16	Ea	$1,500	$24,000	1	$24,000
Long-Term Costs Subtotal						$619,000
Total Initial Construction and Consultant Costs						$1,488,840
Total Construction/Consultant and Long-Term Costs						$2,107,840
Contingency					25%	$526,960
TOTAL PROJECT COST						**$2,635,000**
TOTAL NET PRESENT VALUE COST						**$2,484,700**

Notes and Assumptions

1. Cost includes institutional controls and monitored natural attenuation.
2. The net present value is based on a net discount rate of 2% (Interest rate of 4.5% and inflation of 2.5%).
3. Push probe depths are assumed to be 30 feet deep, with a treatment thickness of 15-30 feet (no injection in wood waste areas).
4. Areas with the largest NAPL layer will be treated by overlapping events. An average of 3 injections will be completed per day. Each event will offset injection points in order to ensure good contact of oxidant with contaminants. Offsets may be replaced with targeting of other remaining NAPL areas, depending on pilot testing and initial injection results, but all thick NAPL areas will be treated at least twice with overlapping injections.
5. Assumes onsite fresh water source at $4 per CCF (750 gallons)
6. Assumes for the initial 5 years, the monitoring will be semiannual, limited to 20 wells for pentachlorophenol and 7 wells for polyaromatic hydrocarbons. Costs associated with data validation are not included.
7. Assumes after 5 years, the monitoring will be annual, limited to 10 wells for pentachlorophenol and 4 wells for polycyclic aromatic hyrdocarbons and MNA.
8. Assumes average well operational lifetime of 25 years.

Abbreviations

LS = lump sum
O&M = operations and maintenance

NET PRESENT VALUE CALCULATION

Year	Const./Consult	Annual	Contingency	Total	Year	Const./Consult	Annual	Contingency	Total
1	$1,488,840	$58,000	$386,710	$1,933,550	51		$0	$0	$0
2		$58,000	$14,500	$72,500	52		$0	$0	$0
3		$58,000	$14,500	$72,500	53		$0	$0	$0
4		$58,000	$14,500	$72,500	54		$0	$0	$0
5		$58,000	$14,500	$72,500	55		$0	$0	$0
6		$15,000	$3,750	$18,750	56		$0	$0	$0
7		$15,000	$3,750	$18,750	57		$0	$0	$0
8		$15,000	$3,750	$18,750	58		$0	$0	$0
9		$15,000	$3,750	$18,750	59		$0	$0	$0
10		$15,000	$3,750	$18,750	60		$0	$0	$0
11		$95,000	$23,750	$118,750	61		$0	$0	$0
12		$15,000	$3,750	$18,750	62		$0	$0	$0
13		$15,000	$3,750	$18,750	63		$0	$0	$0
14		$15,000	$3,750	$18,750	64		$0	$0	$0
15		$15,000	$3,750	$18,750	65		$0	$0	$0
16		$15,000	$3,750	$18,750	66		$0	$0	$0
17		$15,000	$3,750	$18,750	67		$0	$0	$0
18		$15,000	$3,750	$18,750	68		$0	$0	$0
19		$15,000	$3,750	$18,750	69		$0	$0	$0
20		$15,000	$3,750	$18,750	70		$0	$0	$0
21		$24,000	$6,000	$30,000	71		$0	$0	$0
22		$0	$0	$0	72		$0	$0	$0
23		$0	$0	$0	73		$0	$0	$0
24		$0	$0	$0	74		$0	$0	$0
25		$0	$0	$0	75		$0	$0	$0
26		$0	$0	$0	76		$0	$0	$0
27		$0	$0	$0	77		$0	$0	$0
28		$0	$0	$0	78		$0	$0	$0
29		$0	$0	$0	79		$0	$0	$0
30		$0	$0	$0	80		$0	$0	$0
31		$0	$0	$0	81		$0	$0	$0
32		$0	$0	$0	82		$0	$0	$0
33		$0	$0	$0	83		$0	$0	$0
34		$0	$0	$0	84		$0	$0	$0
35		$0	$0	$0	85		$0	$0	$0
36		$0	$0	$0	86		$0	$0	$0
37		$0	$0	$0	87		$0	$0	$0
38		$0	$0	$0	88		$0	$0	$0
39		$0	$0	$0	89		$0	$0	$0
40		$0	$0	$0	90		$0	$0	$0
41		$0	$0	$0	91		$0	$0	$0
42		$0	$0	$0	92		$0	$0	$0
43		$0	$0	$0	93		$0	$0	$0
44		$0	$0	$0	94		$0	$0	$0
45		$0	$0	$0	95		$0	$0	$0
46		$0	$0	$0	96		$0	$0	$0
47		$0	$0	$0	97		$0	$0	$0
48		$0	$0	$0	98		$0	$0	$0
49		$0	$0	$0	99		$0	$0	$0
50		$0	$0	$0	100		$0	$0	$0
					TOTAL	$1,488,840	$619,000	$527,000	$2,634,800

NET PRESENT VALUE **$2,484,700**

APPENDIX D

Groundwater Hydrographs

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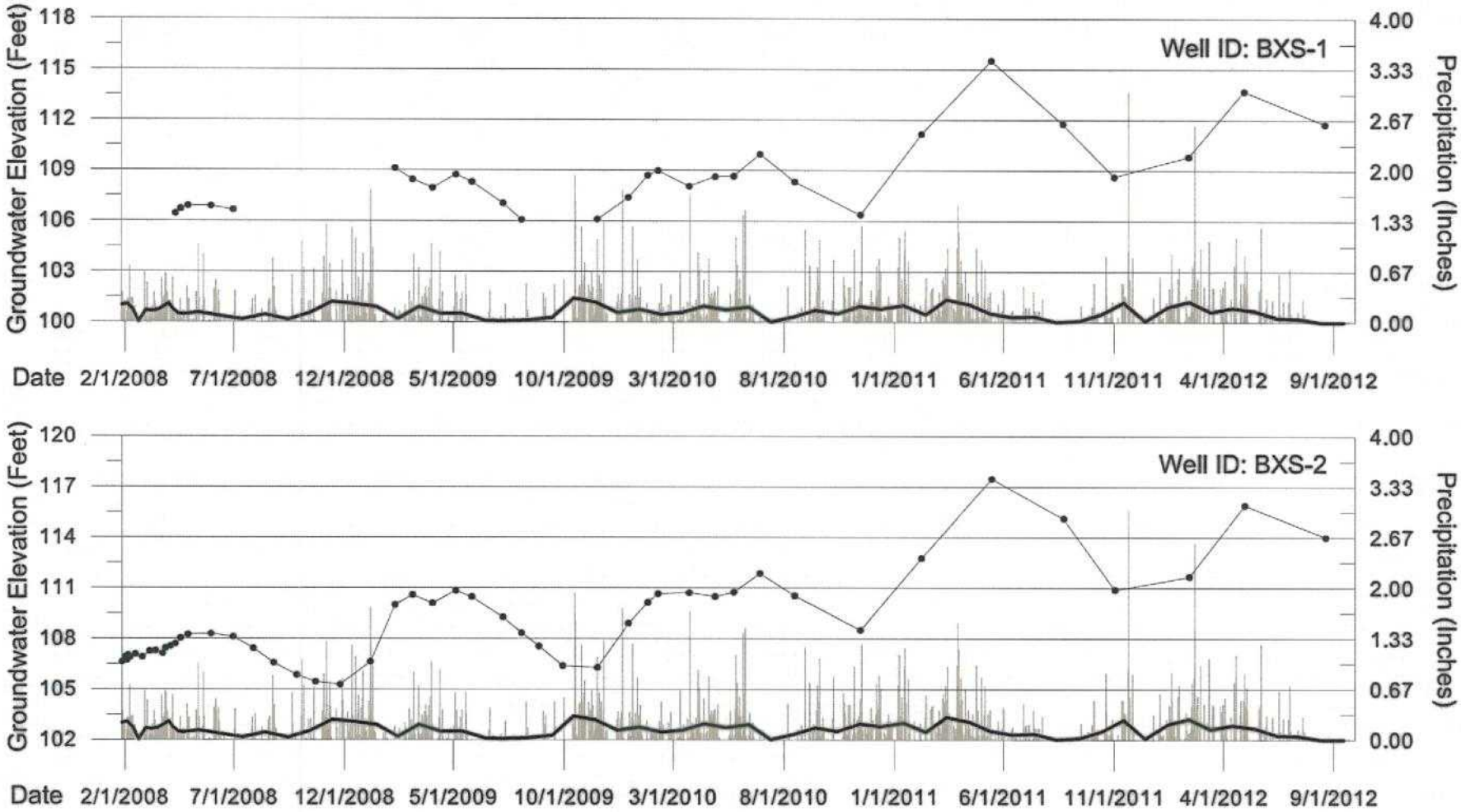

Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

LEGEND
- Groundwater elevation time series
- Daily Precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS BXS-1 AND BXS-2
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-1

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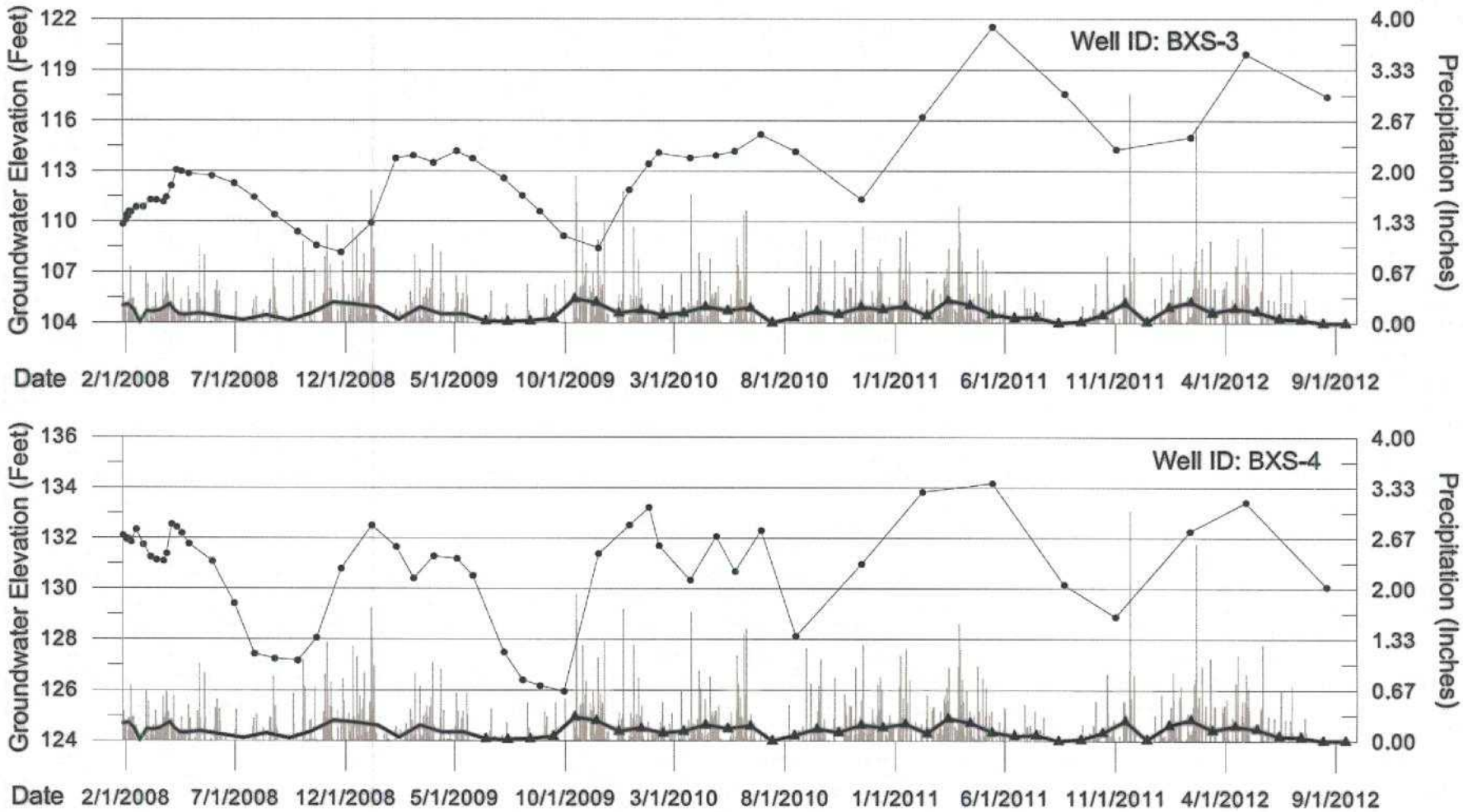

Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS BXS-3 AND BXS-4
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-2

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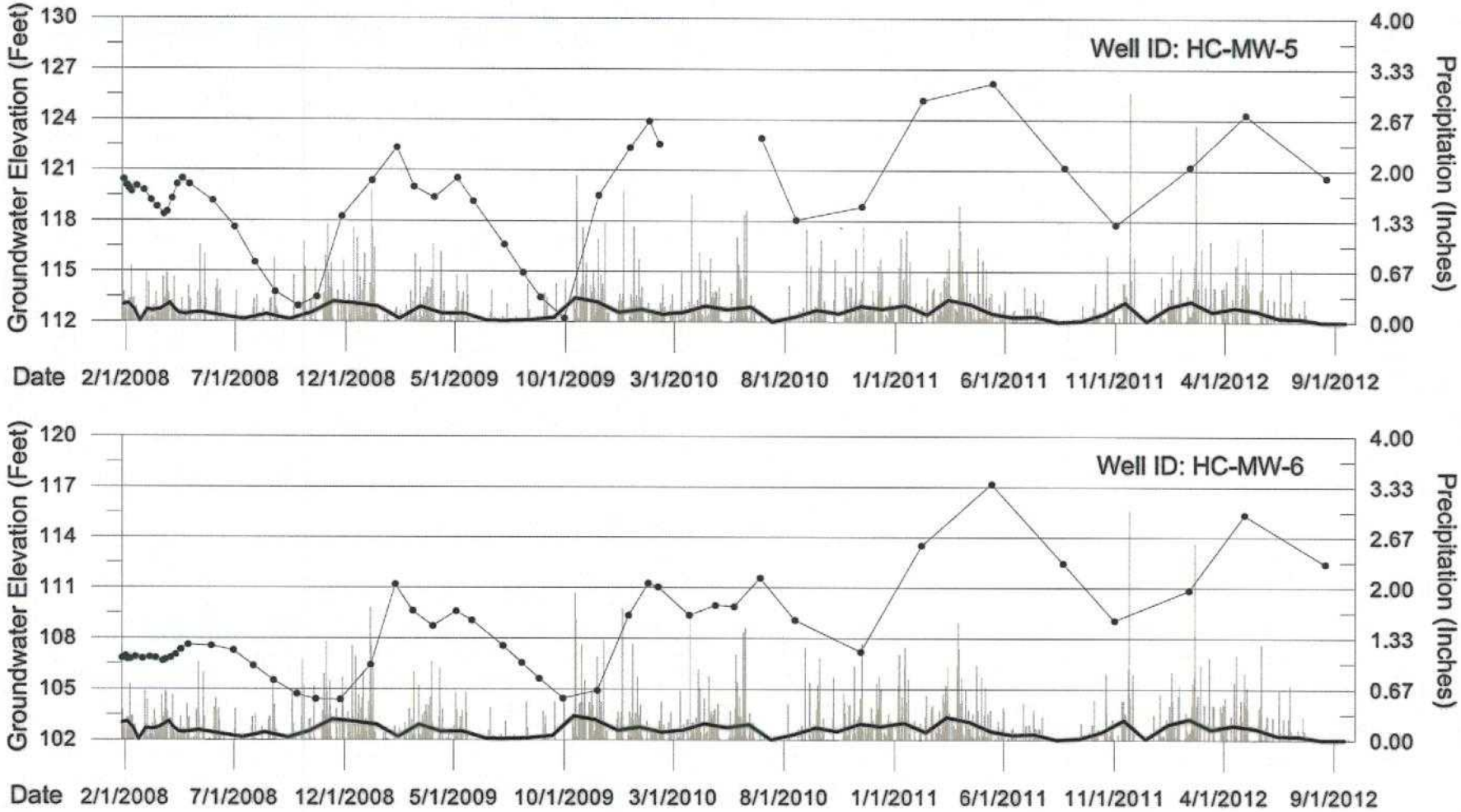

Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Groundwater elevation was not collected at HC-MW-5 during the March and April 2010 sampling period due to damaged well monument lid that could not be opened.
5. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
6. Precipitation is listed as zero for some unavailable June, August, and September 2012 data points.

LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS HC-MW-5 AND HC-MW-6
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-3

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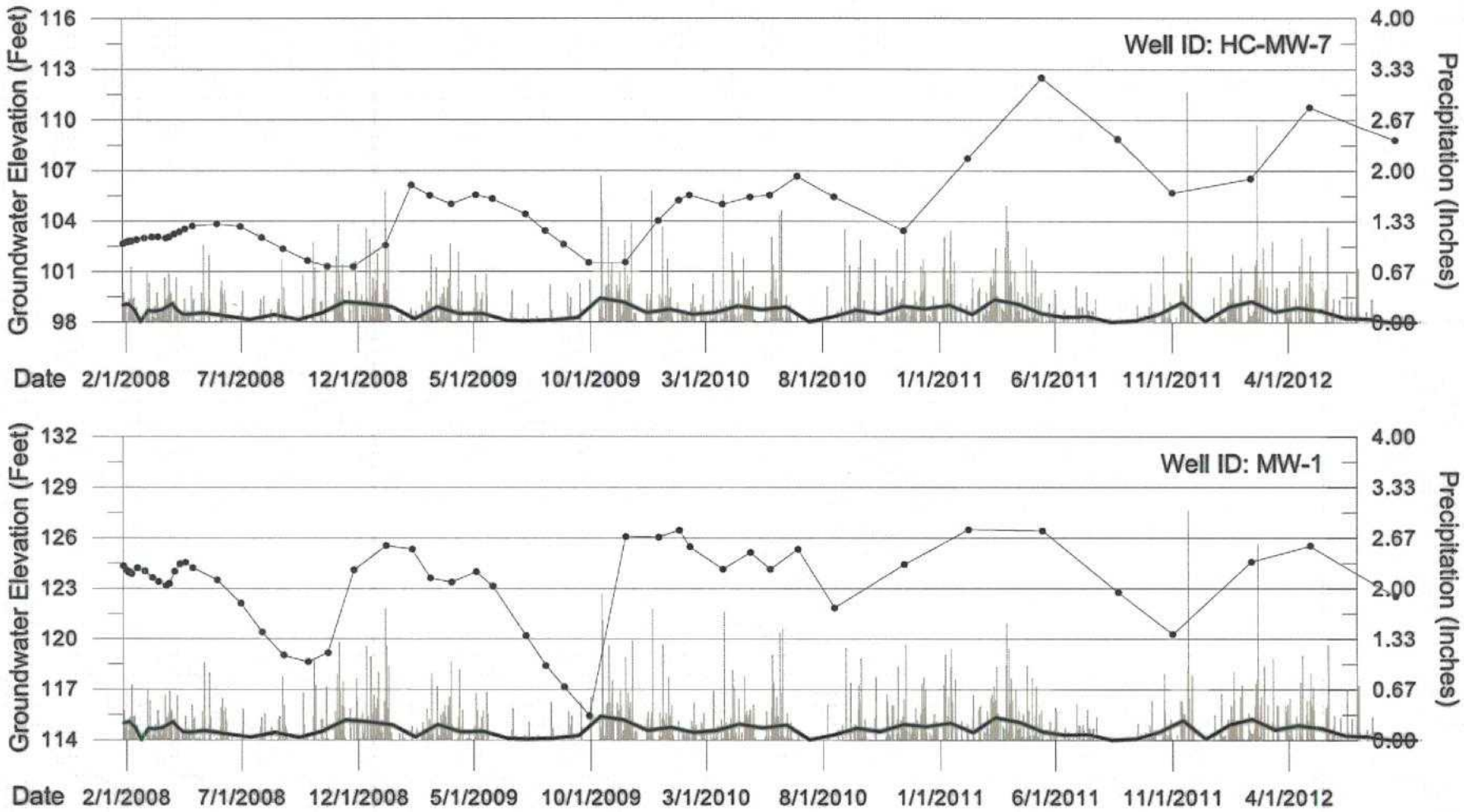


Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

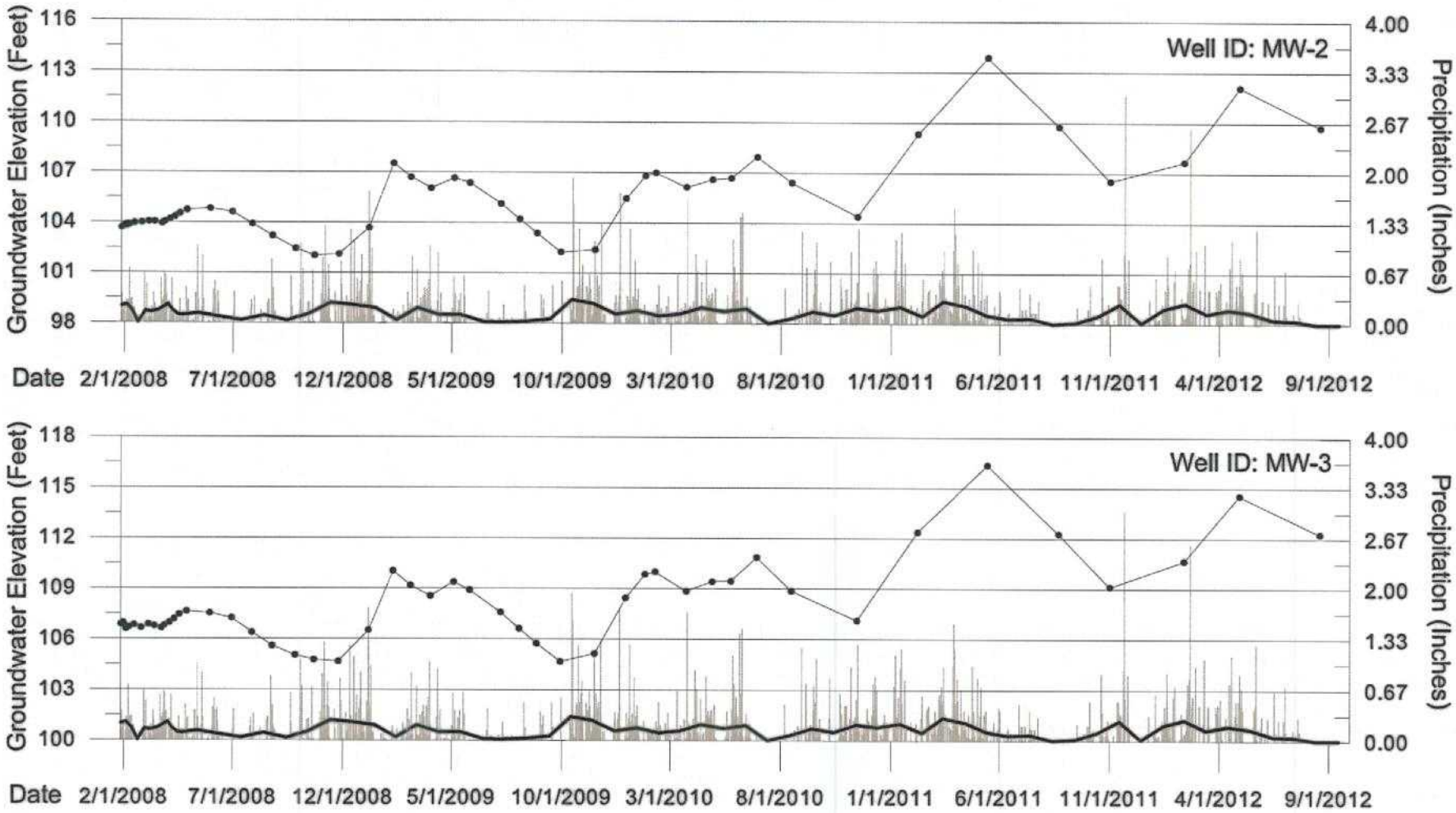
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS HC-MW-7 AND MW-1
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-4

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-2 AND MW-3
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-5

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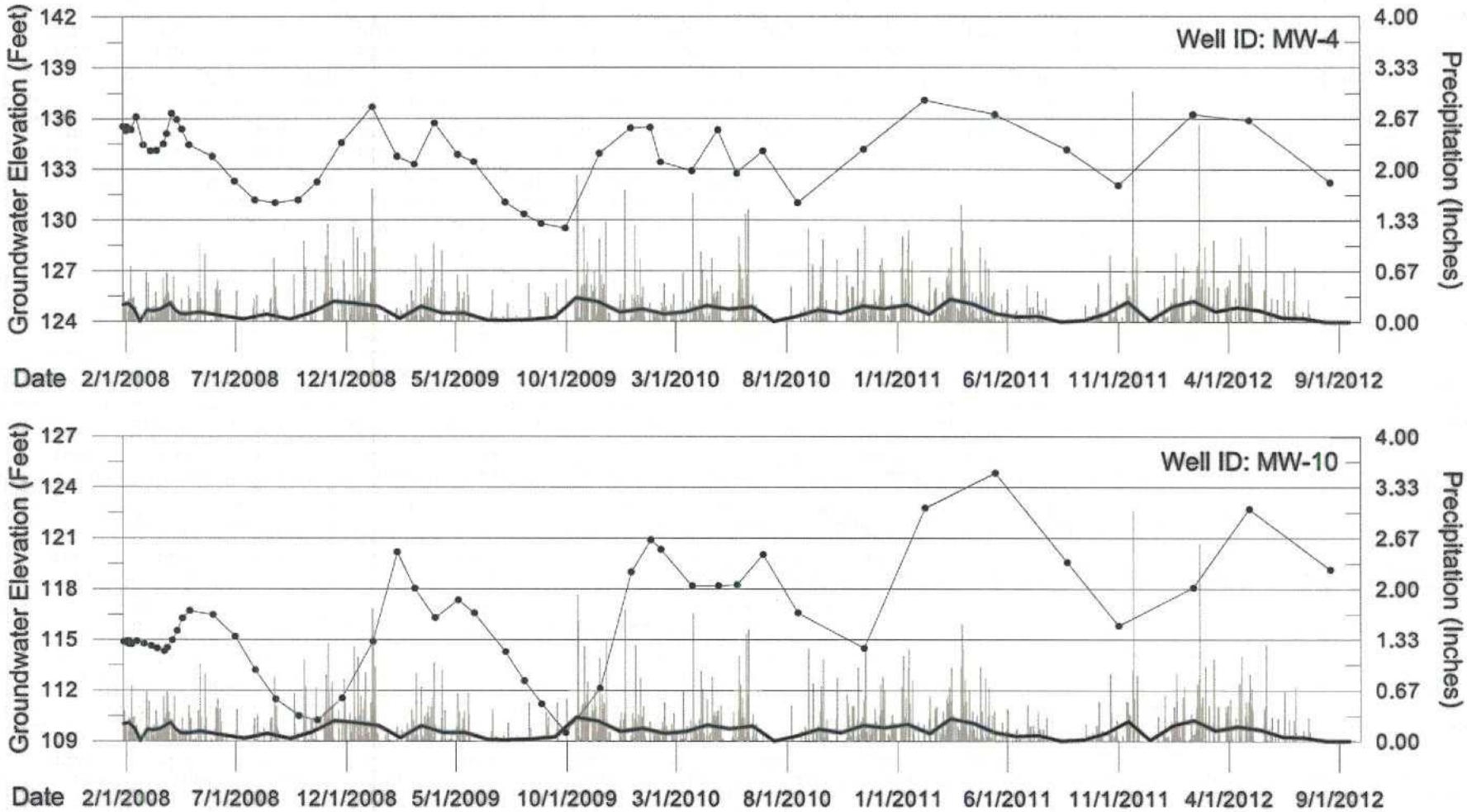


Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

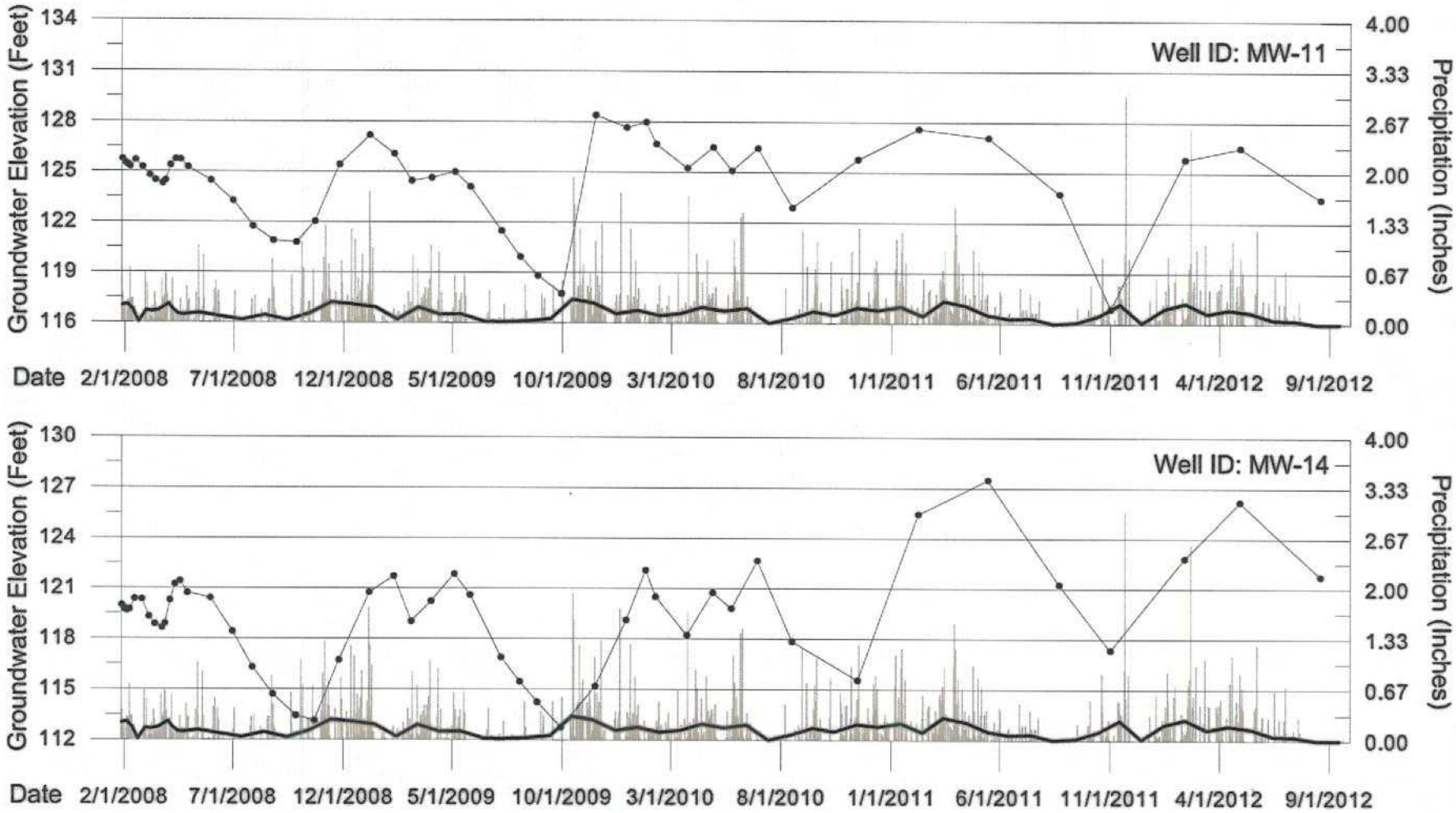
LEGEND
- Precipitation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-4 AND MW-10
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-6

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

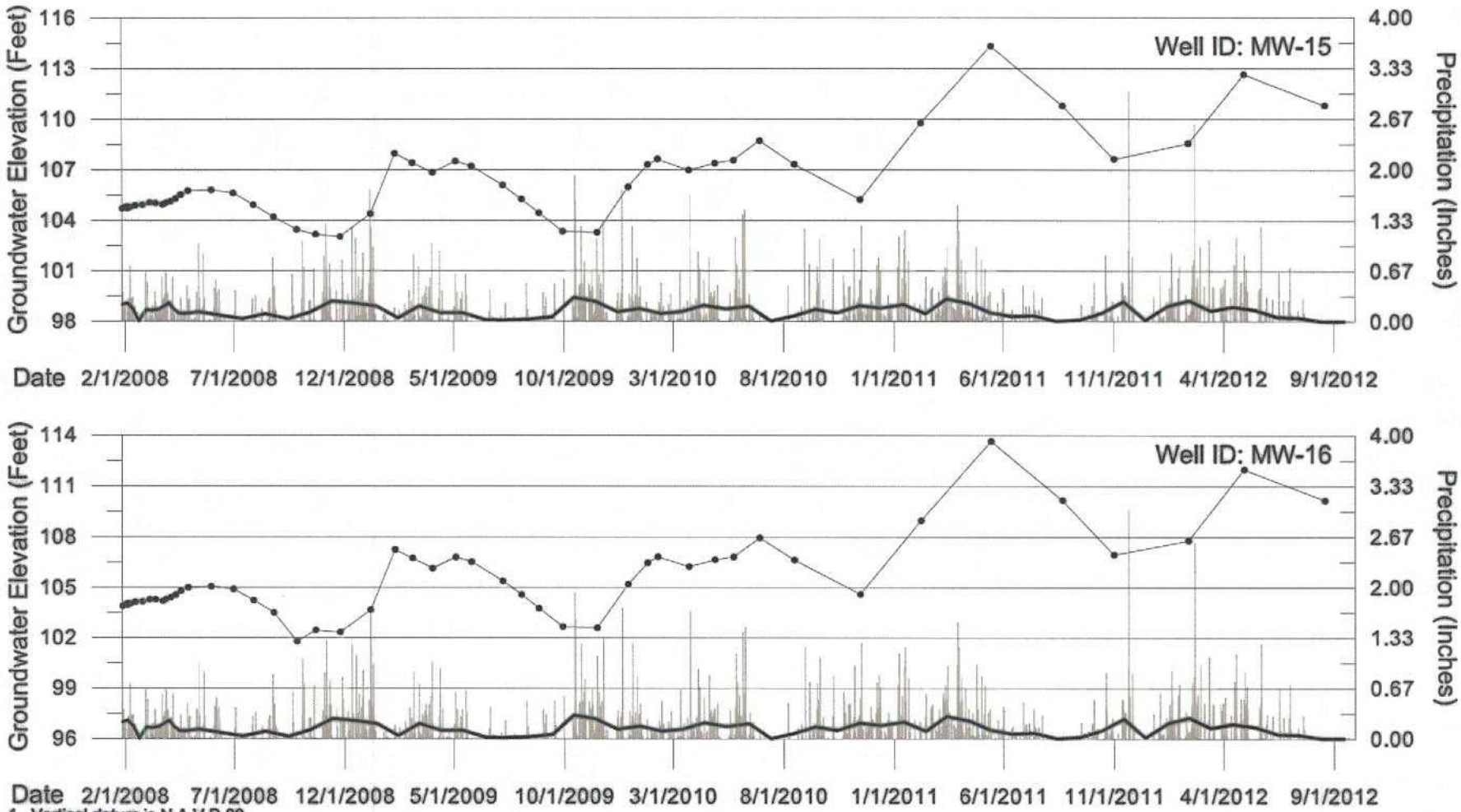
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-11 AND MW-14
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-7

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, August, and September 2012 data points.
6. In May 2011, a suspected incorrect depth to water measurement occurred at MW-15. The 2nd Quarter 2011 groundwater elevation at MW-15 was estimated by calculating the average elevation difference between MW-15 and MW-40 for the 3rd Quarter 2010 through the 1st Quarter 2011 and adding this difference to the 2nd Quarter 2011 groundwater elevation measured at MW-40.

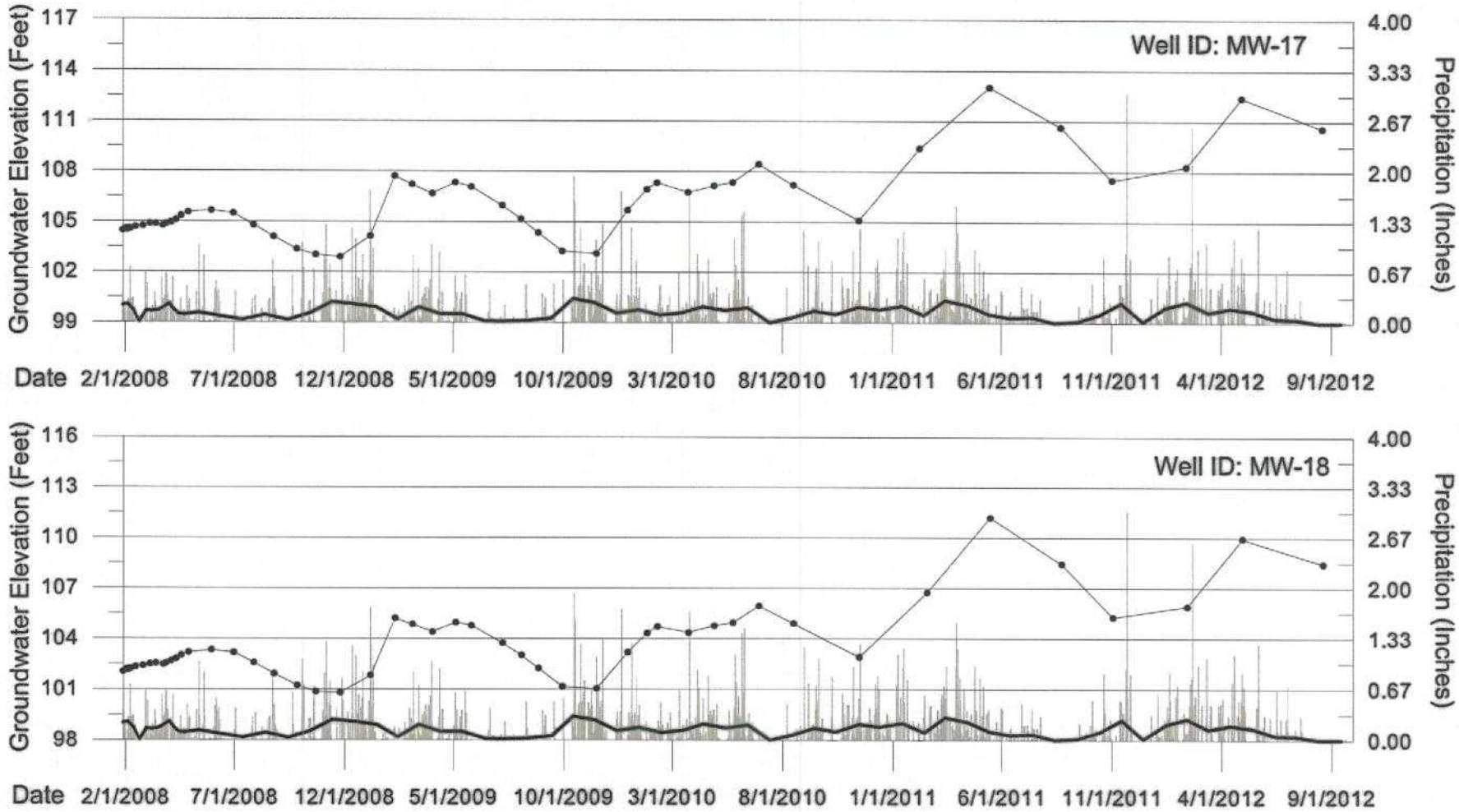
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-15 AND MW-16
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-8

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

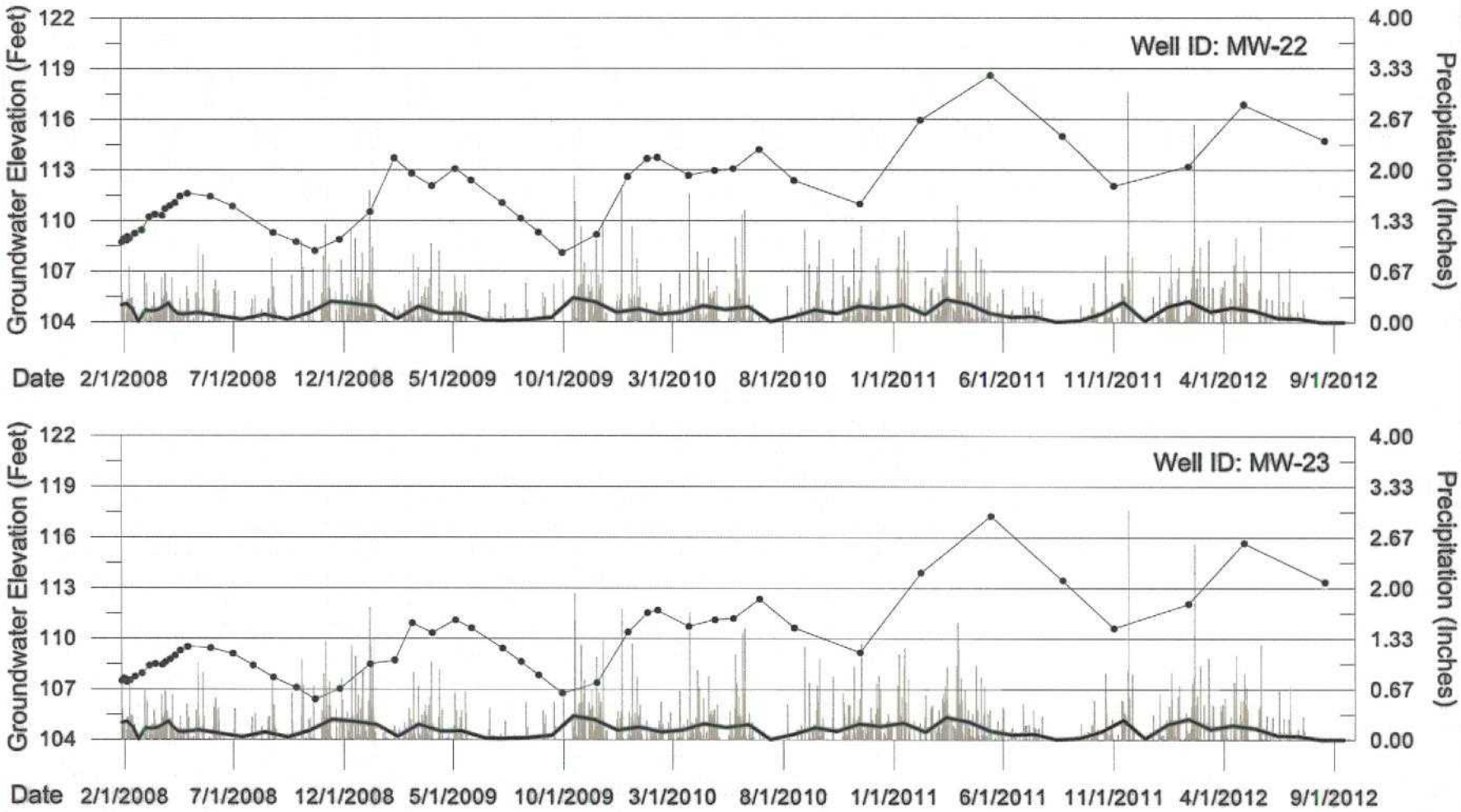
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-17 AND MW-18
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-9

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
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2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

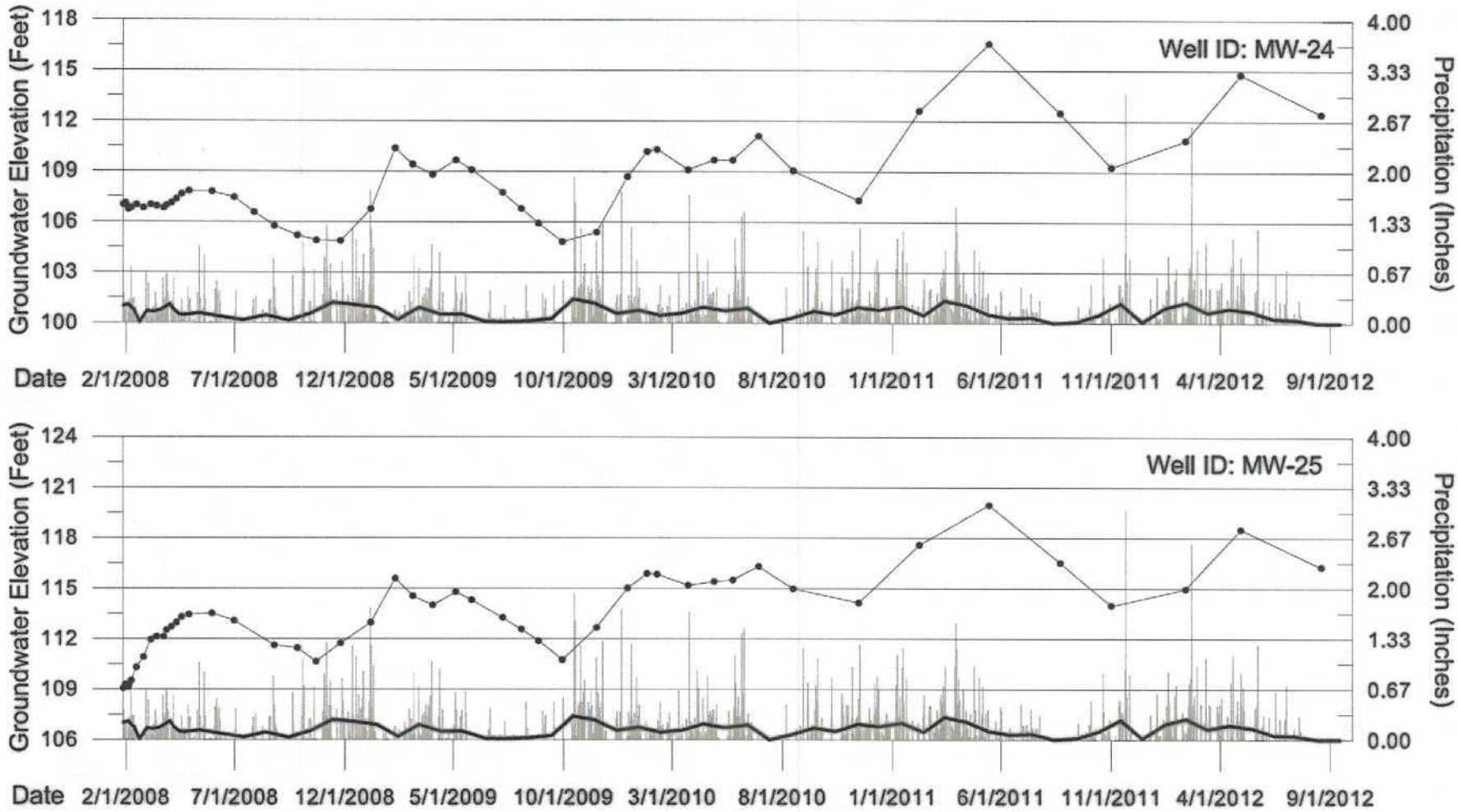
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-22 AND MW-23
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-10

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

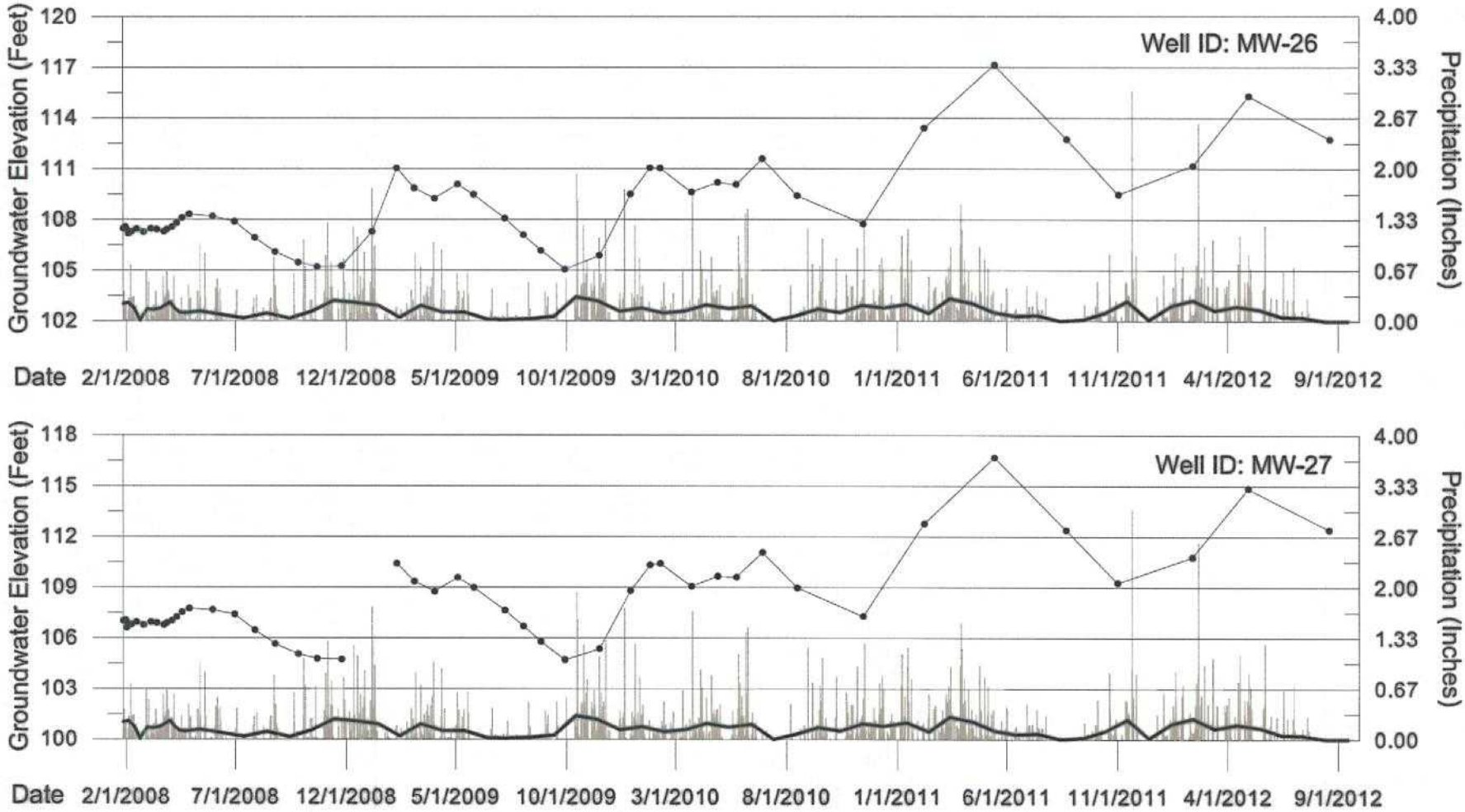
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-24 AND MW-25
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-11

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Groundwater elevation was not collected at MW-27 during the December 2008 sampling period due to high surface water conditions surrounding the well.
5. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
6. Precipitation is listed as zero for some unavailable June, August, and September 2012 data points.

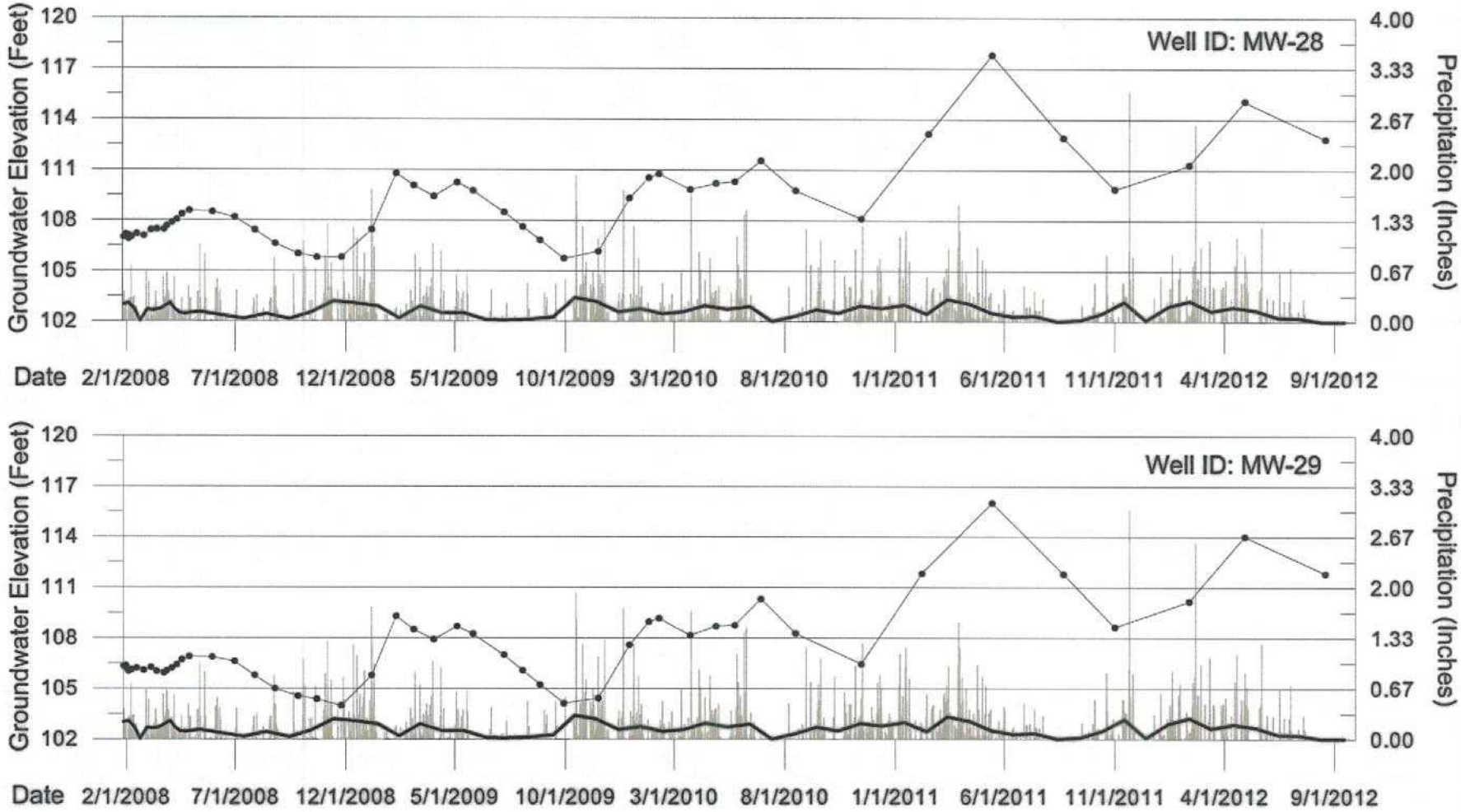
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-26 AND MW-27
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-12

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

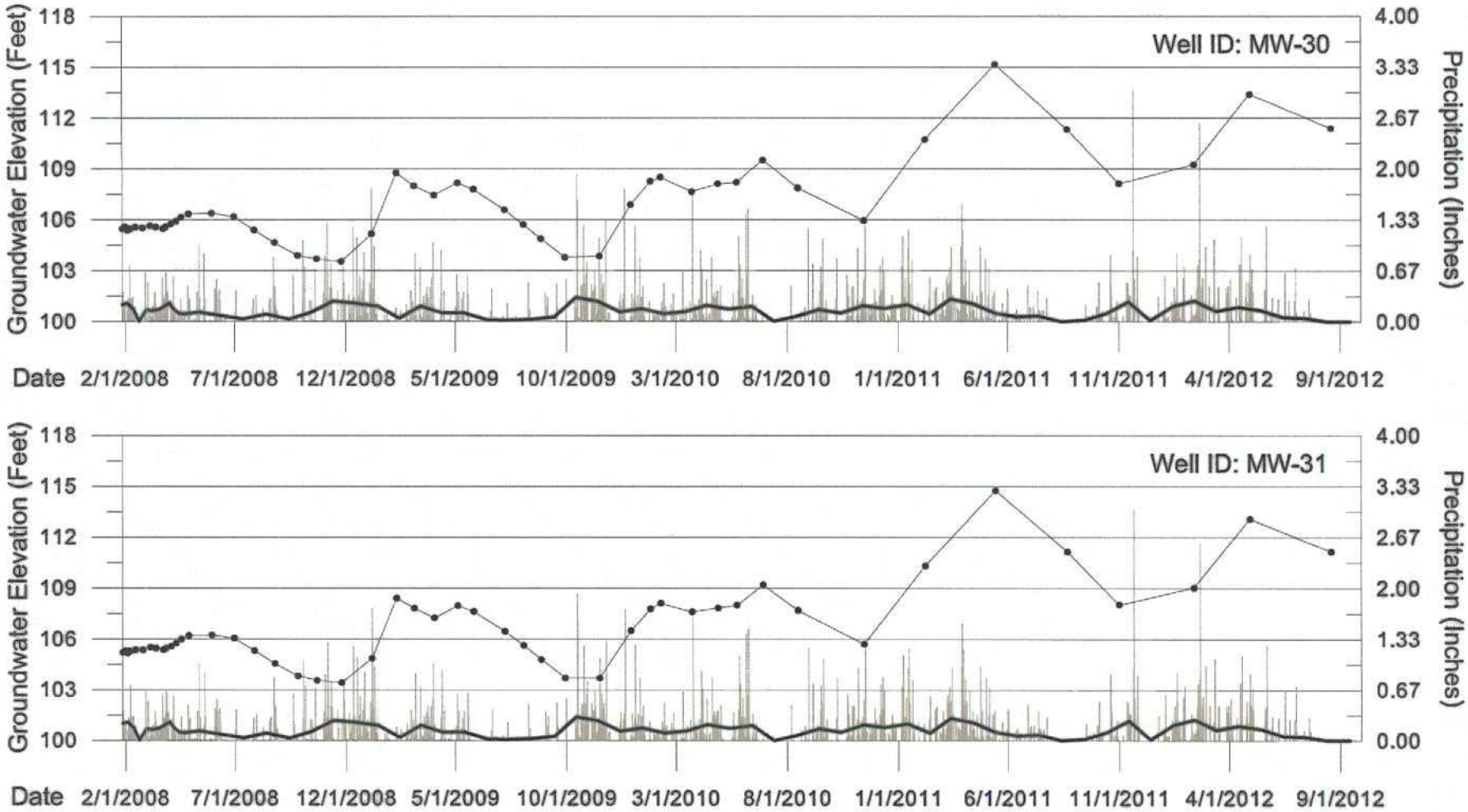
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-28 AND MW-29
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-13

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
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2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

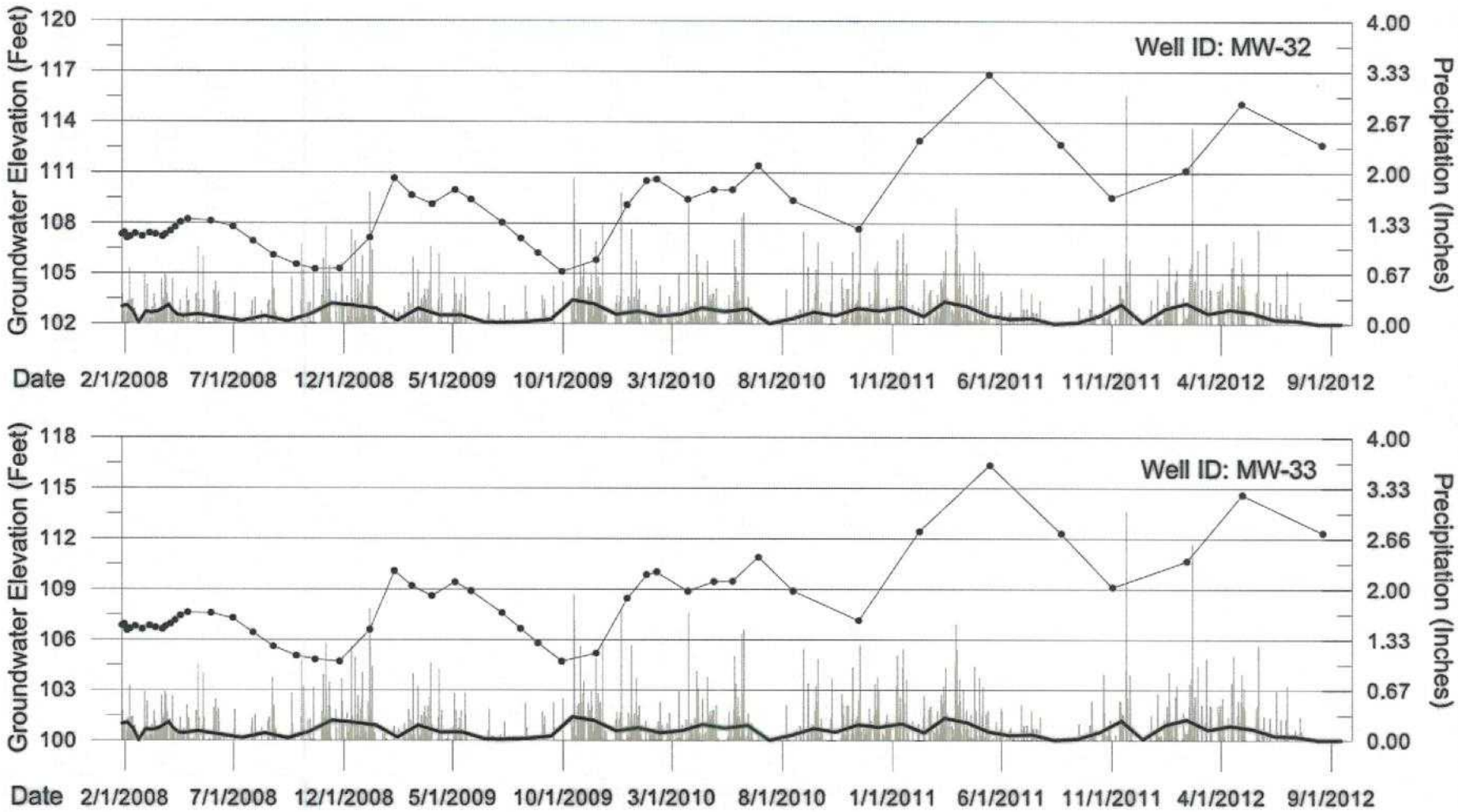
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-30 AND MW-31
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-14

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

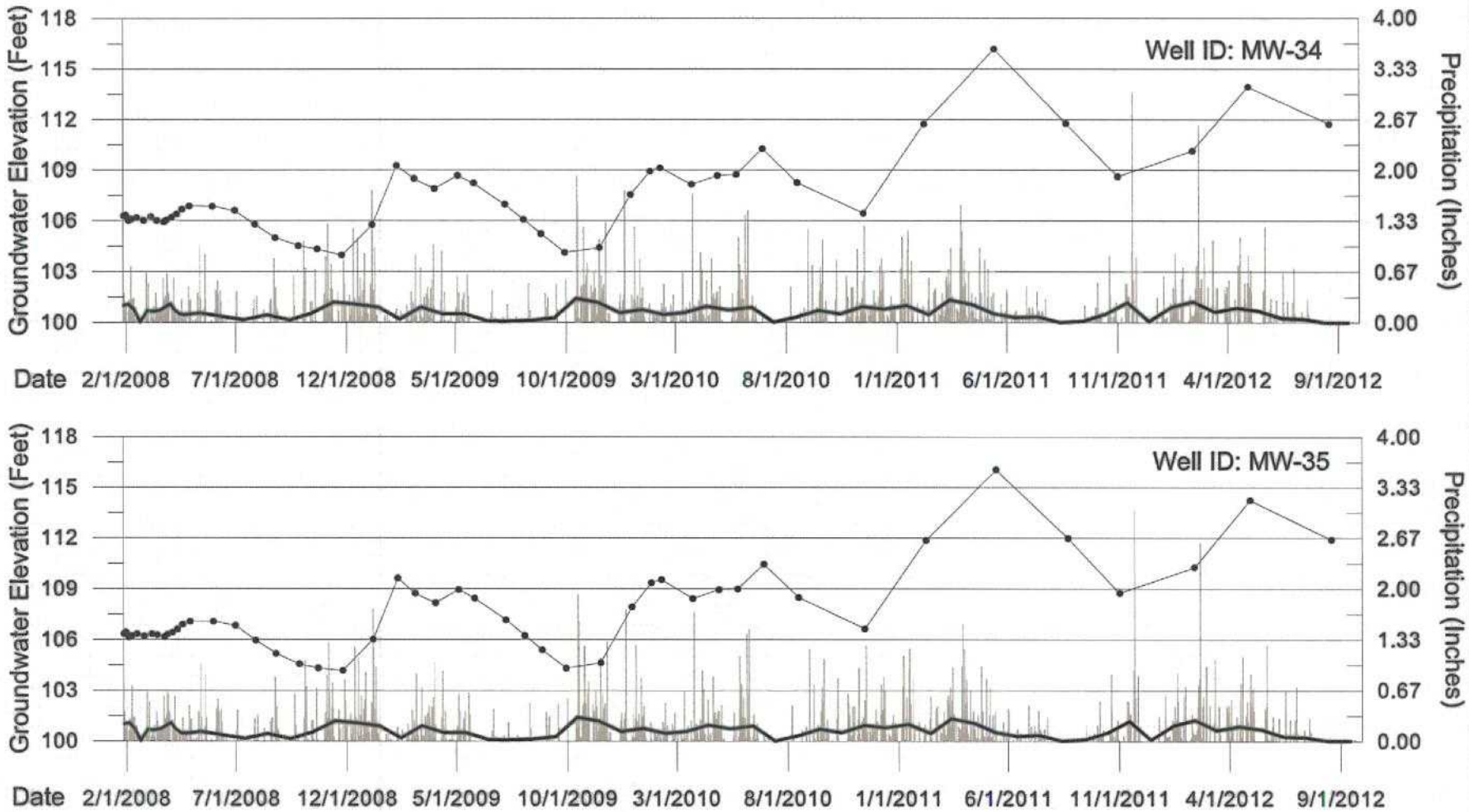
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-32 AND MW-33
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-15

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
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2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

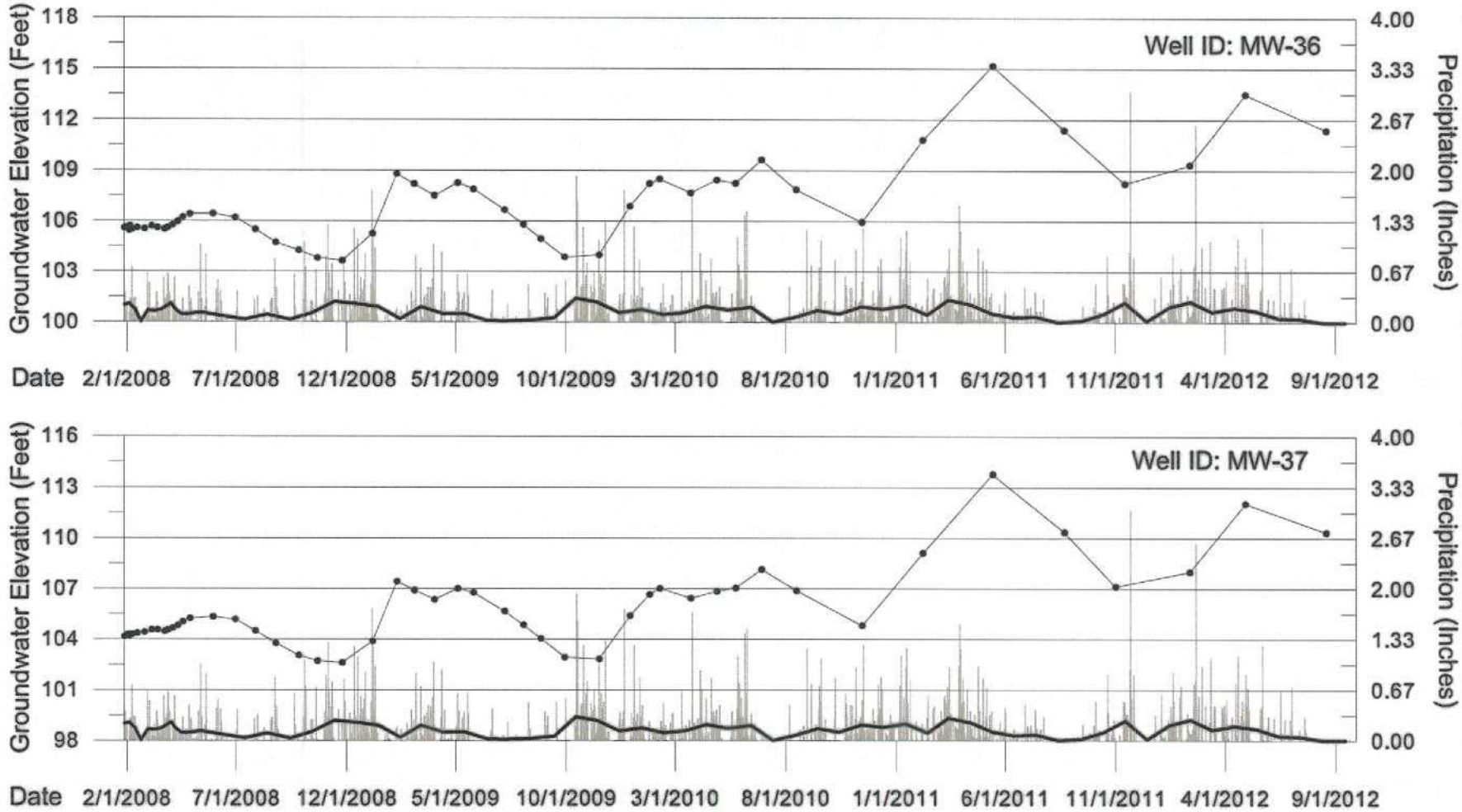
LEGEND
- Groundwater elevation time series
- Daily precipitation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-34 AND MW-35
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-16

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
1. Vertical datum is N.A.V.D 88.
2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

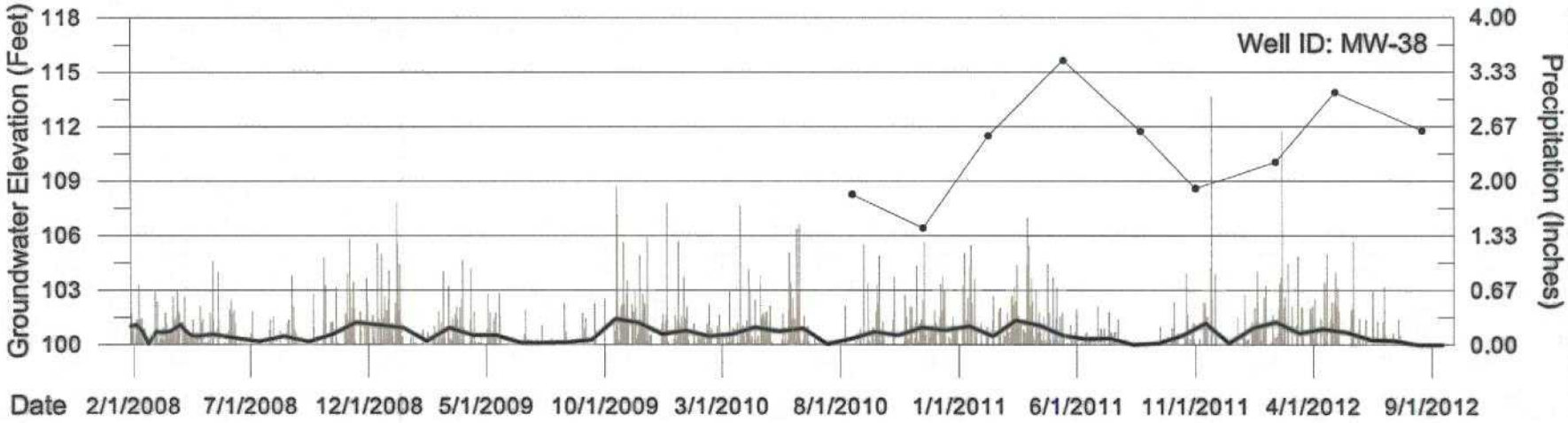
LEGEND
- Groundwater elevation time series
- Daily precipation (inches)
- Average precipitation between groundwater measurements (inches/day)

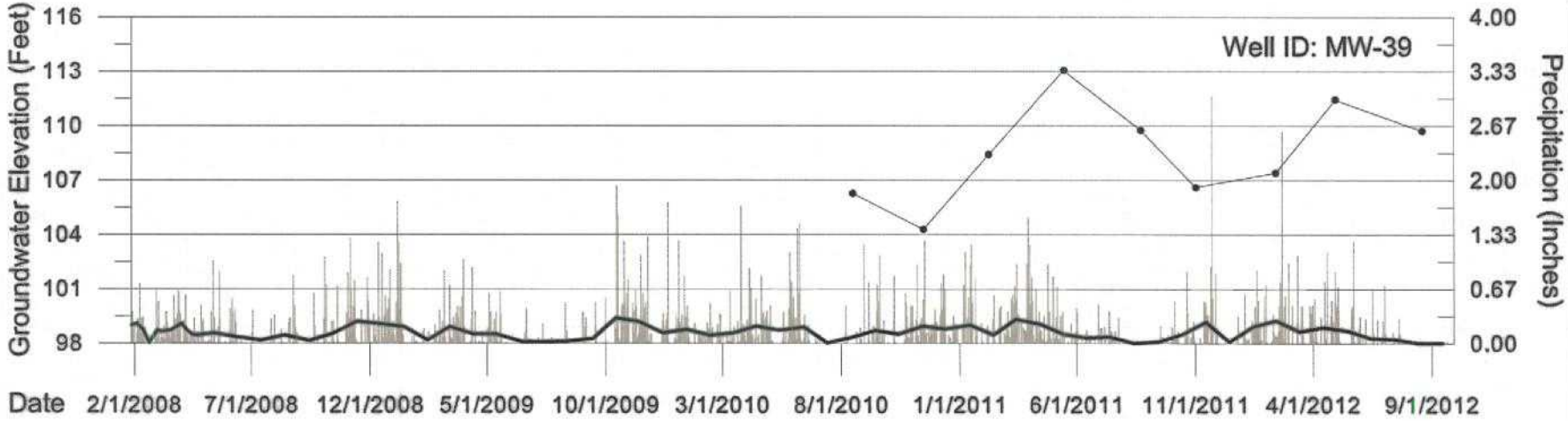
amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-36 AND MW-37
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-17

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf





Notes:
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2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

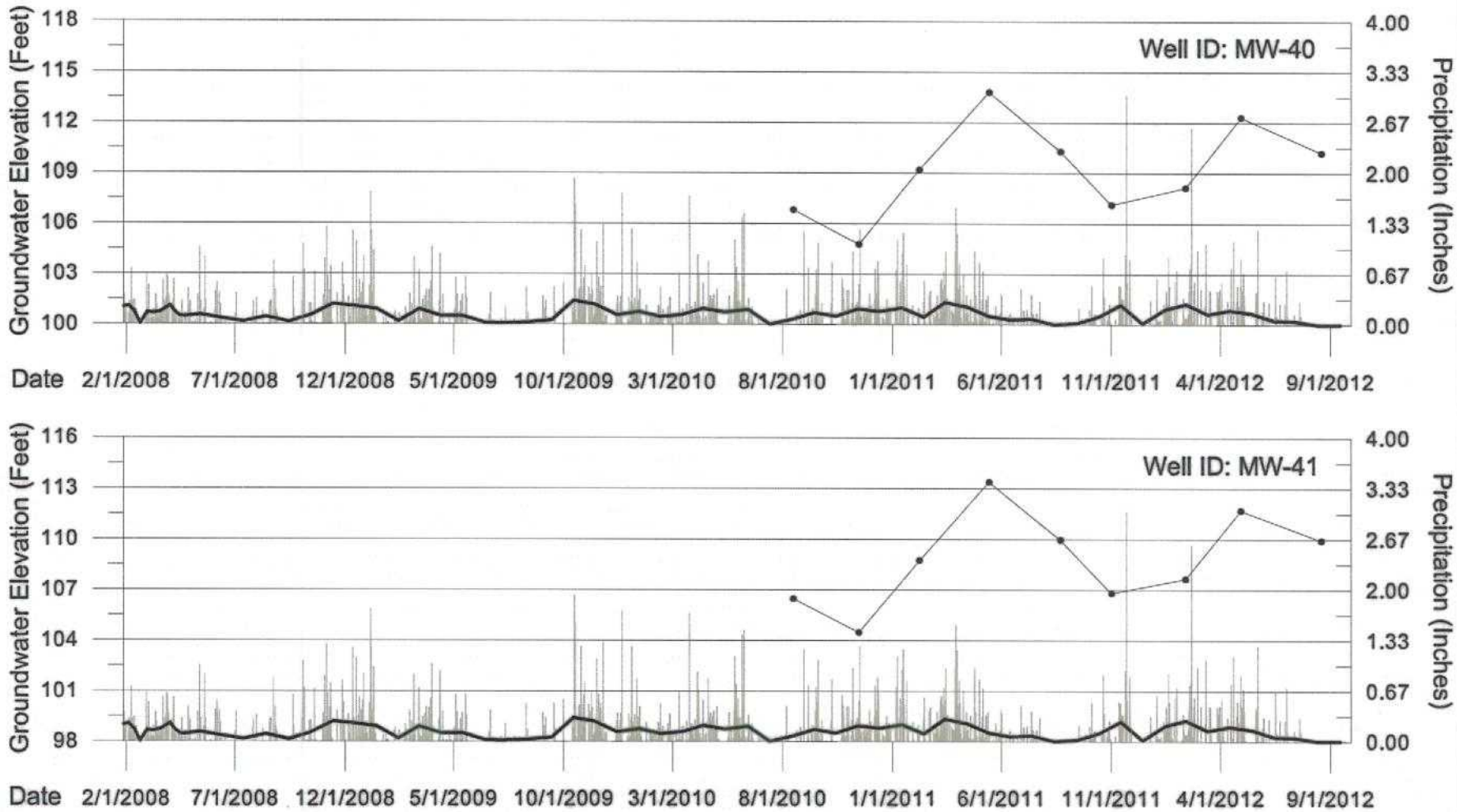
LEGEND
- Groundwater elevation time series
- Daily precipation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-38 AND MW-39
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-18

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
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2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

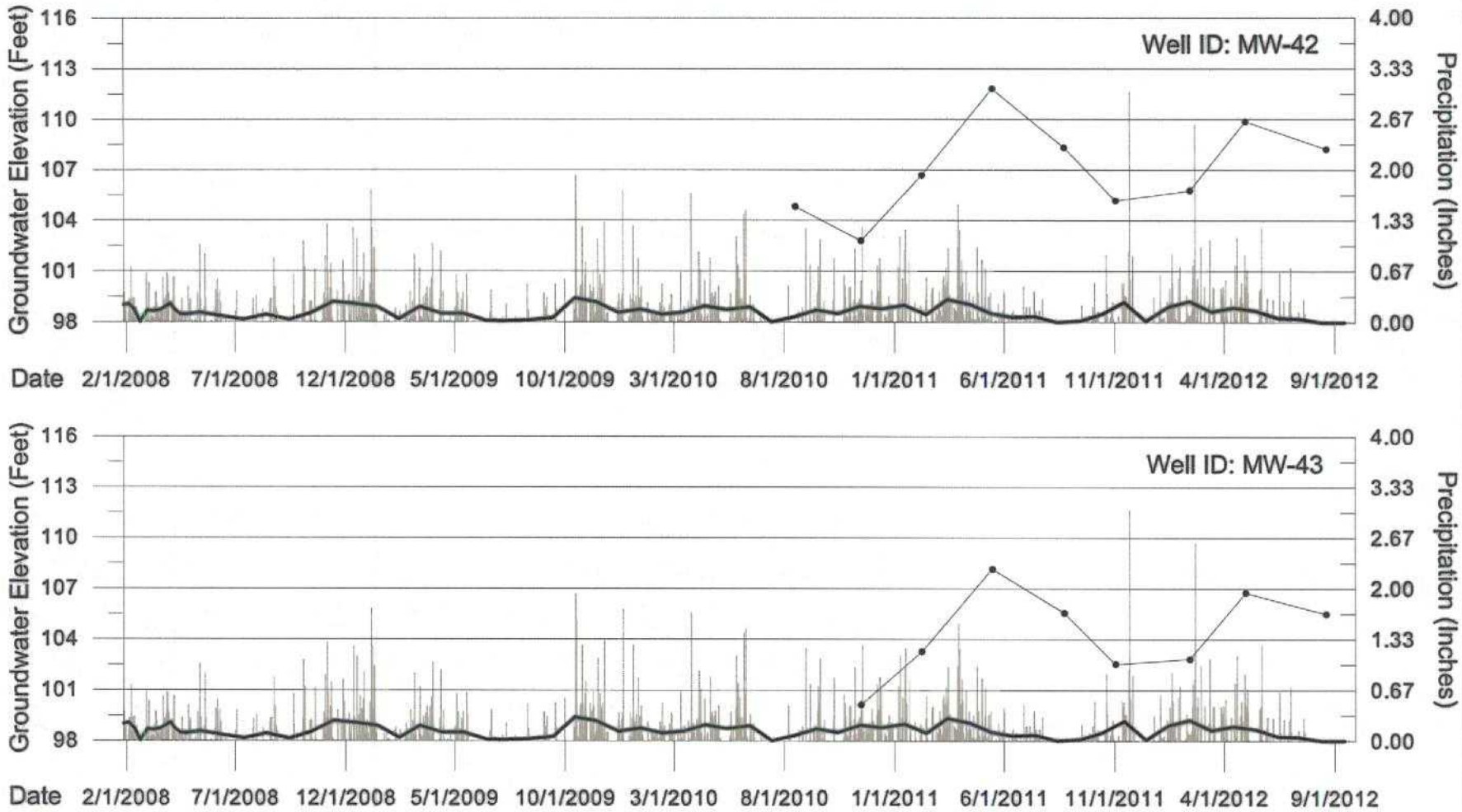
LEGEND
- Groundwater elevation time series
- Daily precipation (inches)
- Average precipitation between groundwater measurements (inches/day)

amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-40 AND MW-41
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-19

P:\12706 - JH Baxter Arlington\7000 Remediation\Performance Monitoring\Water_Fluctuations O&M.grf



Notes:
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2. Precipitation data source is the National Climatic Data Center (NCDC) Arlington, WA station (COOP ID: 450257).
3. Precipitation data include rain and/or melted snow.
4. Precipitation data from December 2010 through December 2011 are preliminary and are not final, quality-controlled data.
5. Precipitation is listed as zero for some unavailable June, September, and October 2012 data points.

LEGEND
- Groundwater elevation time series
- Daily precipation (inches)
- Average precipitation between groundwater measurements (inches/day)

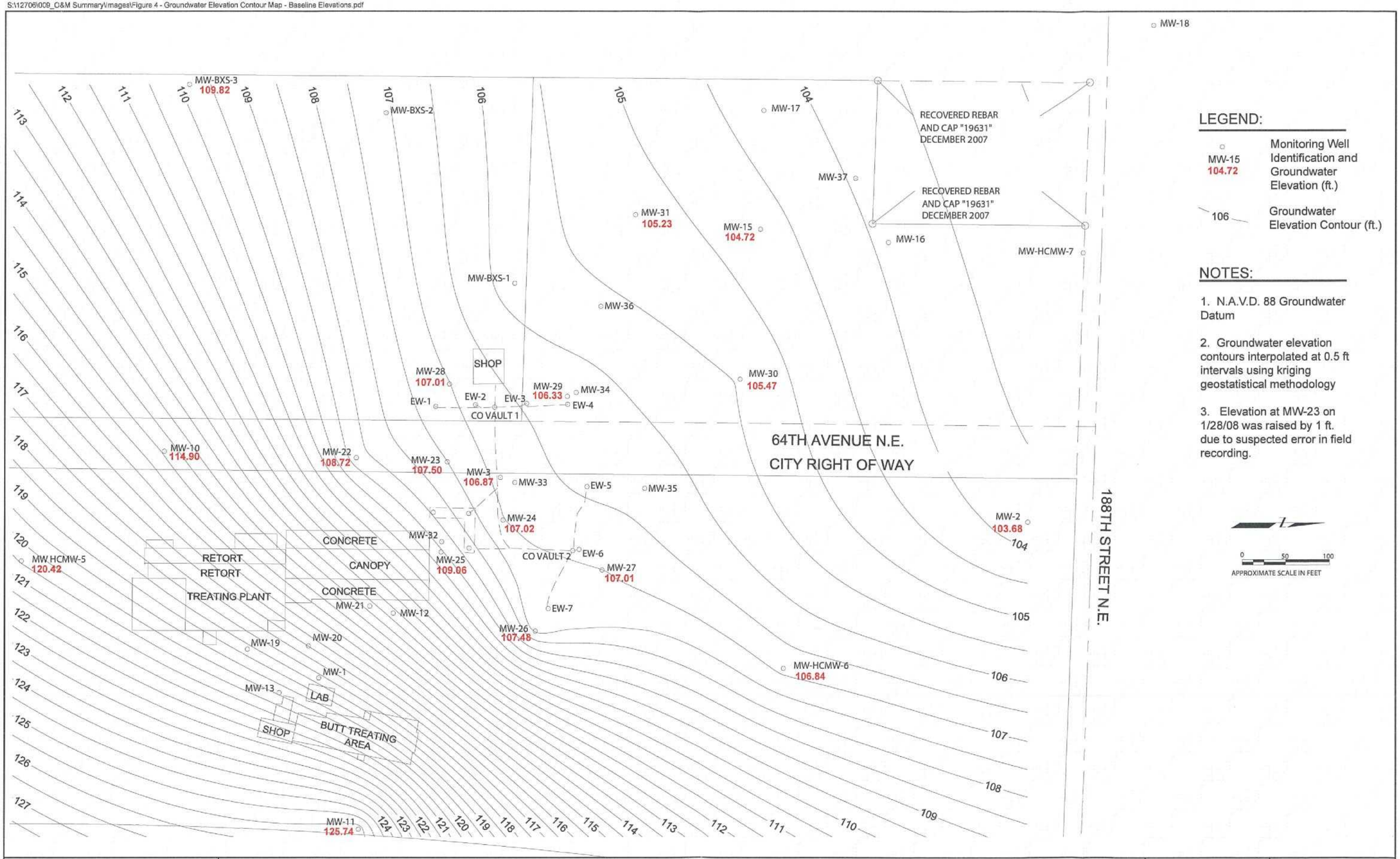
amec

GROUNDWATER ELEVATION VERSUS TIME: WELLS MW-42 AND MW-43
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: ERO	Project No. 12706
9/25/12	Figure No. D-20

APPENDIX E

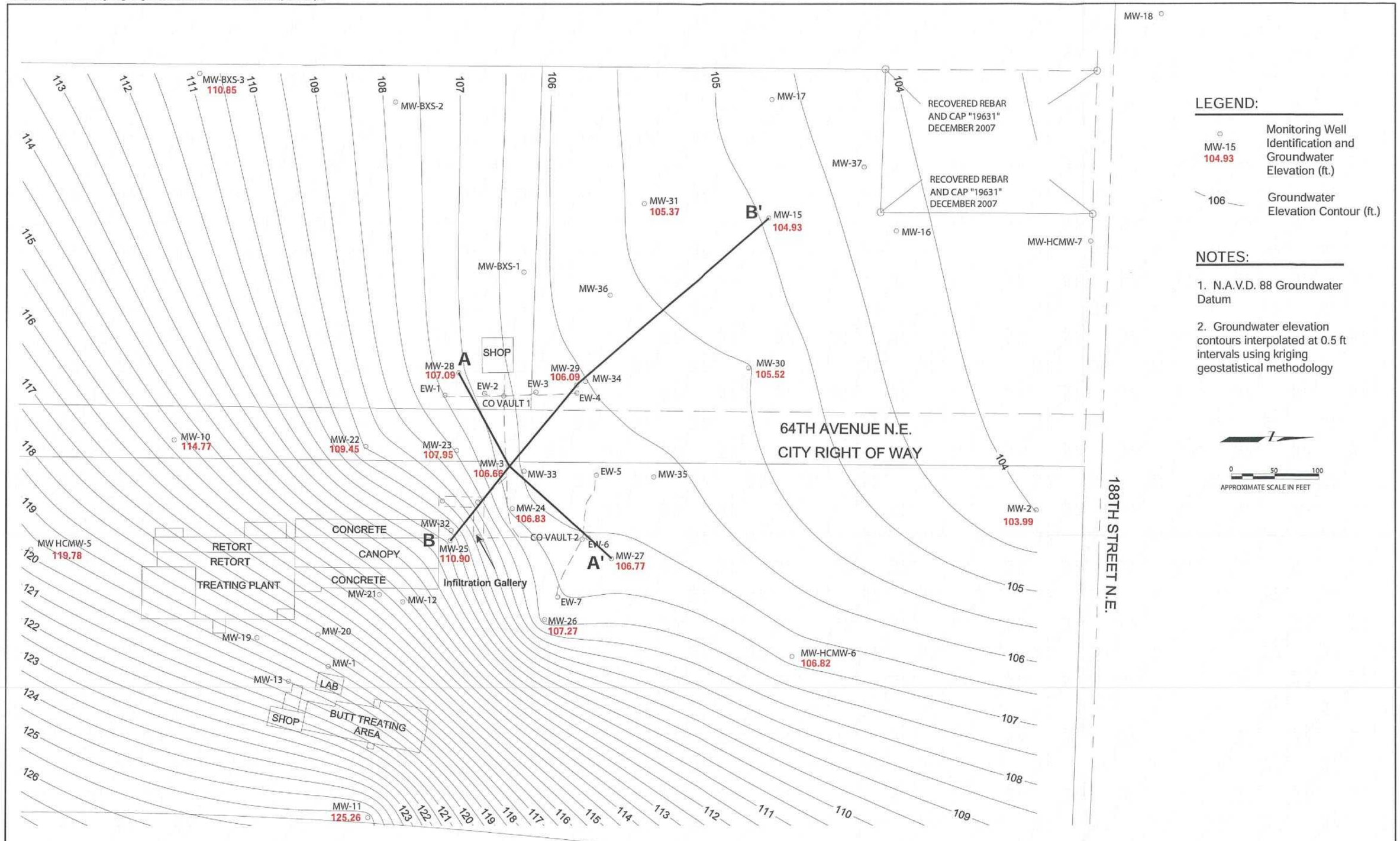
Groundwater Contour Maps



Geomatrix

January 28, 2008, GROUNDWATER ELEVATION CONTOUR MAP - BASELINE ELEVATIONS
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

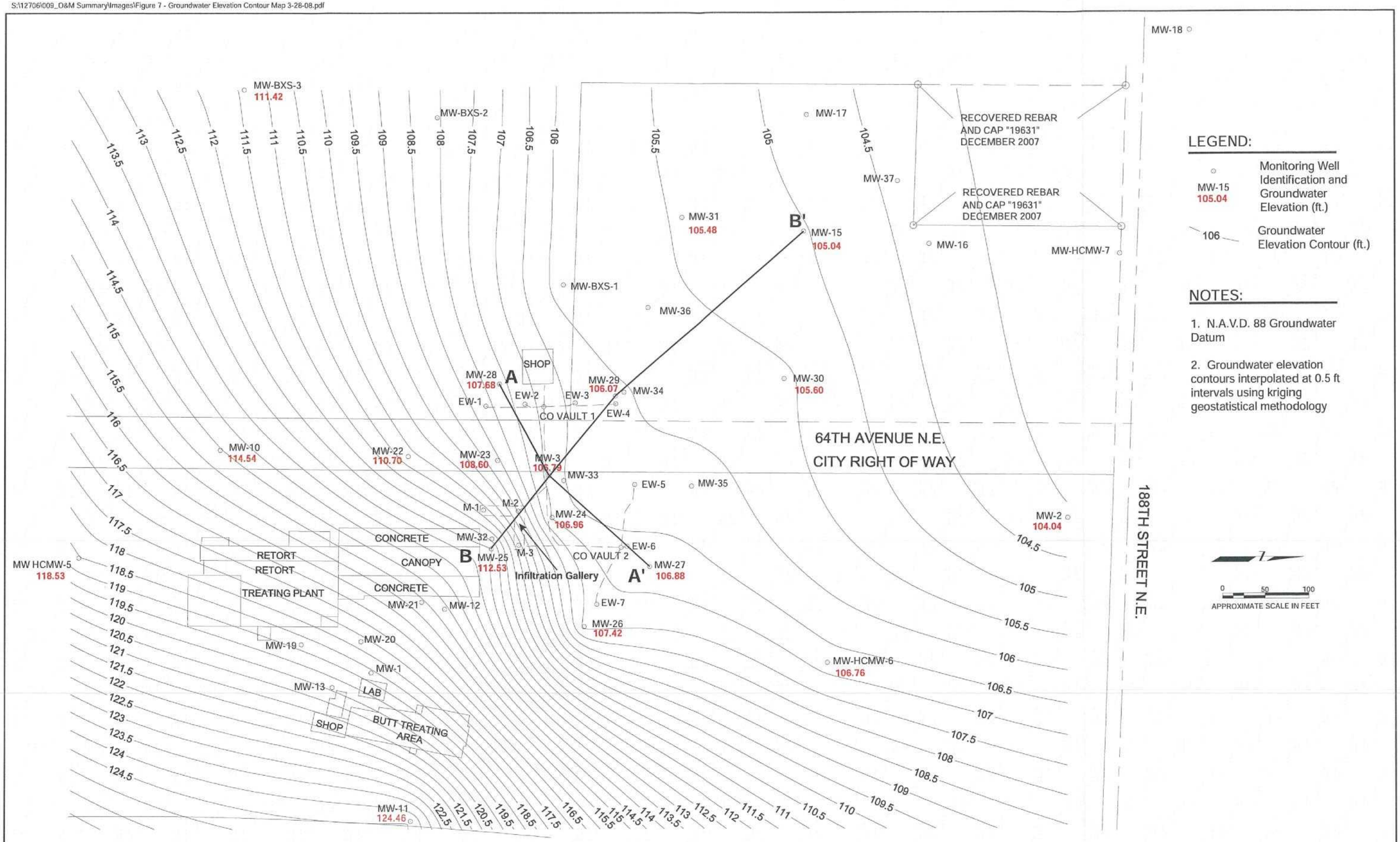
Prepared By: RLW	Project No. 12706
Date: 04/21/08	Figure E.1



Geomatrix

February 25, 2008, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 04/21/08	Figure E.2

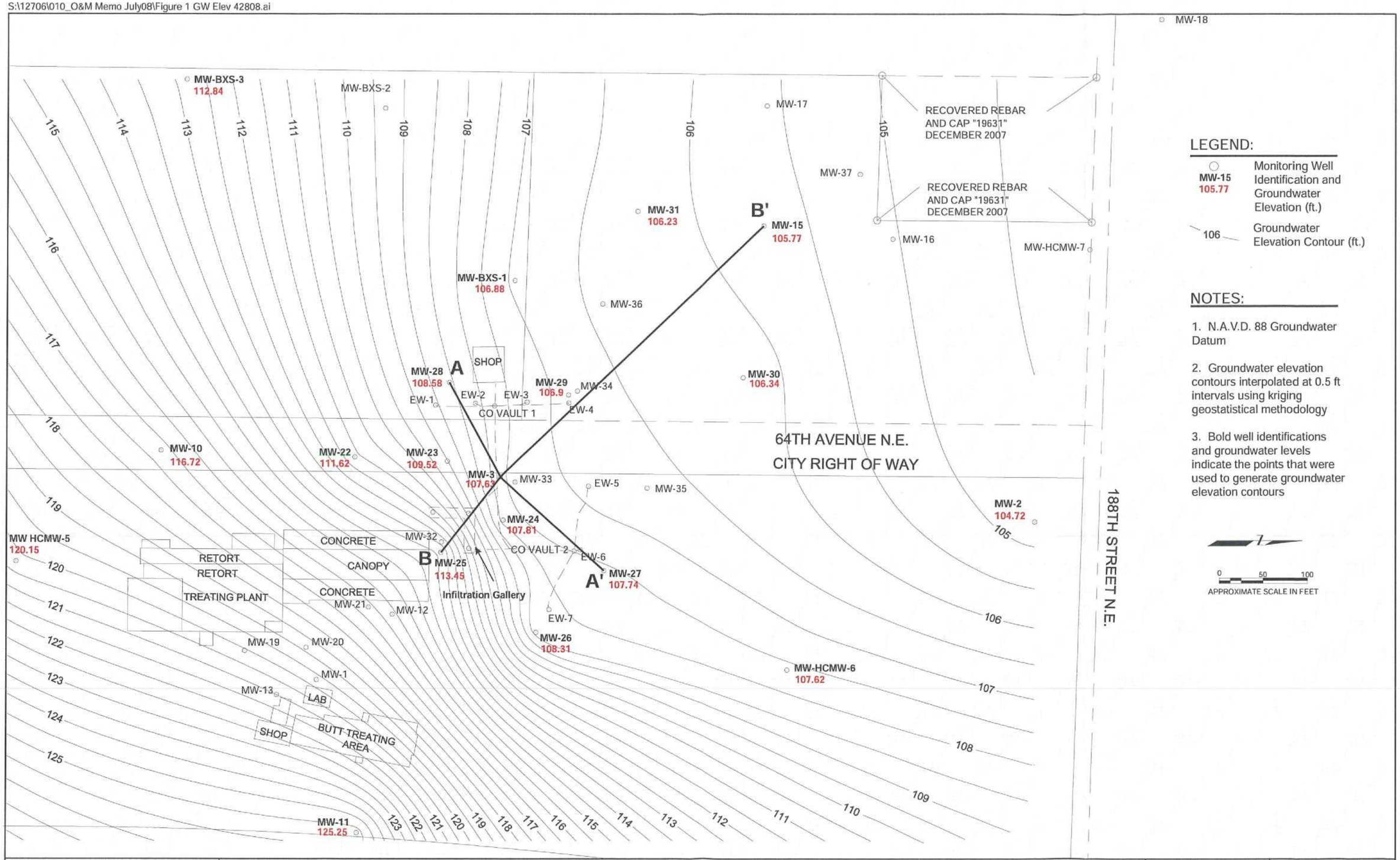


Geomatrix

March 28, 2008, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

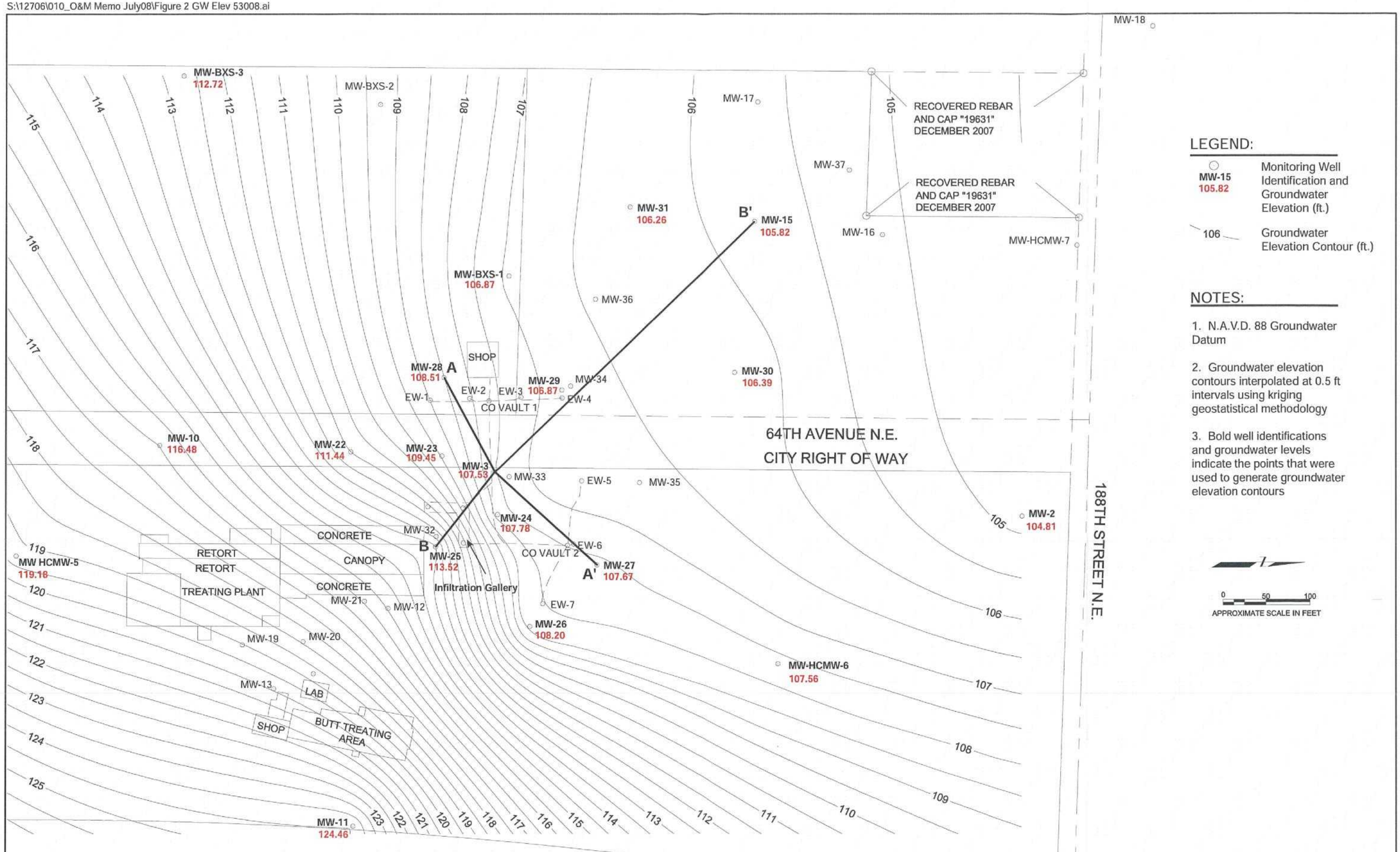
Prepared By: RLW	Project No. 12706
Date: 04/04/08	Figure E.3

S:\12706\010_O&M Memo July08\Figure 1 GW Elev 42808.ai



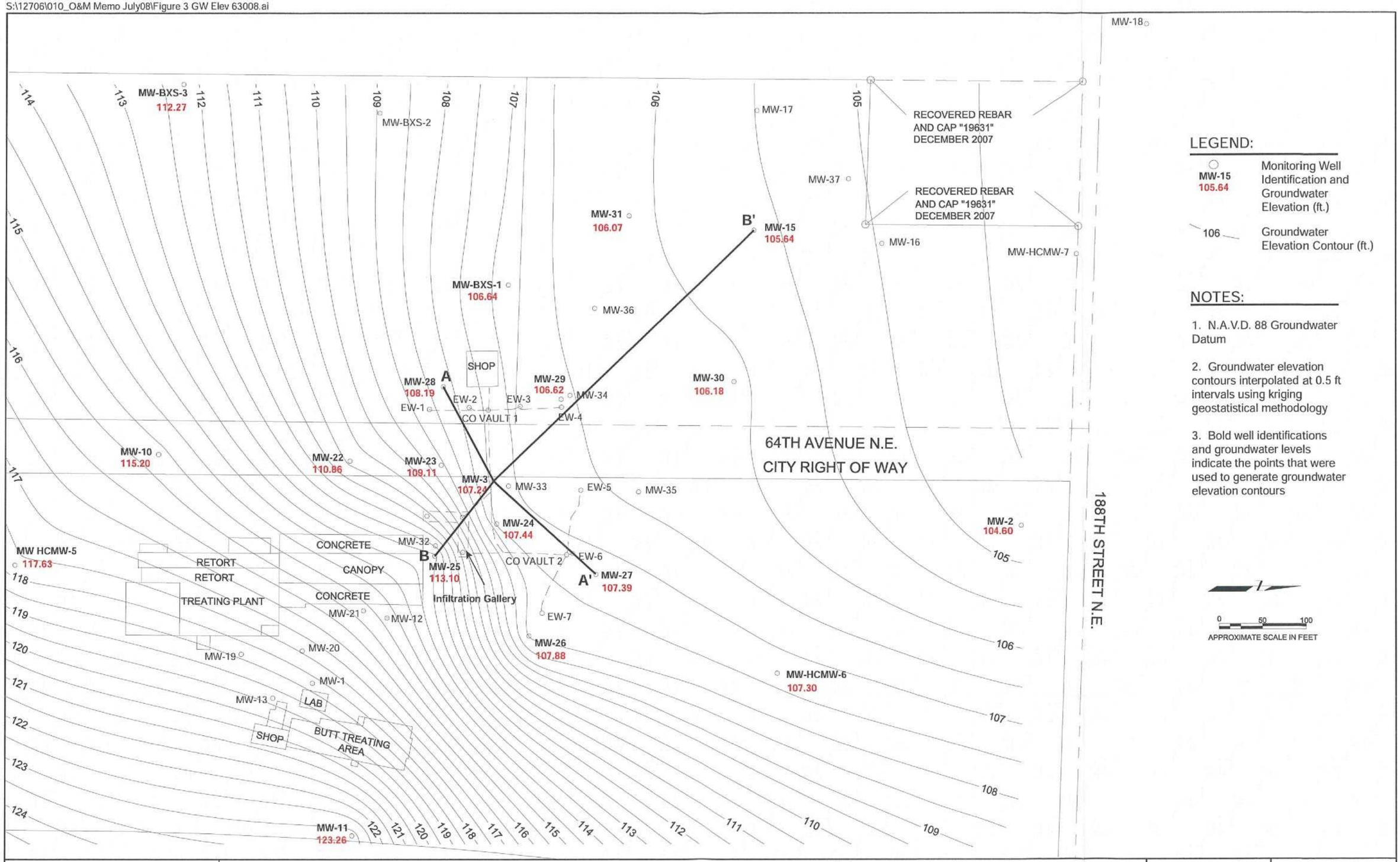
AMEC Geomatrix	April 28, 2008 GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 06/28/08	Figure E.4

S:\12706\010_O&M Memo July08\Figure 2 GW Elev 53008.ai



AMEC Geomatrix	May 30, 2008 GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 06/28/08	Figure E.5

S:\12706\010_O&M Memo July08\Figure 3 GW Elev 63008.ai



LEGEND:

MW-15 105.64	Monitoring Well Identification and Groundwater Elevation (ft.)
106	Groundwater Elevation Contour (ft.)

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology

3. Bold well identifications and groundwater levels indicate the points that were used to generate groundwater elevation contours

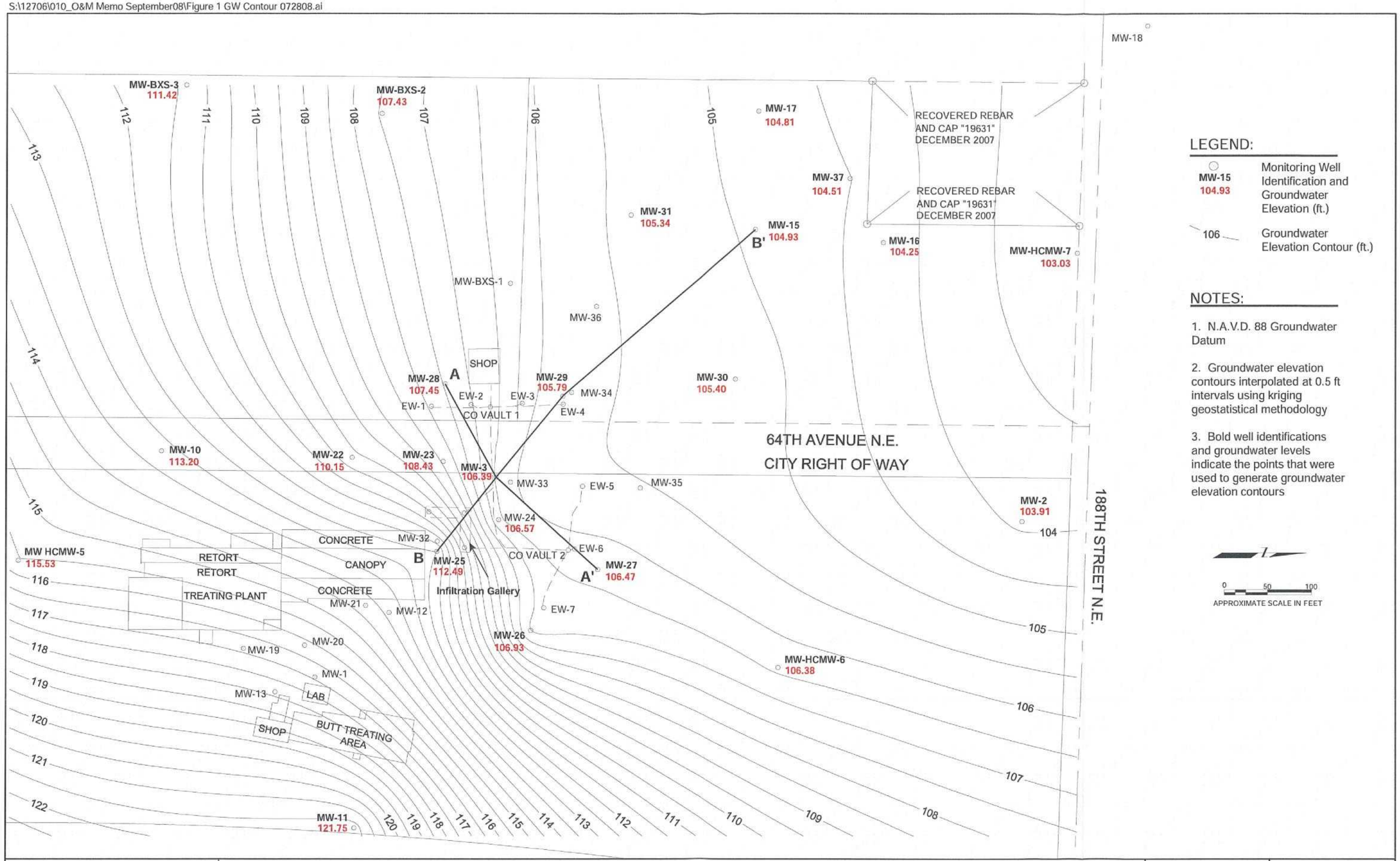
0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

JUNE 30, 2008 GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 07/03/08	Figure E.6

S:\12706\010_O&M Memo September08\Figure 1 GW Contour 072808.ai



LEGEND:

MW-15 104.93	Monitoring Well Identification and Groundwater Elevation (ft.)
106	Groundwater Elevation Contour (ft.)

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology

3. Bold well identifications and groundwater levels indicate the points that were used to generate groundwater elevation contours

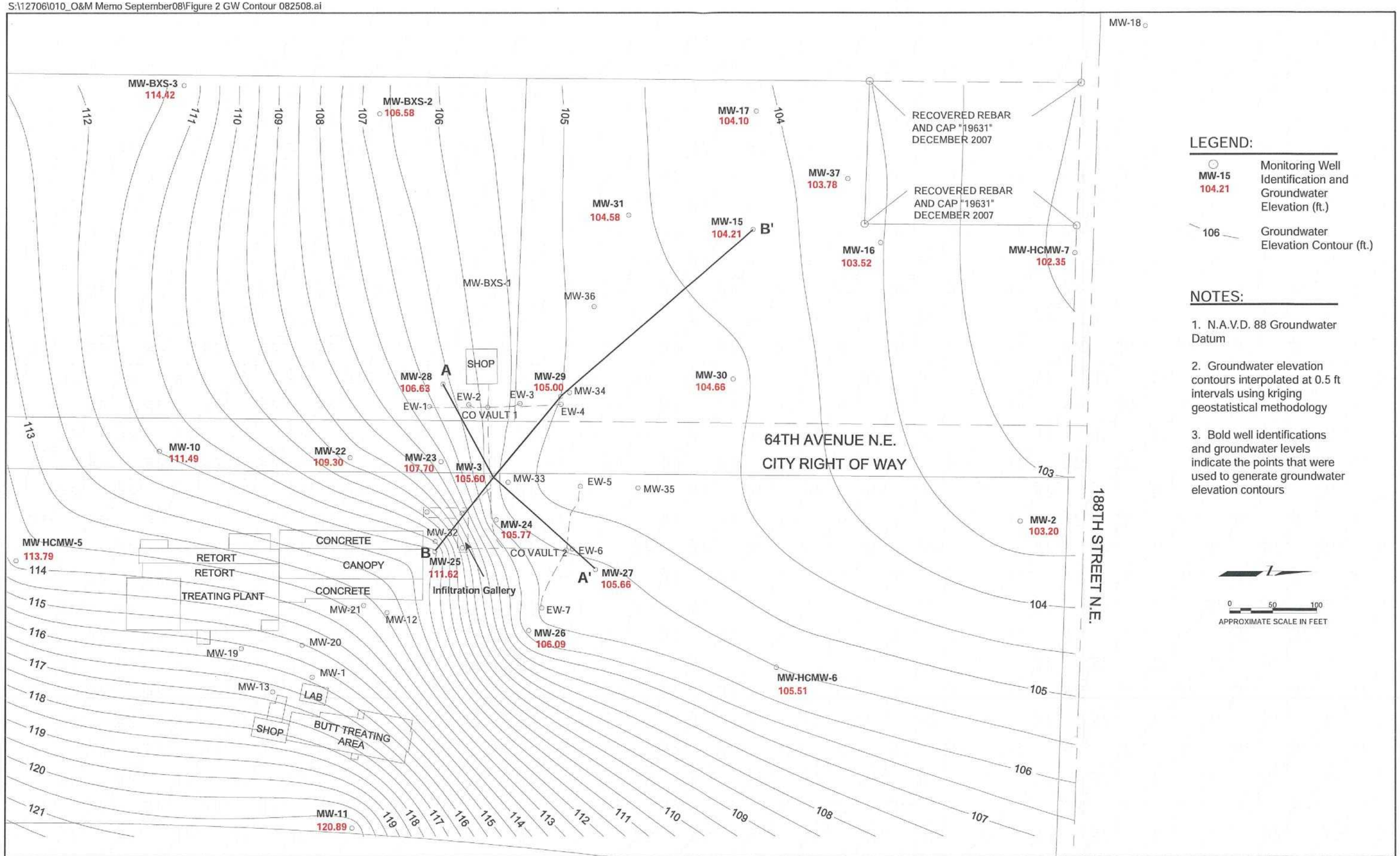
0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

July 28, 2008 GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 10/06/08	Figure E.7

S:\12706\010_O&M Memo September08\Figure 2 GW Contour 082508.ai



LEGEND:

MW-15 104.21	Monitoring Well Identification and Groundwater Elevation (ft.)
106	Groundwater Elevation Contour (ft.)

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology

3. Bold well identifications and groundwater levels indicate the points that were used to generate groundwater elevation contours

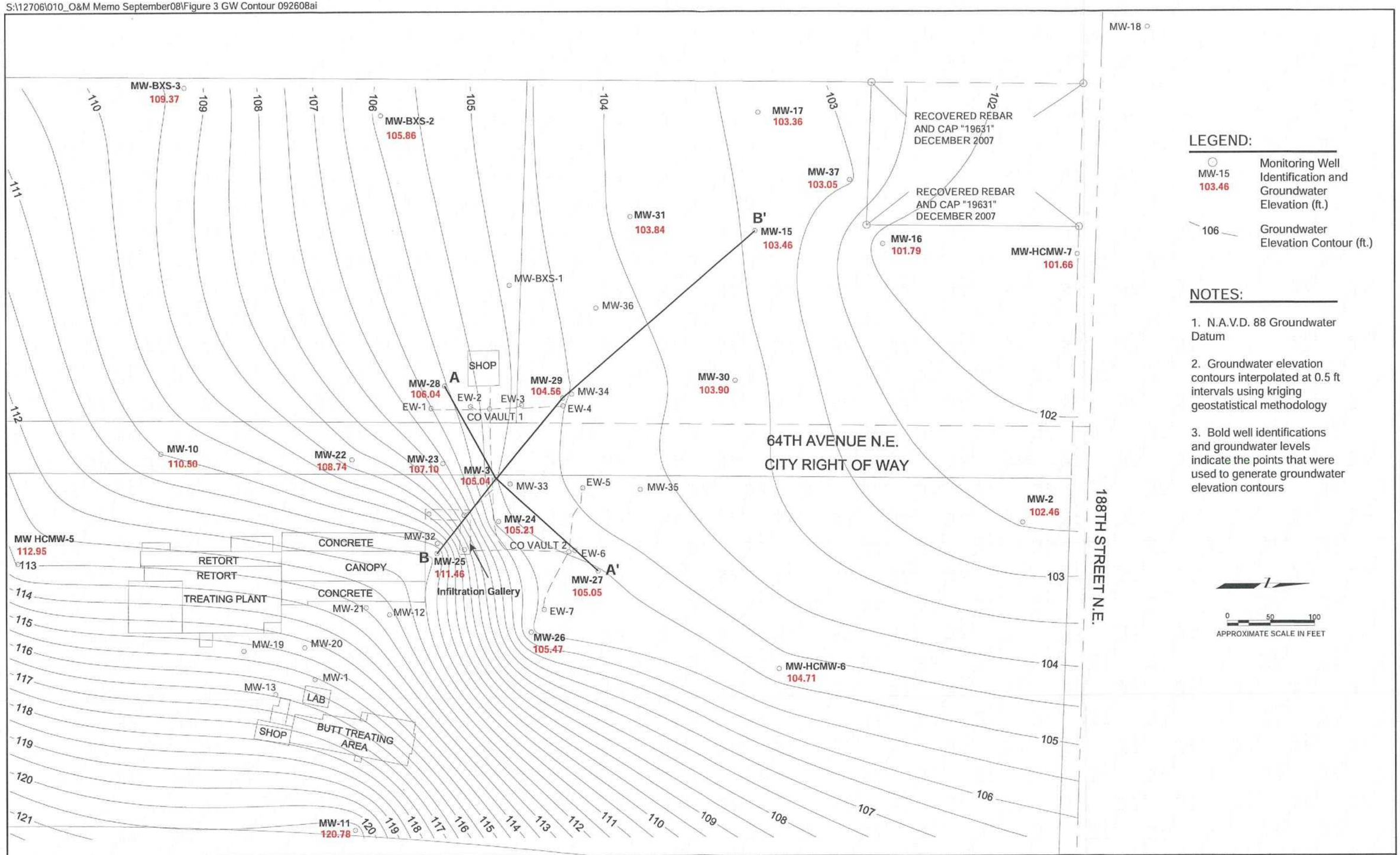
0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

AUGUST 25, 2008 GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 08/26/08	Figure E.8

S:\12706\010_O&M Memo September08\Figure 3 GW Contour 092608ai



LEGEND:

MW-15 103.46	Monitoring Well Identification and Groundwater Elevation (ft.)
106	Groundwater Elevation Contour (ft.)

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology

3. Bold well identifications and groundwater levels indicate the points that were used to generate groundwater elevation contours

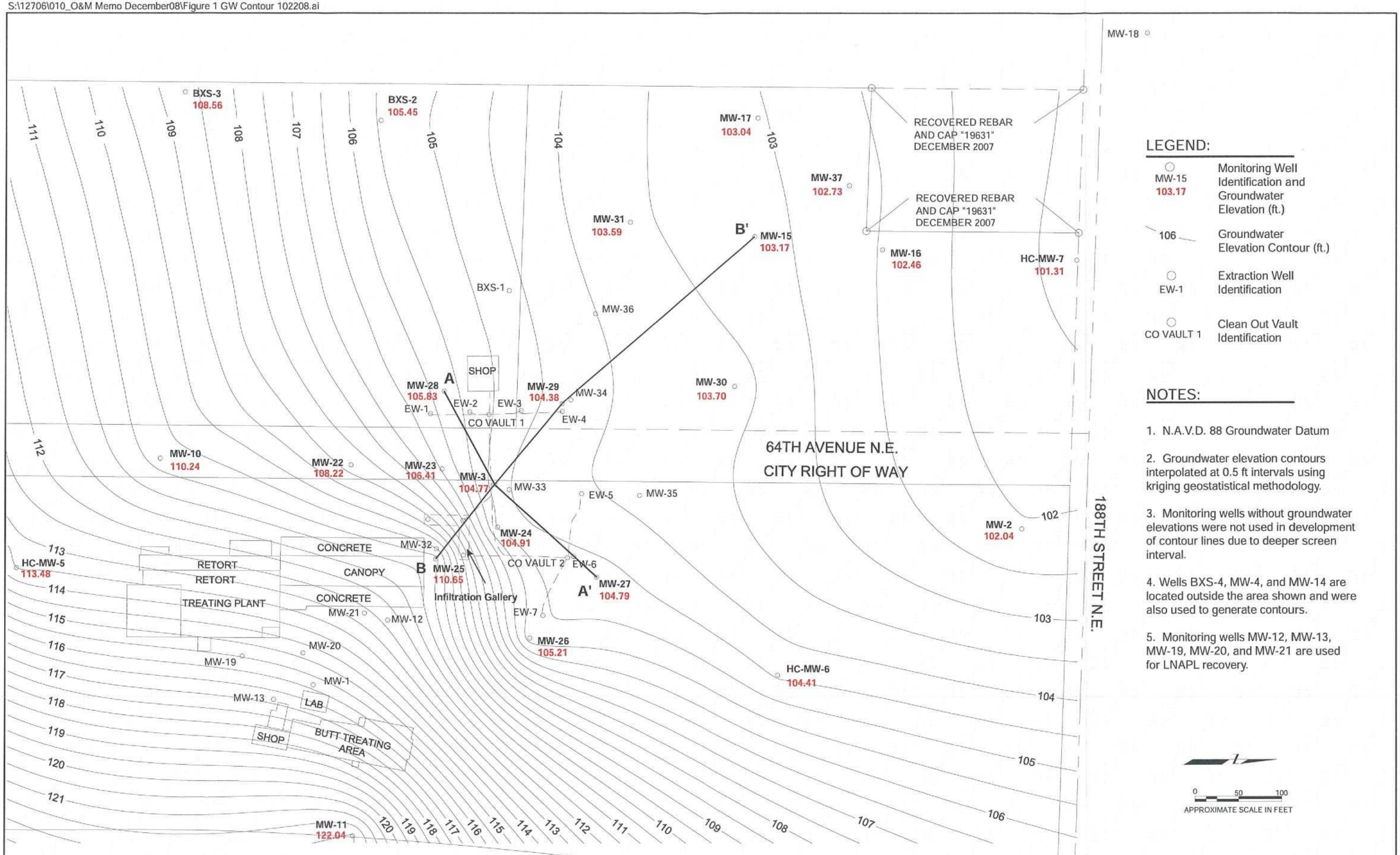
0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

SEPTEMBER 26, 2008 GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 09/30/08	Figure E.9

S:\12706\010_O&M Memo December08\Figure 1 GW Contour 102208.ai



LEGEND:

MW-15 103.17	Monitoring Well Identification and Groundwater Elevation (ft.)
106	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum
2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.
3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.
4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

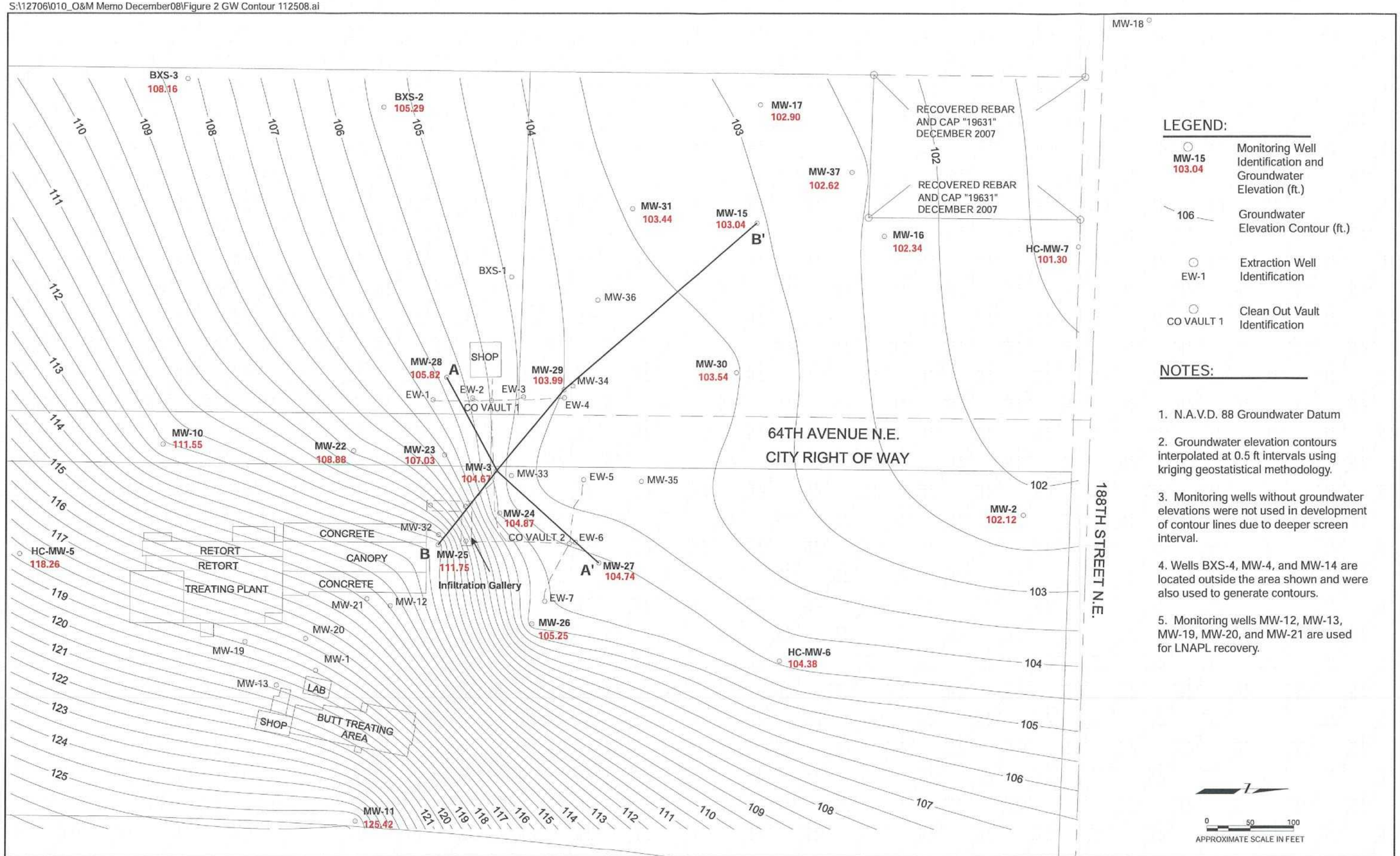
0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

OCTOBER 22, 2008, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

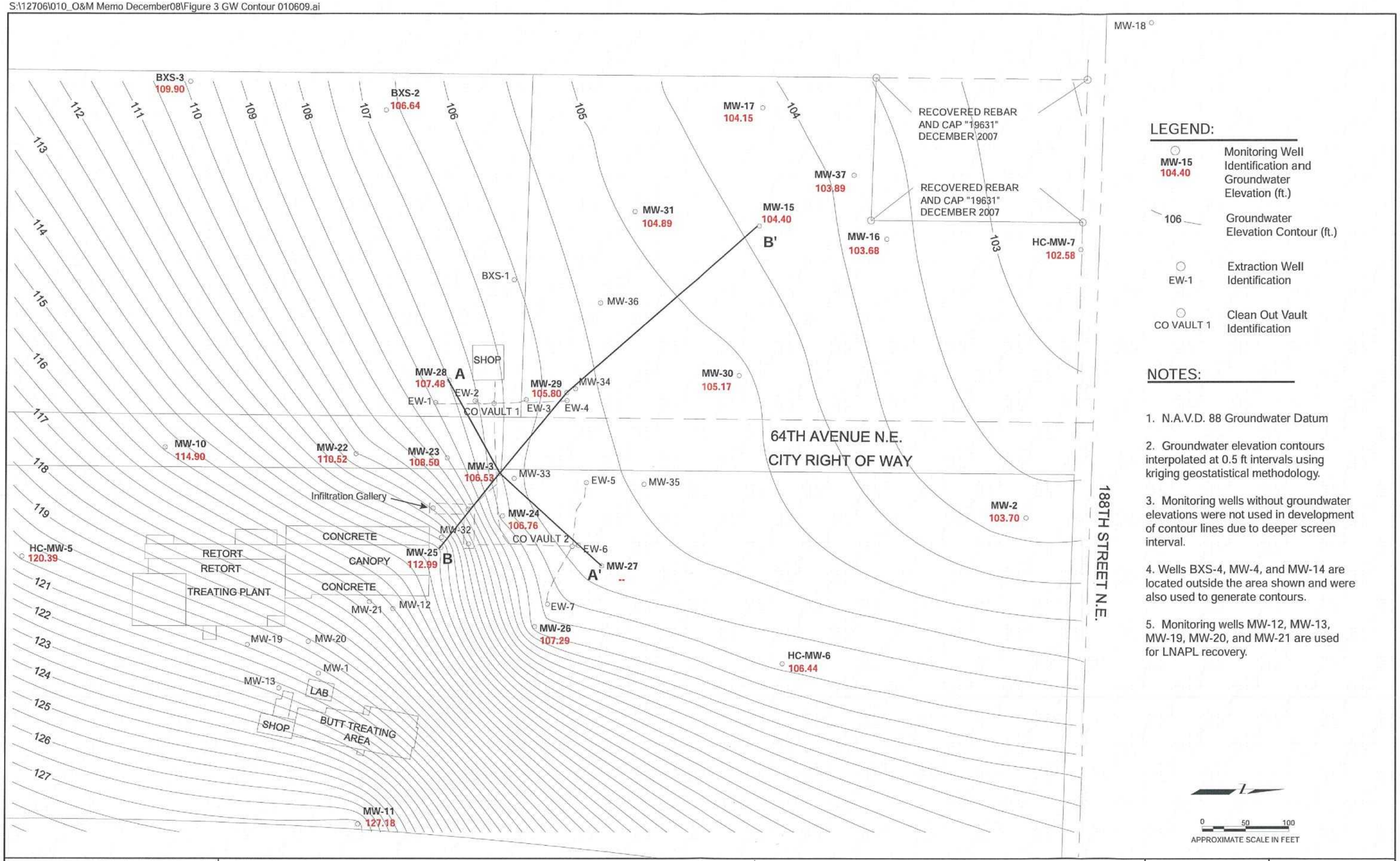
Prepared By: RLW	Project No. 12706
Date: 10/27/08	Figure E.10

S:\12706\010_O&M Memo December08\Figure 2 GW Contour 112508.ai



AMEC Geomatrix	NOVEMBER 25, 2008, GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 11/26/08	Figure E.11

S:\12706\010_O&M Memo December08\Figure 3 GW Contour 010609.ai



LEGEND:

MW-15 104.40	Monitoring Well Identification and Groundwater Elevation (ft.)
106	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

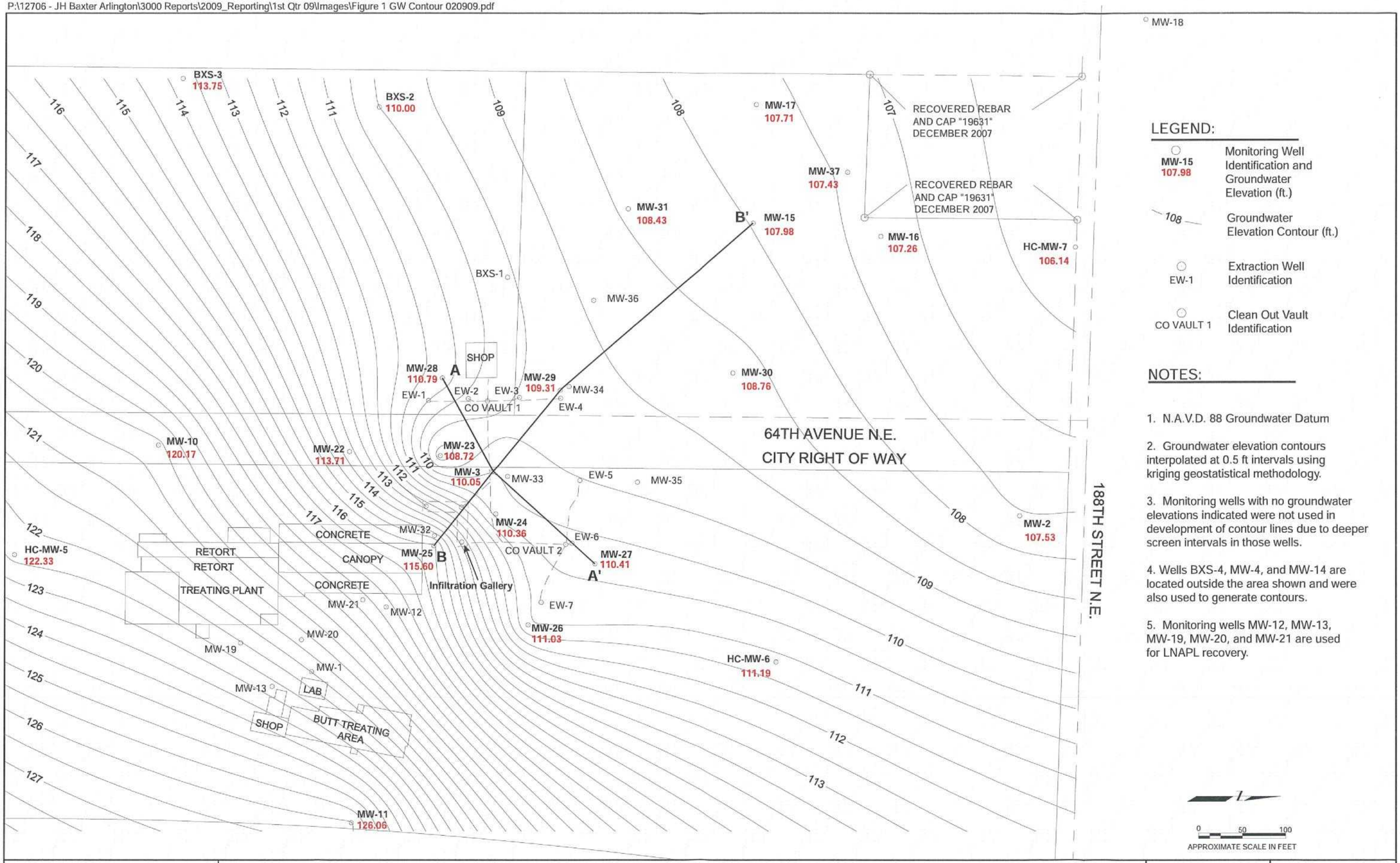
1. N.A.V.D. 88 Groundwater Datum
2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.
3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.
4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

JANUARY 6, 2009, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 01/21/09	Figure E.12



LEGEND:

MW-15 107.98	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells with no groundwater elevations indicated were not used in development of contour lines due to deeper screen intervals in those wells.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

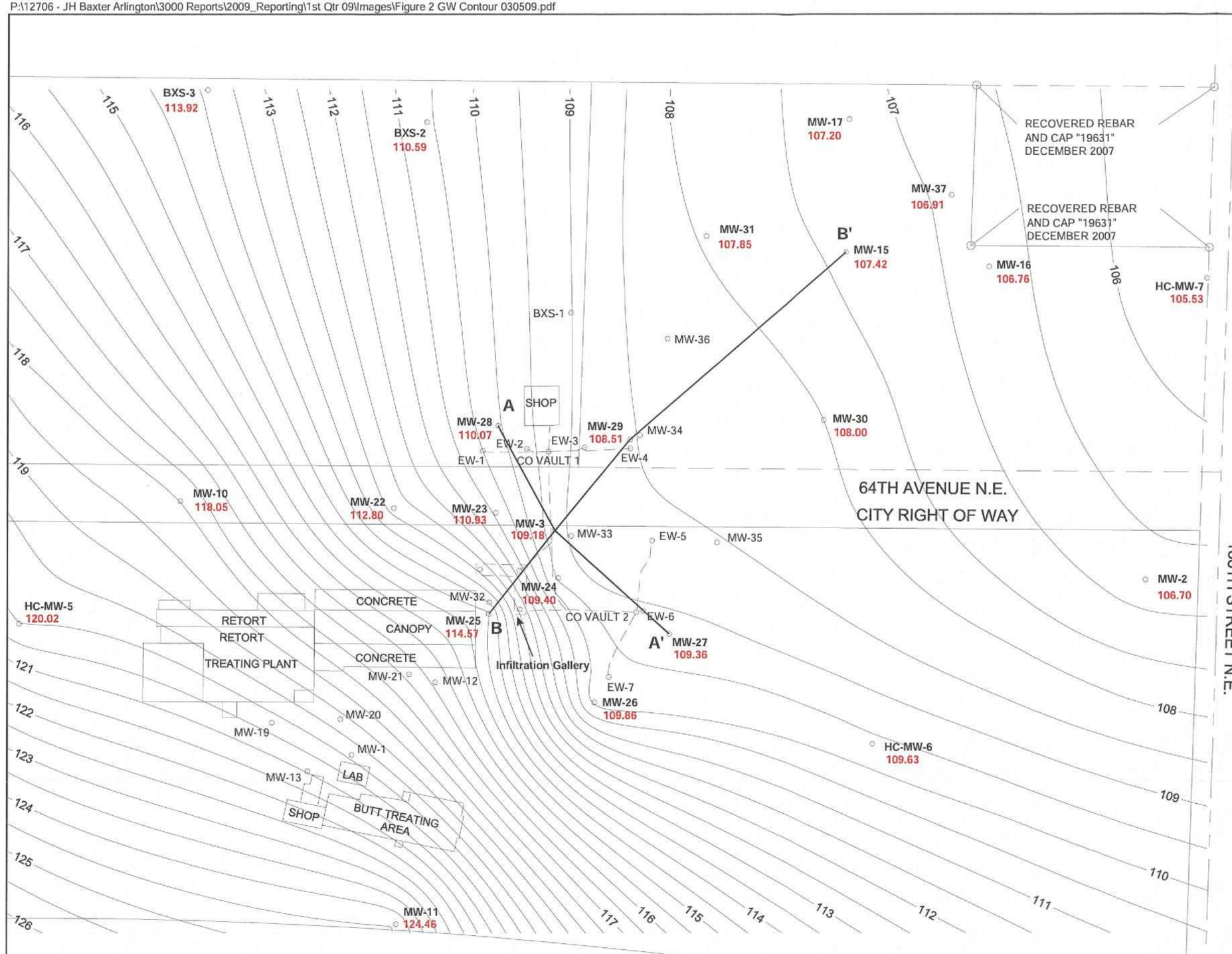
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

FEBRUARY 9, 2009, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 02/19/09	Figure E.13



LEGEND:

MW-15 107.42	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells with no groundwater elevations indicated were not used in development of contour lines due to deeper screen intervals in those wells.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

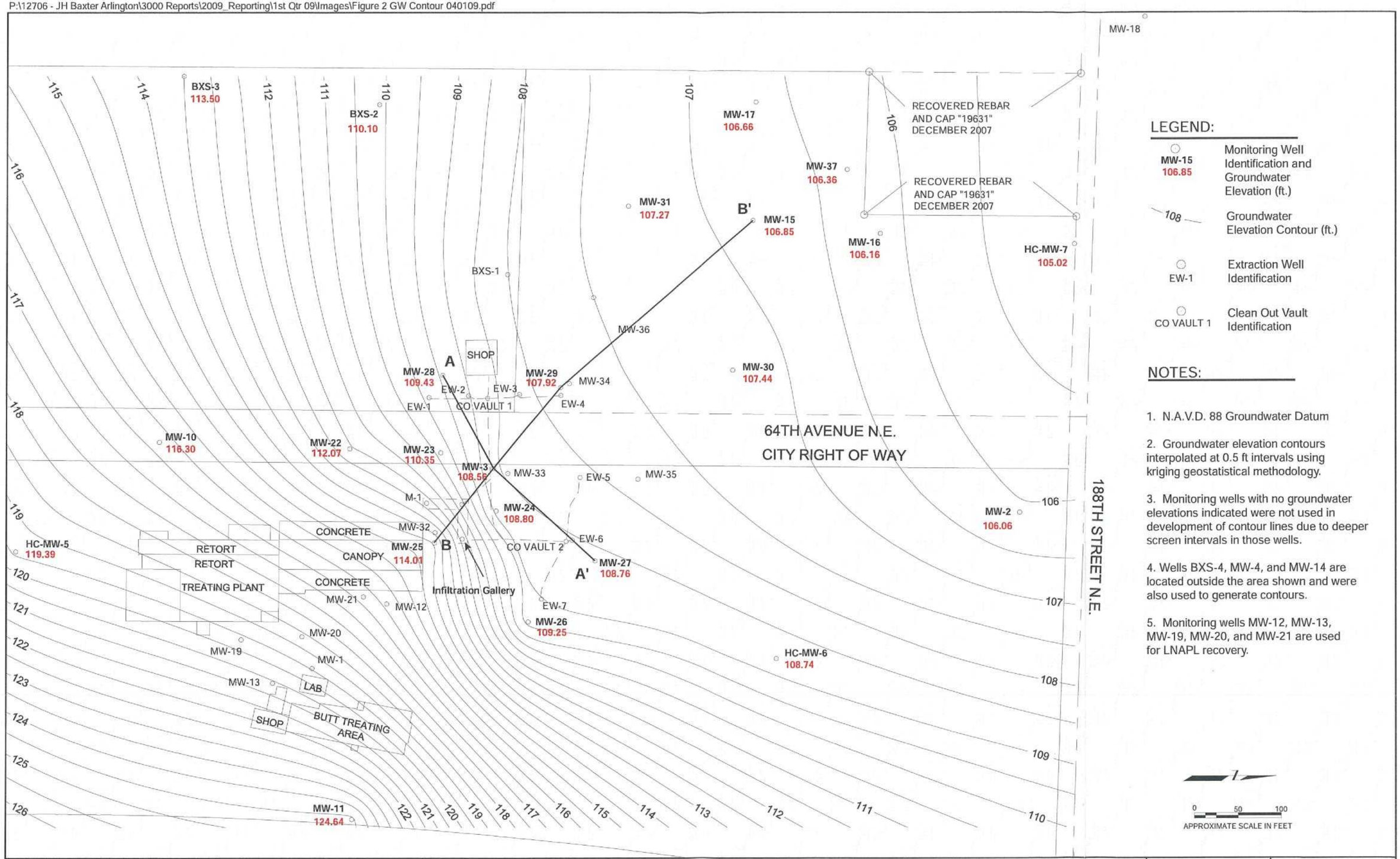
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

MARCH 5, 2009, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 03/13/09	Figure E.14



LEGEND:

MW-15 106.85	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells with no groundwater elevations indicated were not used in development of contour lines due to deeper screen intervals in those wells.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

APRIL 1, 2009, GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 04/03/09	Figure E.15

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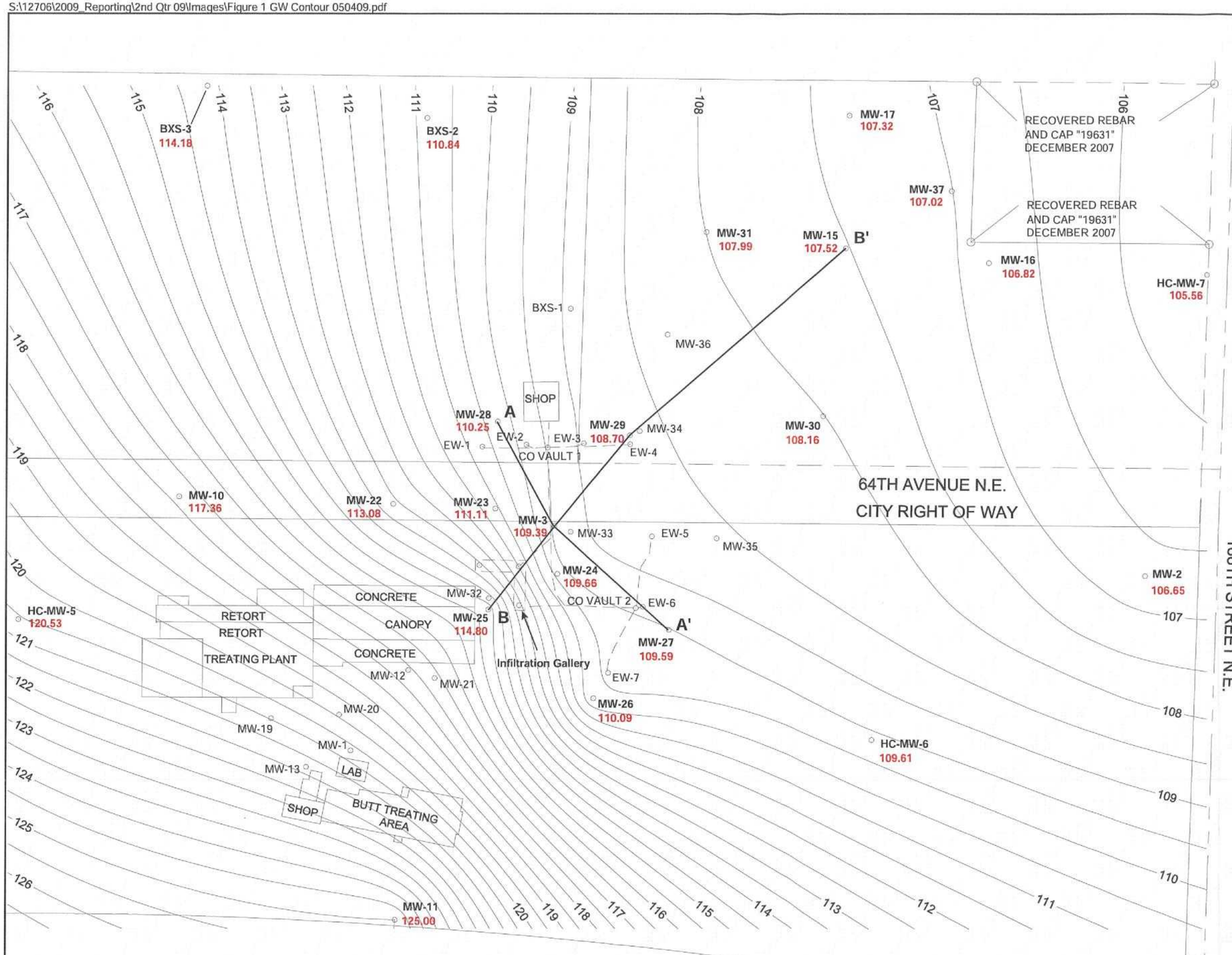

LEGEND:

MW-15 107.52	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. Vertical Datum is N.A.V.D. 88.
2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.
3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.
4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

APRIL MONITORING EVENT (MAY 4, 2009) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 05/13/09	Figure E.16

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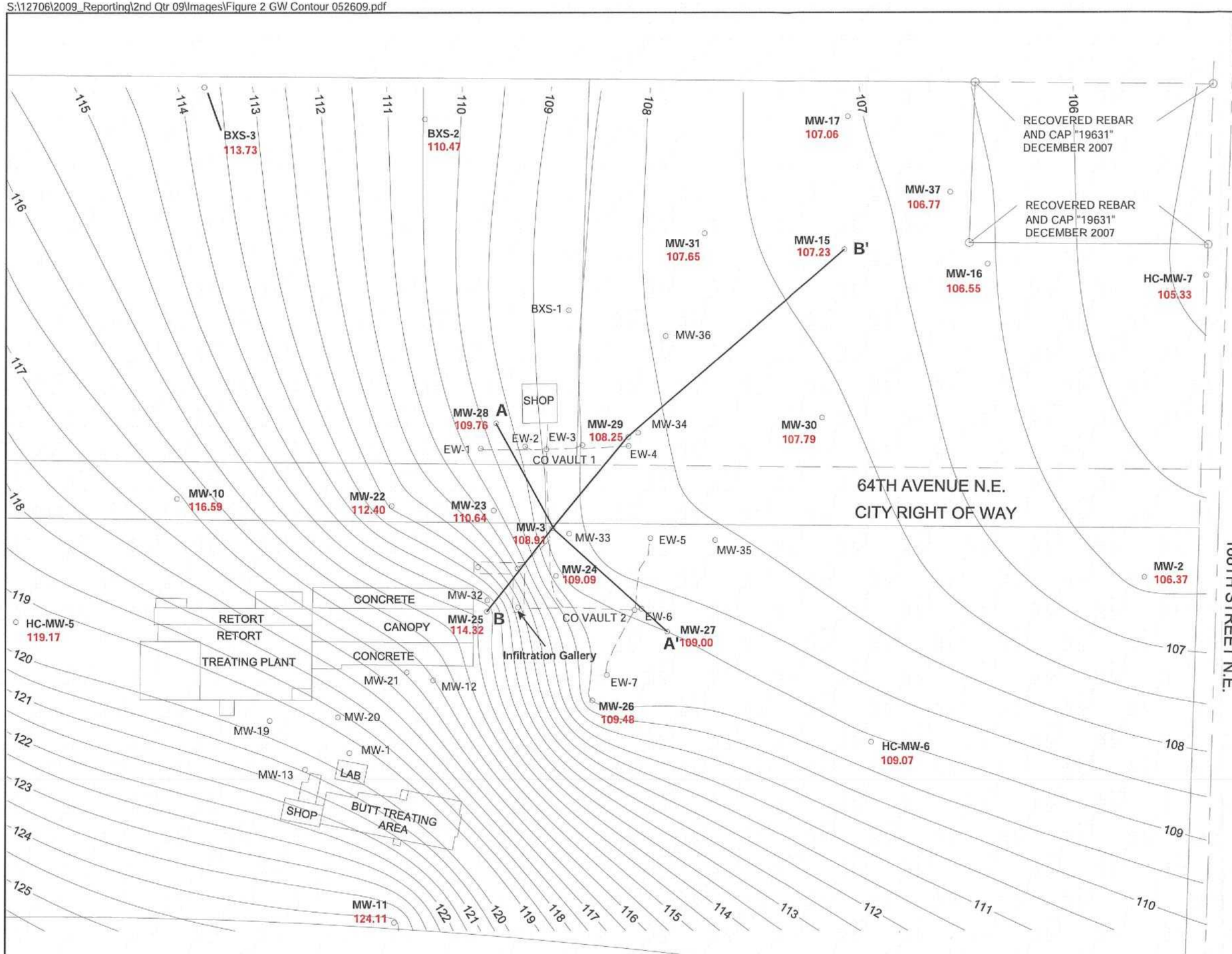

LEGEND:

MW-15 107.23	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

MAY MONITORING EVENT (MAY 26, 2009) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 05/29/09	Figure E.17

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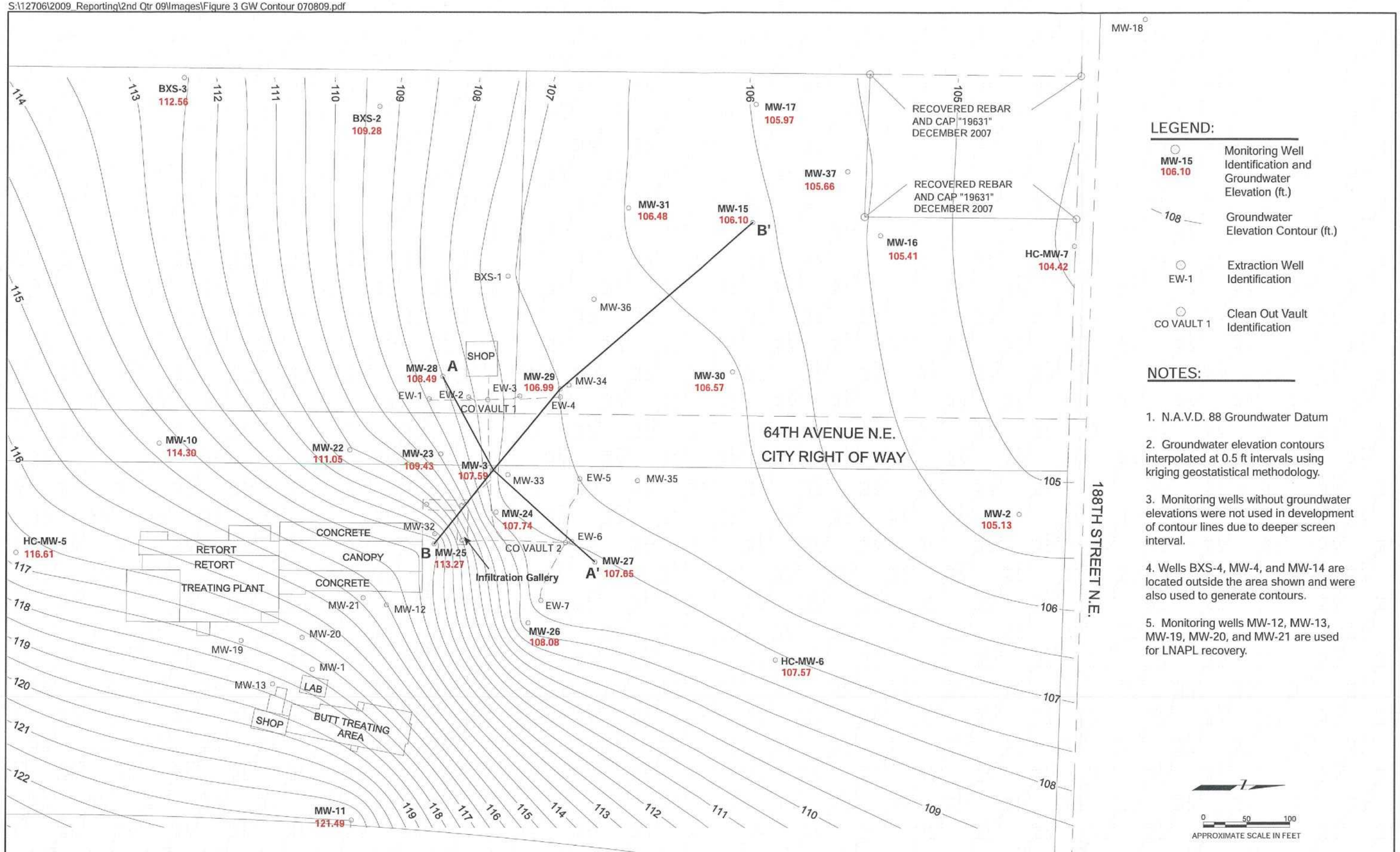
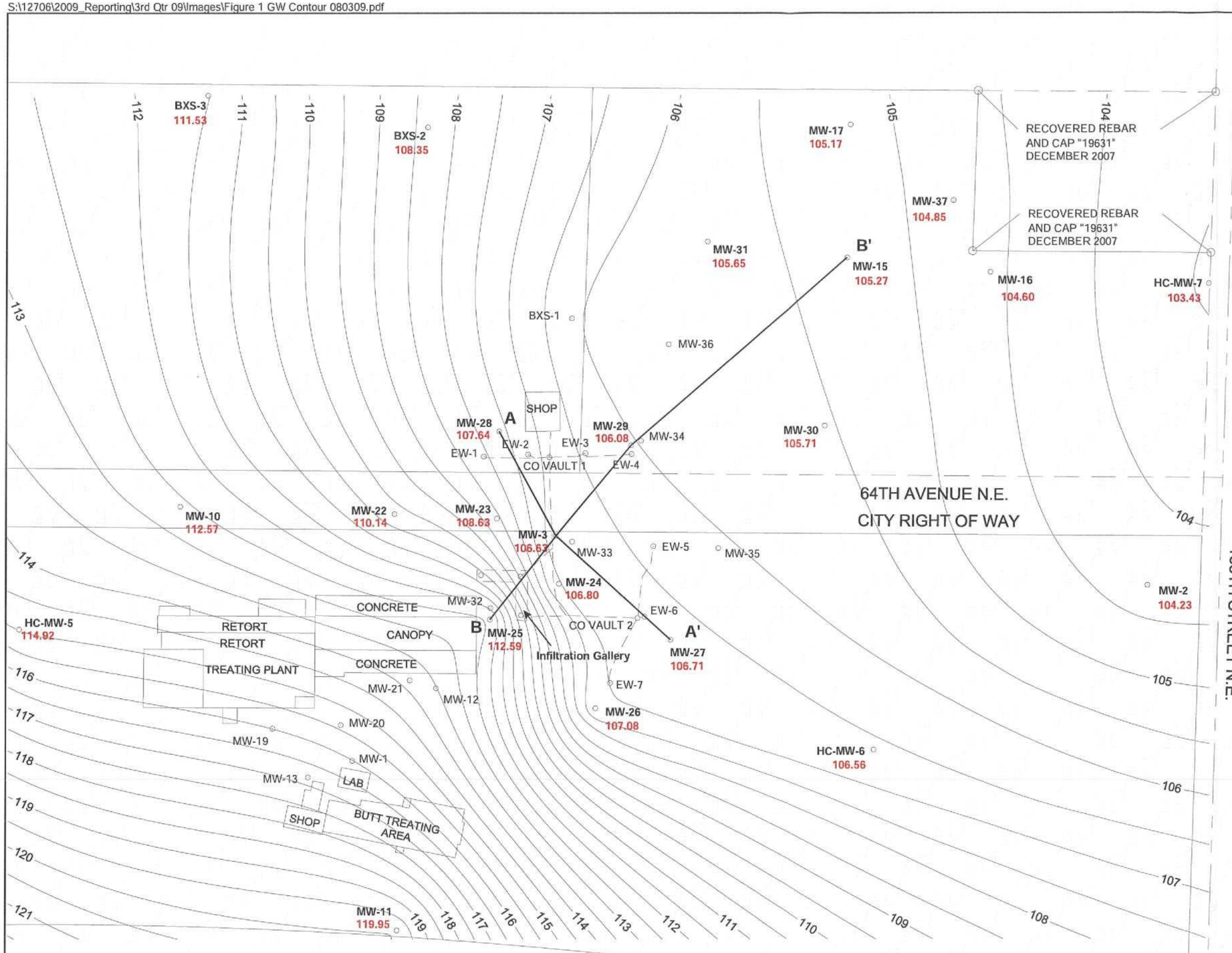


AMEC Geomatrix	JUNE MONITORING EVENT (JULY 8, 2009) GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 07/09/09	Figure E.18



LEGEND:

MW-15 105.27	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum
2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.
3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.
4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.
6. Depth to water measurements at BXS-1, BXS-2, BXS-3, and BXS-4 were performed on August 4, 2009.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

JULY MONITORING EVENT (AUGUST 3, 2009) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 08/08/09	Figure E.19

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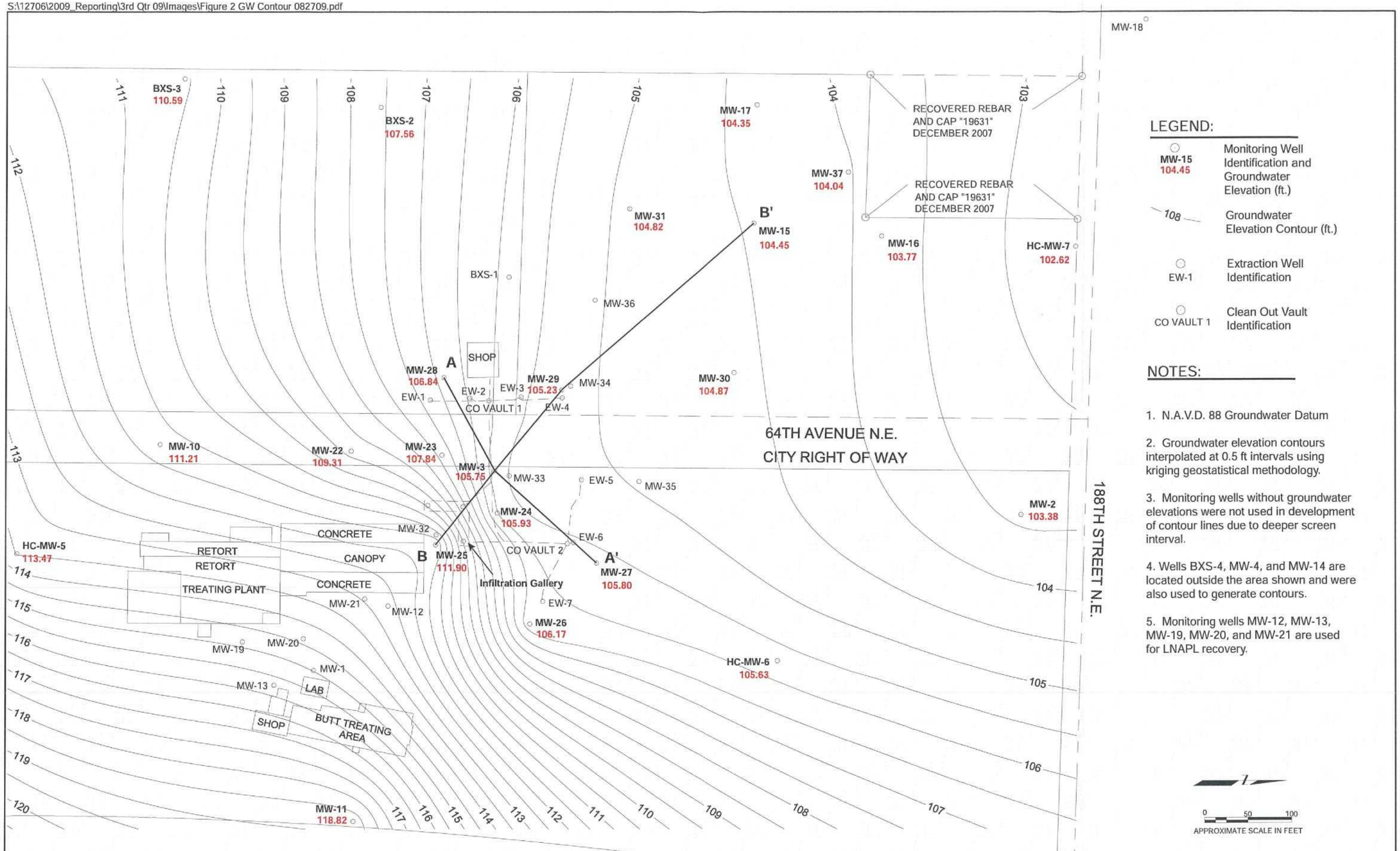

AMEC Geomatrix	AUGUST MONITORING EVENT (AUGUST 27, 2009) GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 08/31/09	Figure E.20

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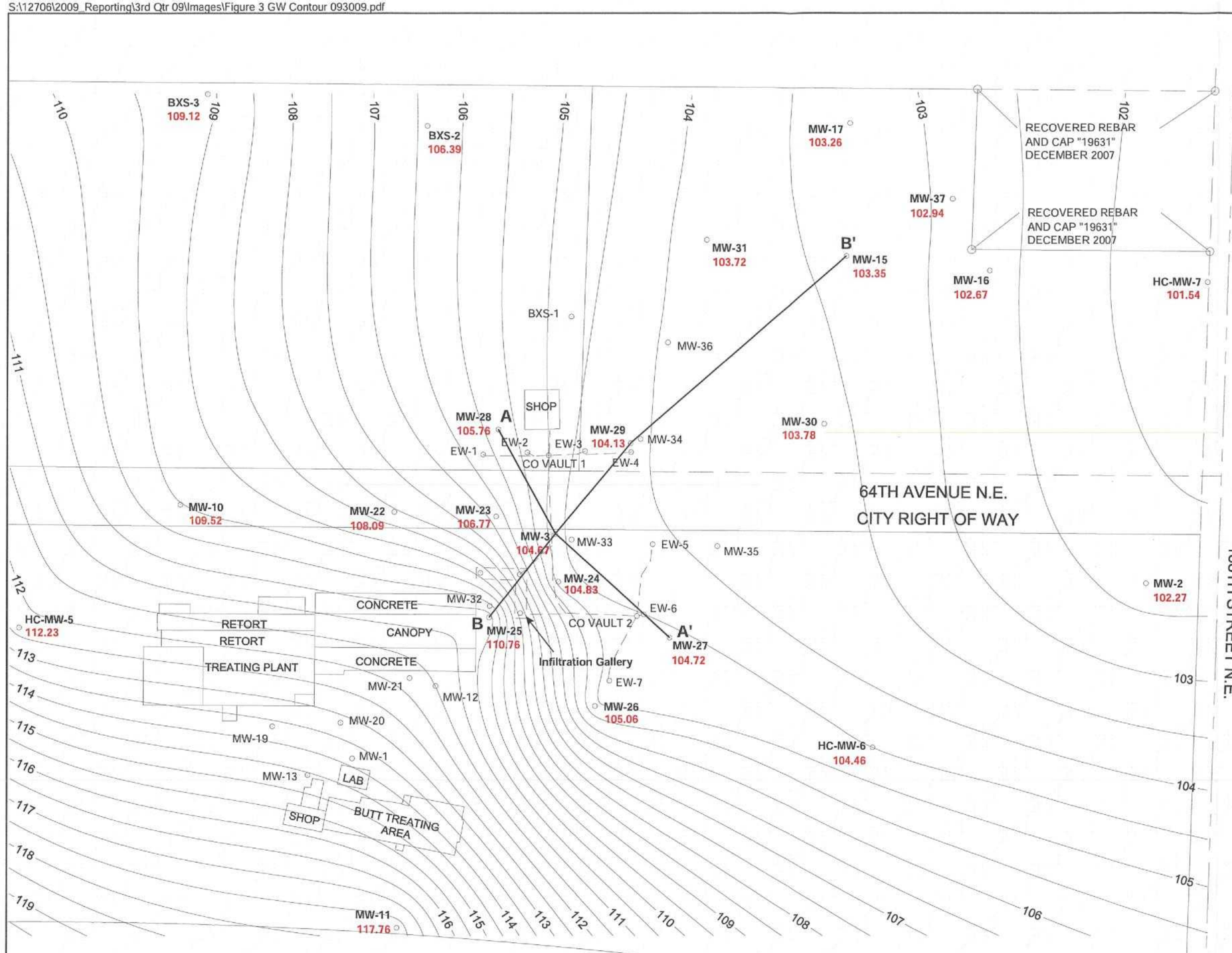

LEGEND:

MW-15 103.35	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum
2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.
3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.
4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.
5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

SEPTEMBER MONITORING EVENT (SEPTEMBER 30, 2009) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 10/01/09	Figure E.21

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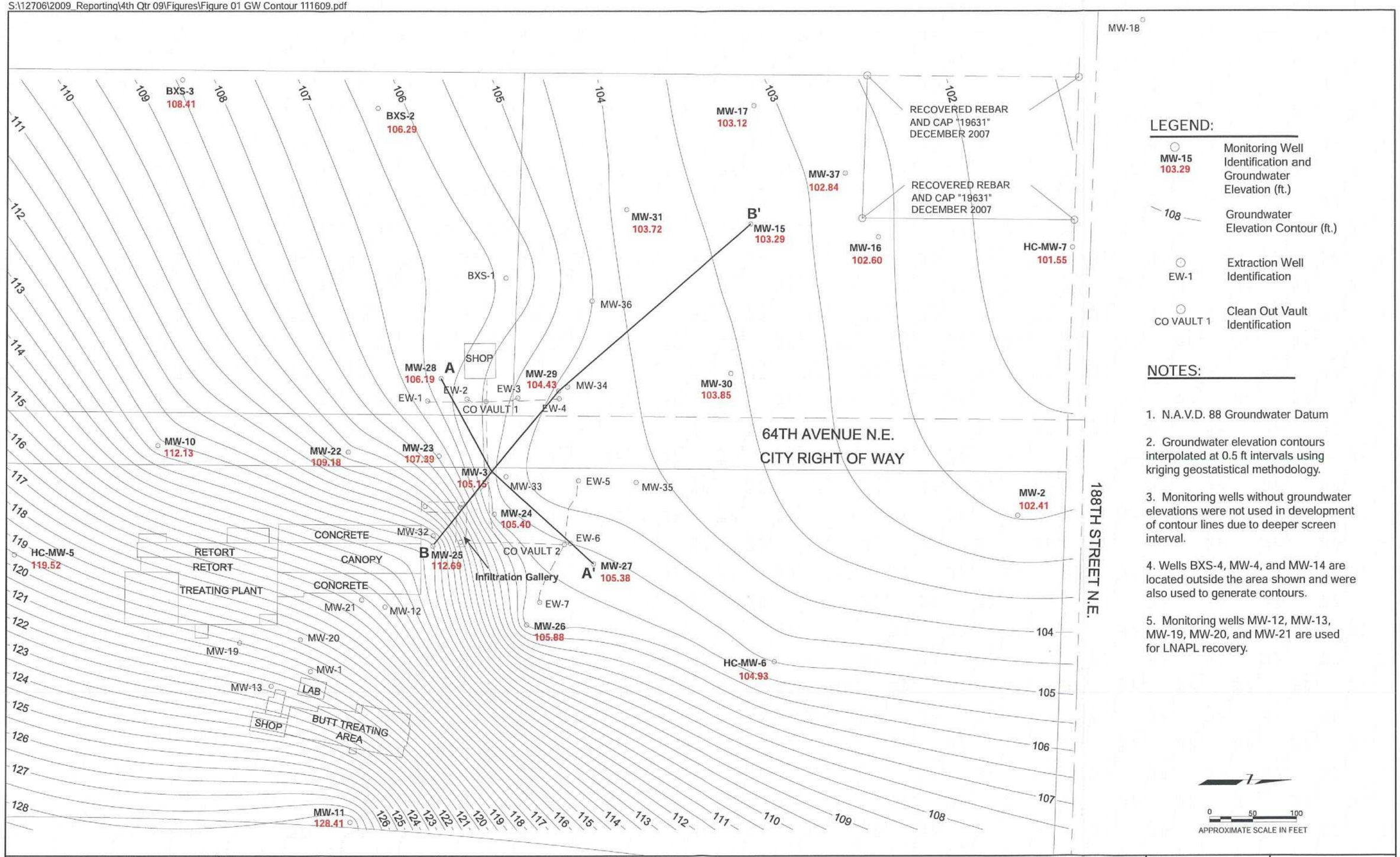
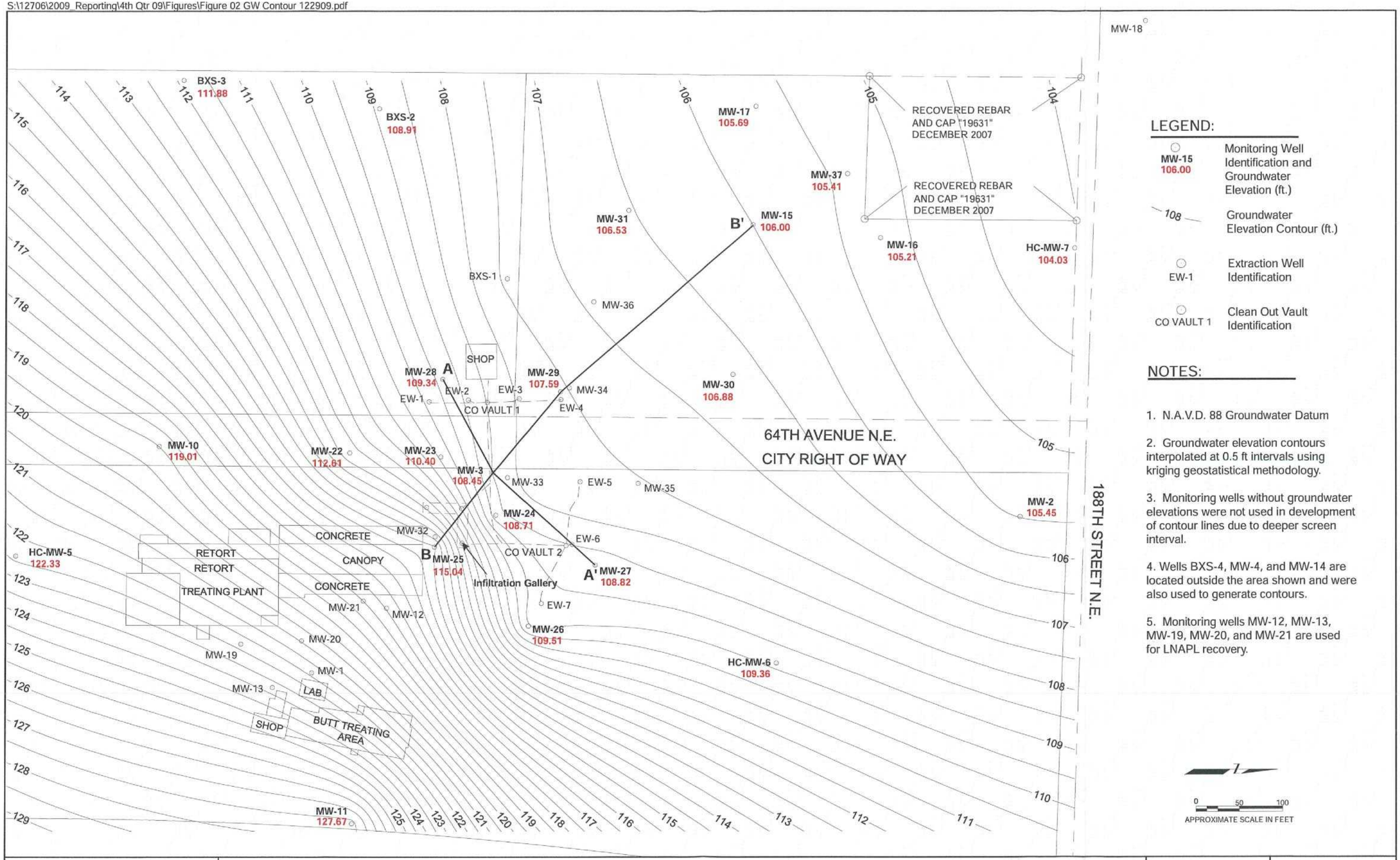


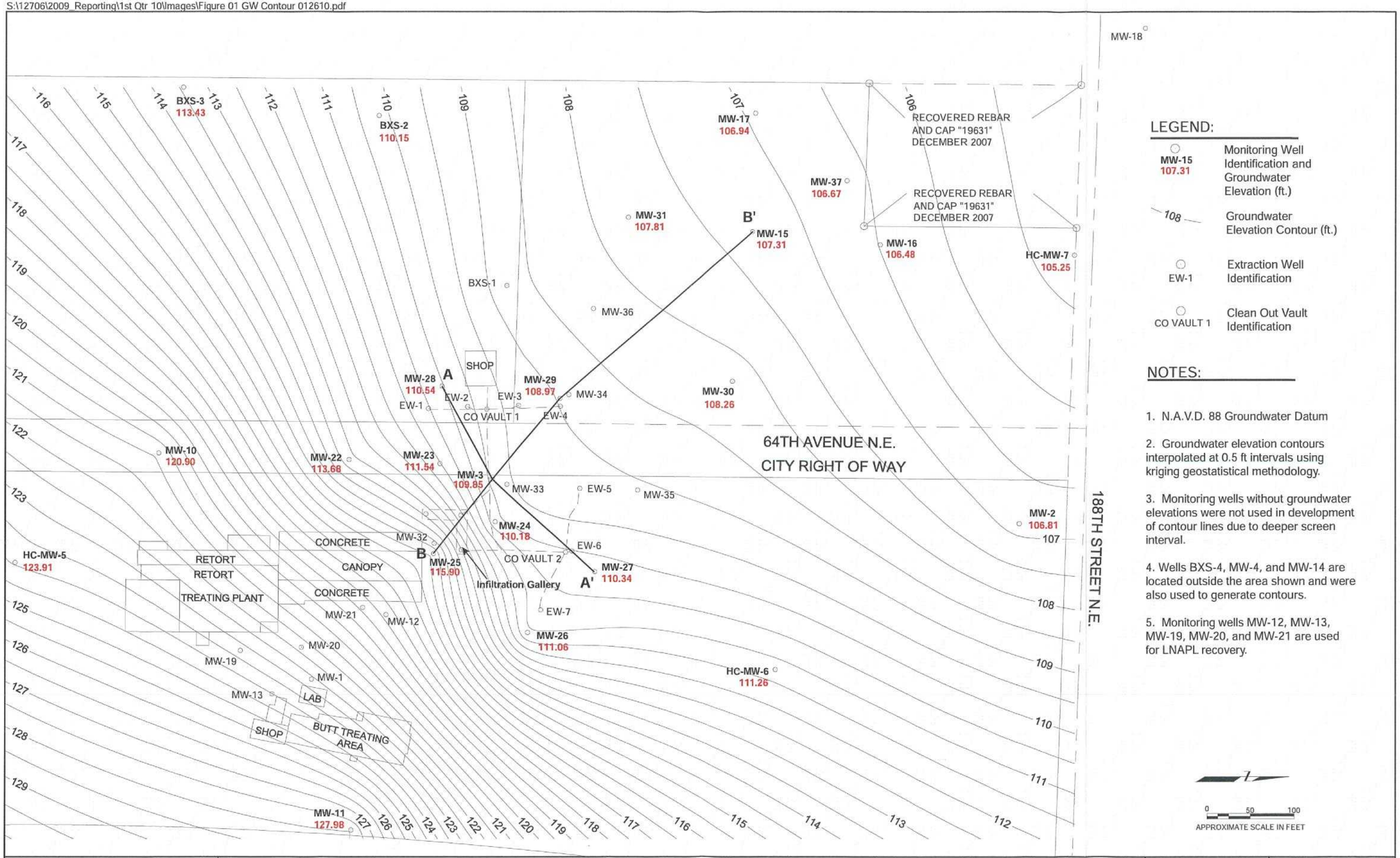
AMEC Geomatrix	NOVEMBER MONITORING EVENT (NOVEMBER 16, 2009) GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 11/30/09	Figure E.22

S:\12706\2009_Reporting\4th Qtr 09\Figures\Figure 02 GW Contour 122909.pdf



AMEC Geomatrix	DECEMBER MONITORING EVENT (DECEMBER 29, 2009) GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 12/30/09	Figure E.23

S:\12706\2009_Reporting\1st Qtr 10\Images\Figure 01 GW Contour 012610.pdf



AMEC Geomatrix

JANUARY MONITORING EVENT (JANUARY 25, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 1/27/10	Figure E.24

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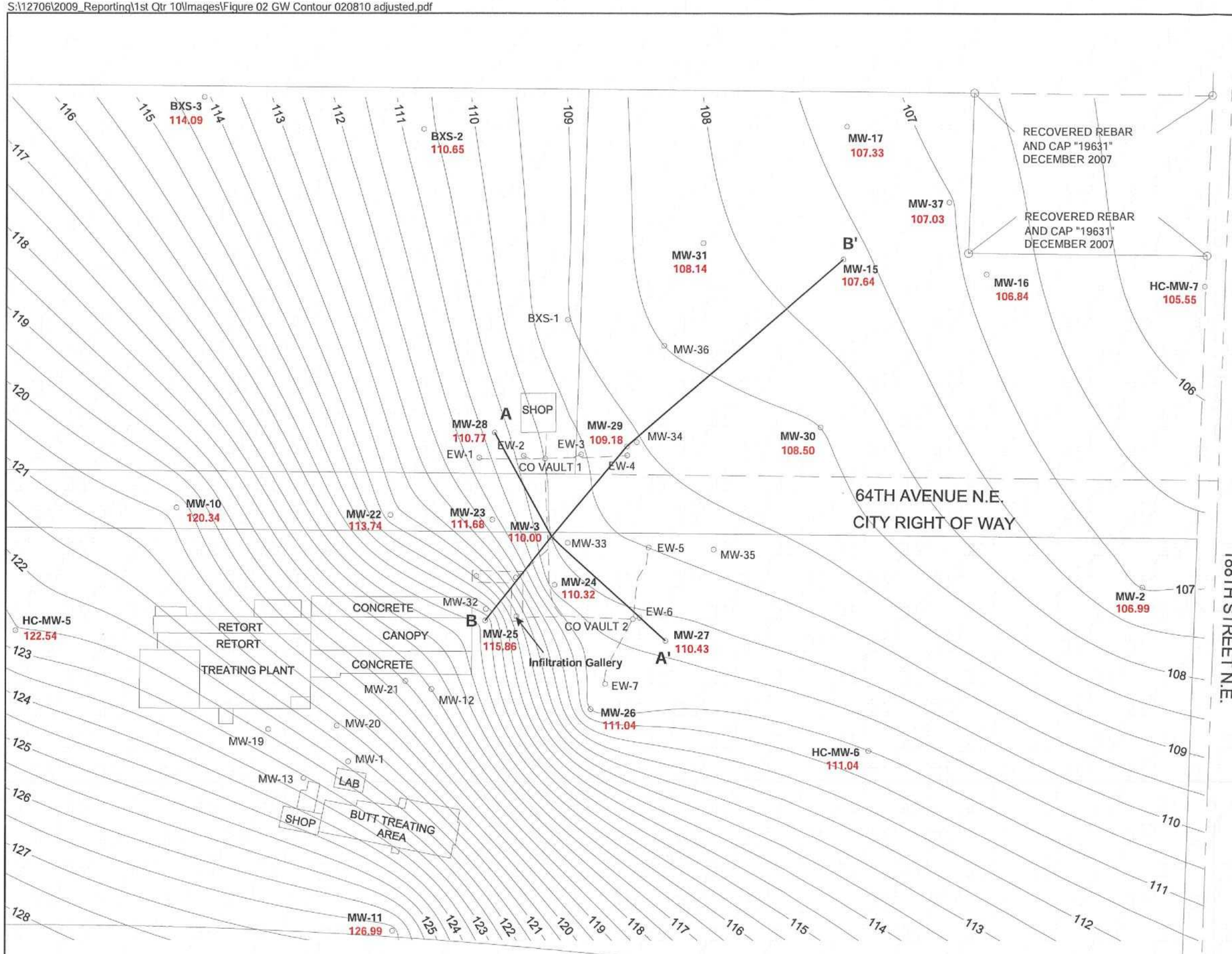

LEGEND:

MW-15 107.64	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. Elevation indicated for MW-23 was raised by 3 feet from values recorded in the field due to suspected error in field recording.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

FEBRUARY MONITORING EVENT (FEBRUARY 8, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 2/15/10	Figure E.25

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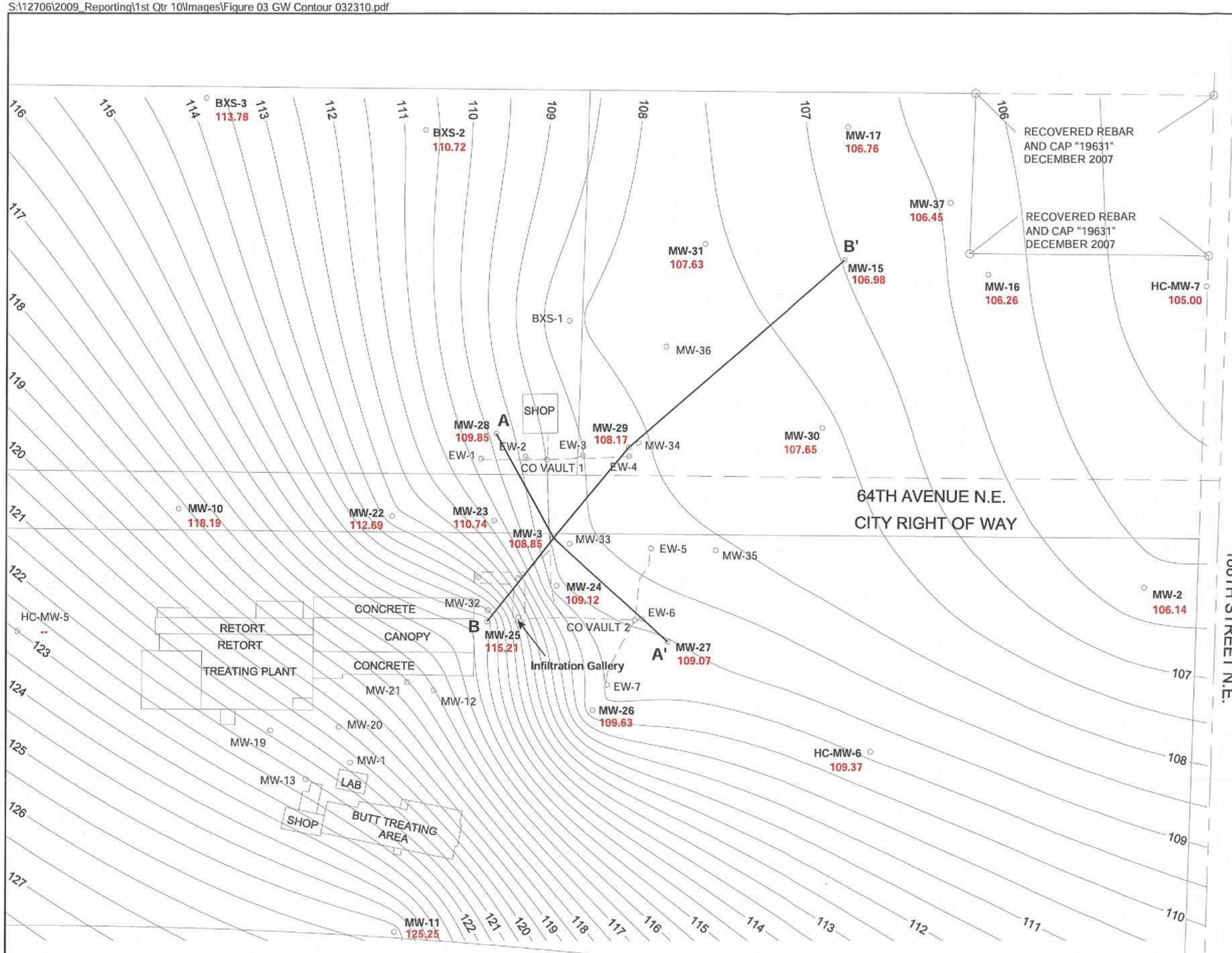


LEGEND:

MW-15 106.98	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. Groundwater elevation at HC-MW-5 was not recorded due to a damaged well monument lid, which could not be opened.

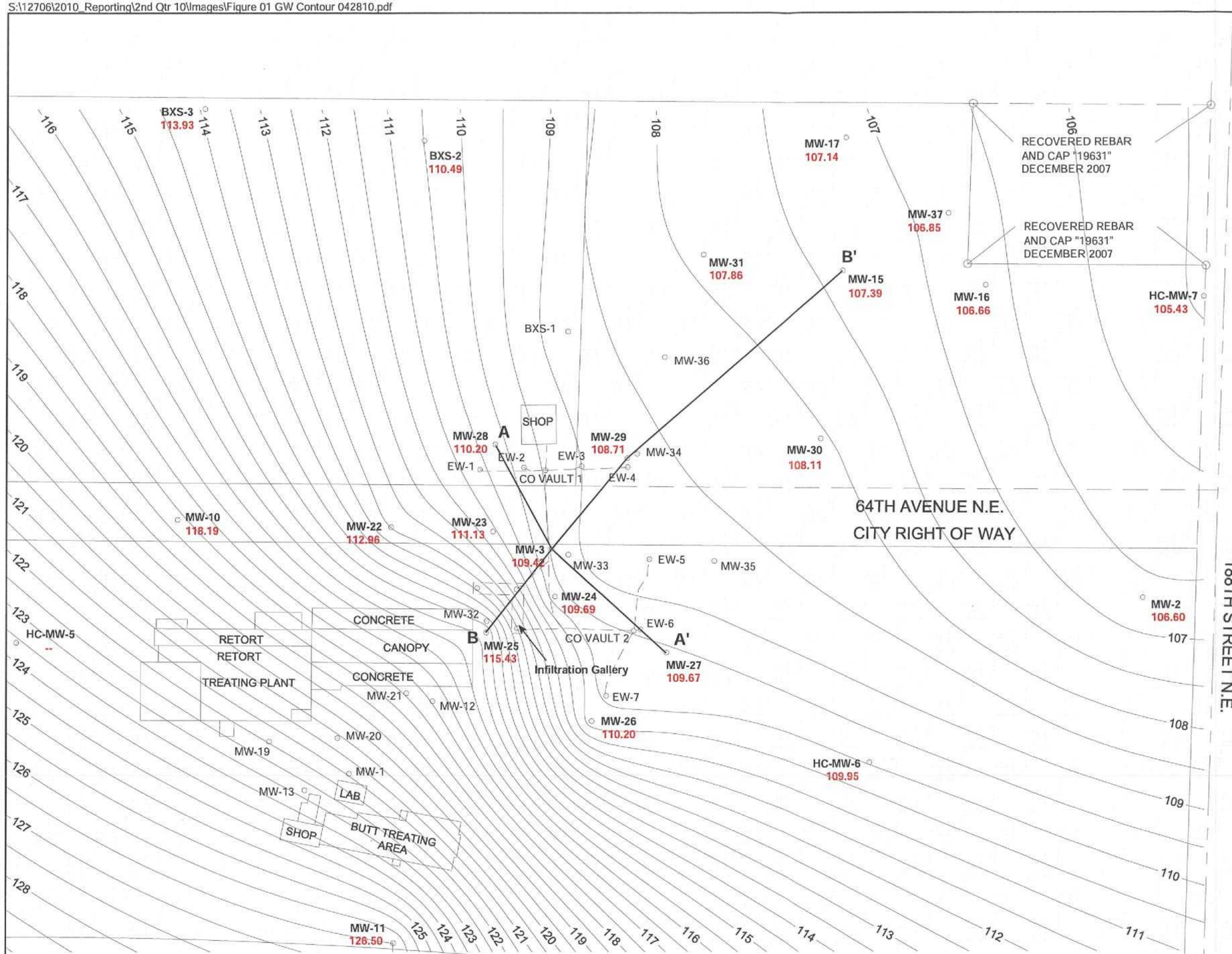
7. Groundwater elevations at MW-16 and MW-31 were lowered by 2 ft. from values recorded in the field due to suspected error in field recording.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

MARCH MONITORING EVENT (MARCH 23, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 4/2/10	Figure E.26



LEGEND:

MW-15 107.39	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. Groundwater elevation at HC-MW-5 was not recorded due to a damaged well monument lid, which could not be opened.

7. Groundwater elevation at MW-15 was increased by 1 ft. from the value recorded in the field due to suspected error in field recording.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

APRIL MONITORING EVENT (APRIL 28, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 5/3/10	Figure E.27

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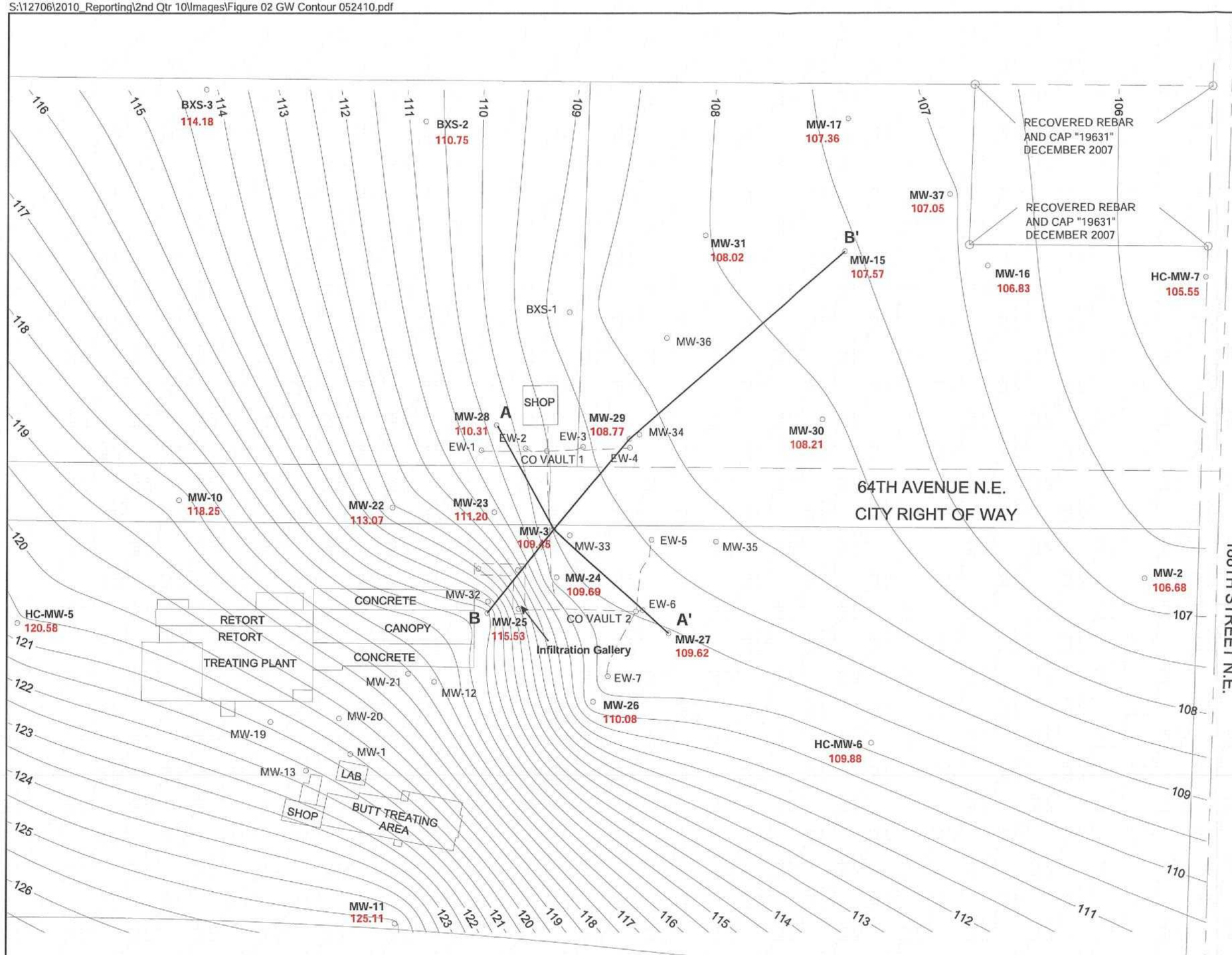

LEGEND:

MW-15 107.57	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. Depth to water measurement at MW-26 was performed 5/25/10. All depth to water measurements were performed within a 24 hour period.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

MAY MONITORING EVENT (MAY 24, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 6/3/10	Figure E.28

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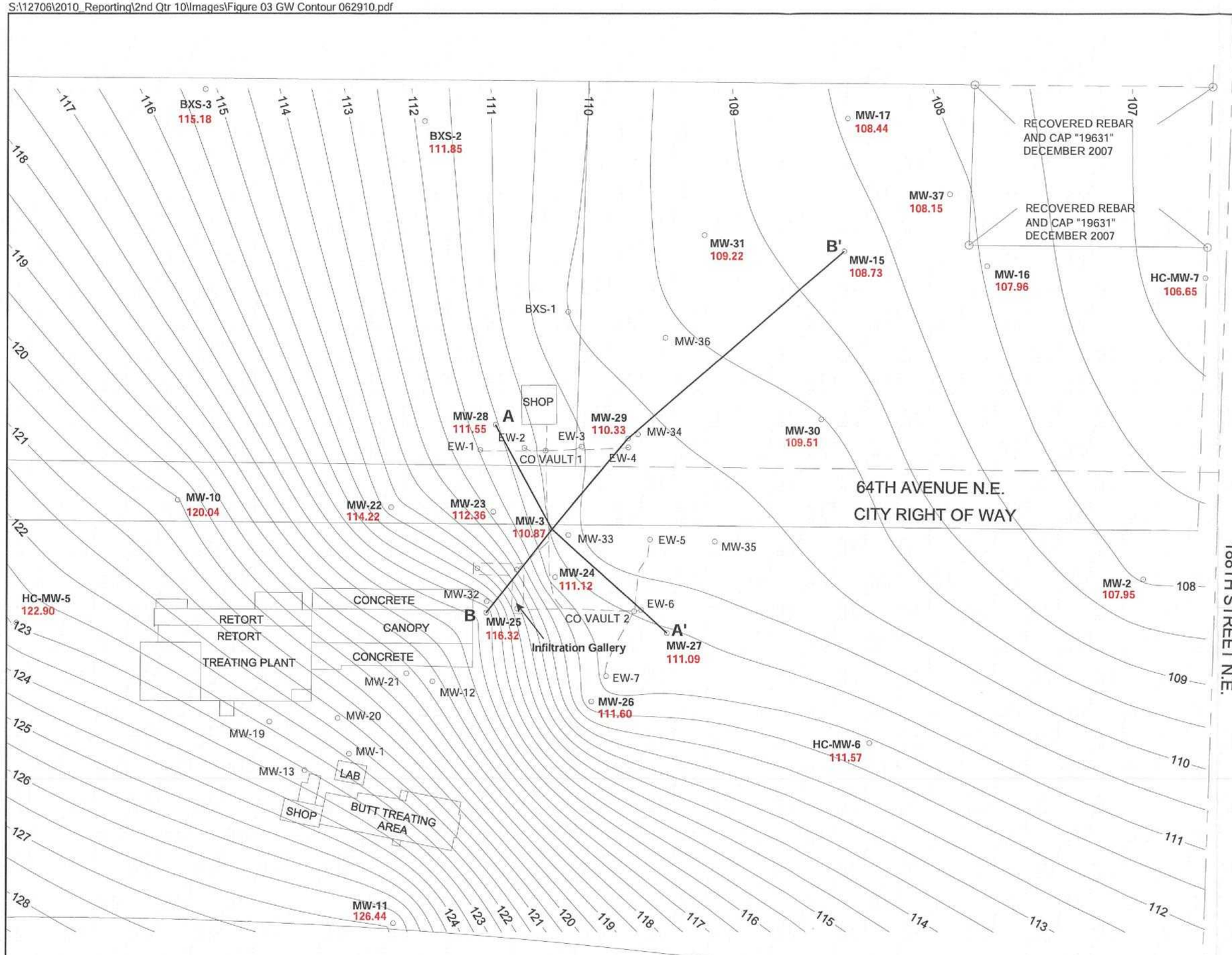


LEGEND:

MW-15 108.73	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, and MW-14 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

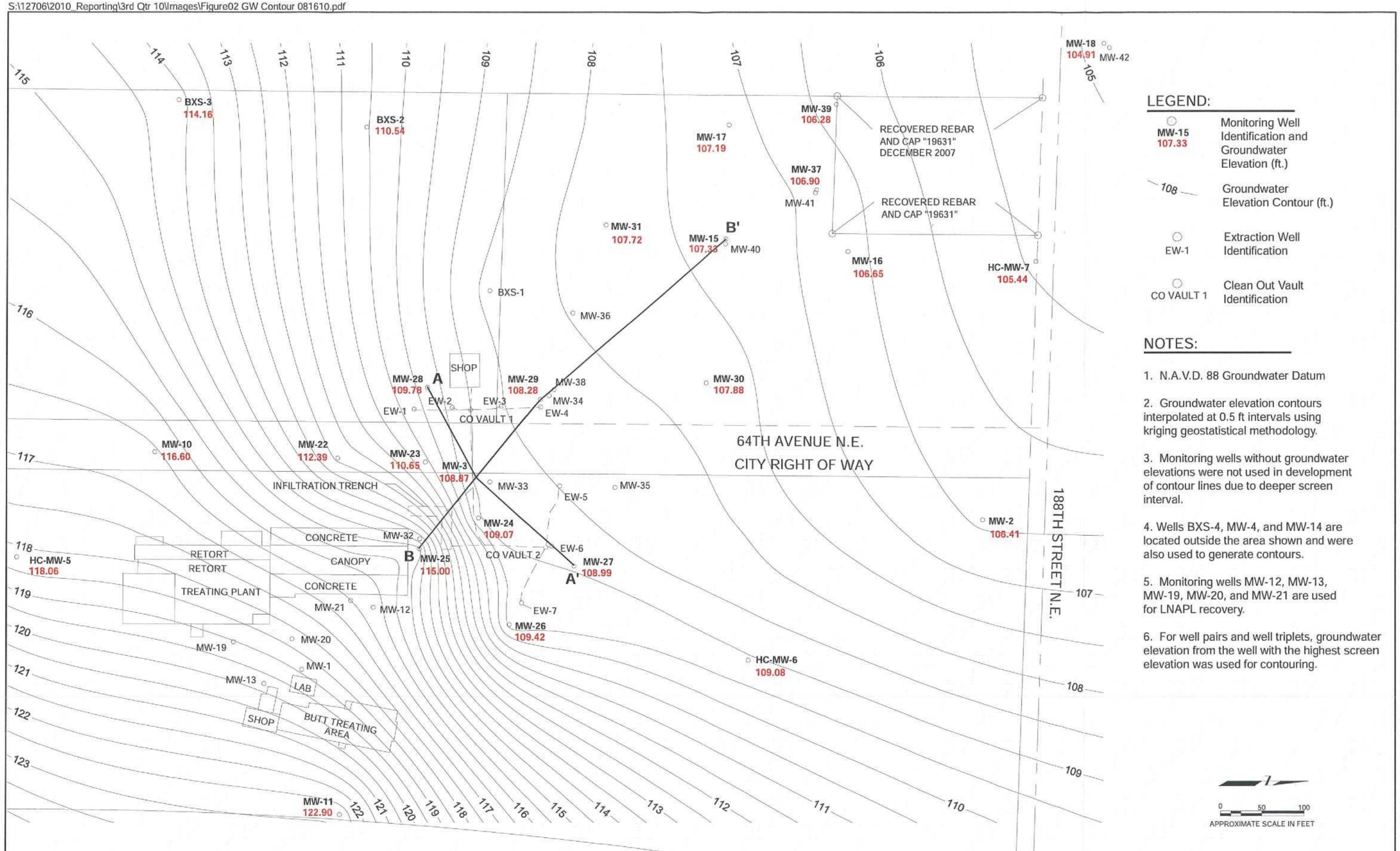
6. Extraction well EW-4 was not in operation during this monitoring event.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

JUNE MONITORING EVENT (JUNE 29, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 7/14/10	Figure E.29

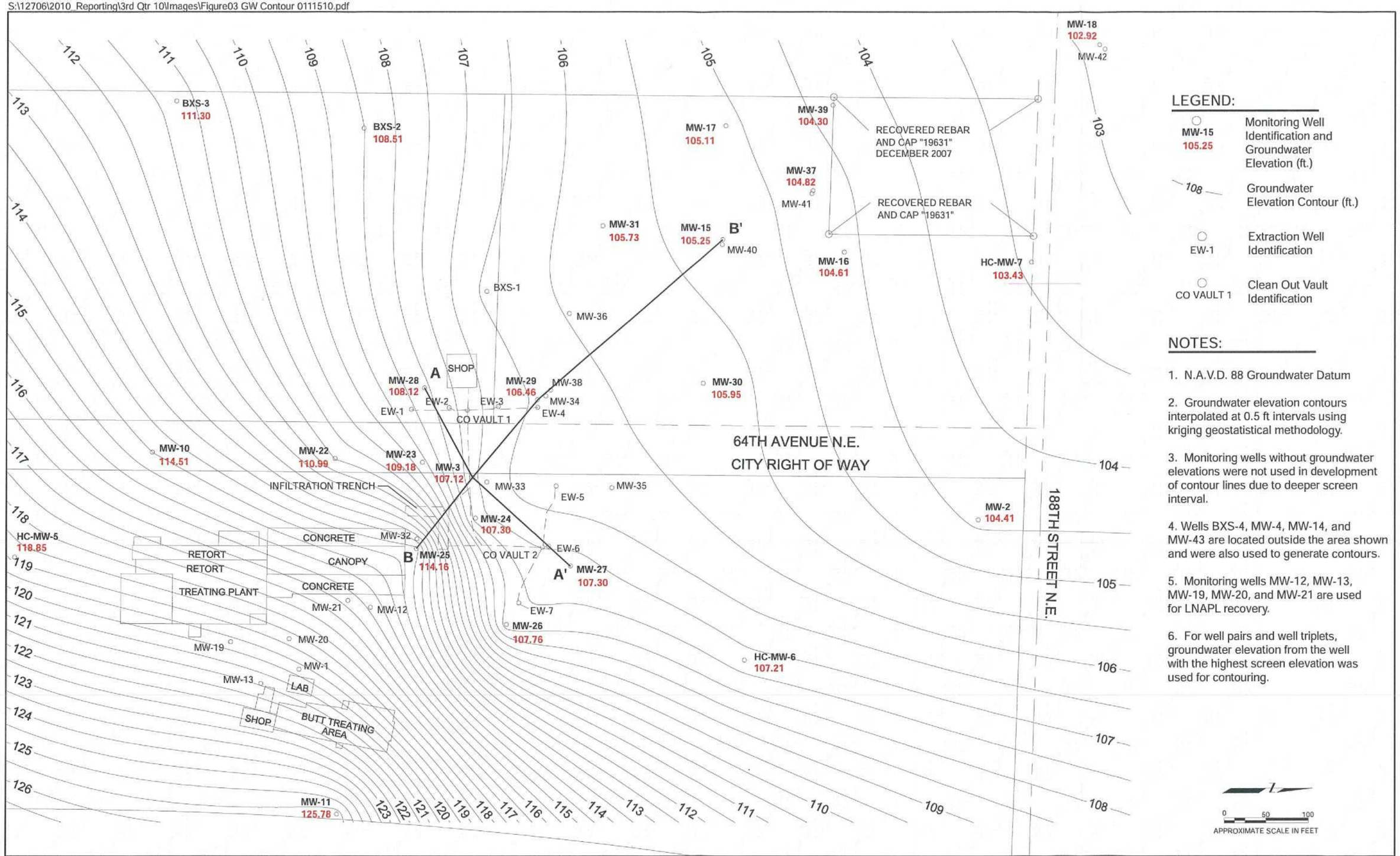


AMEC Geomatrix

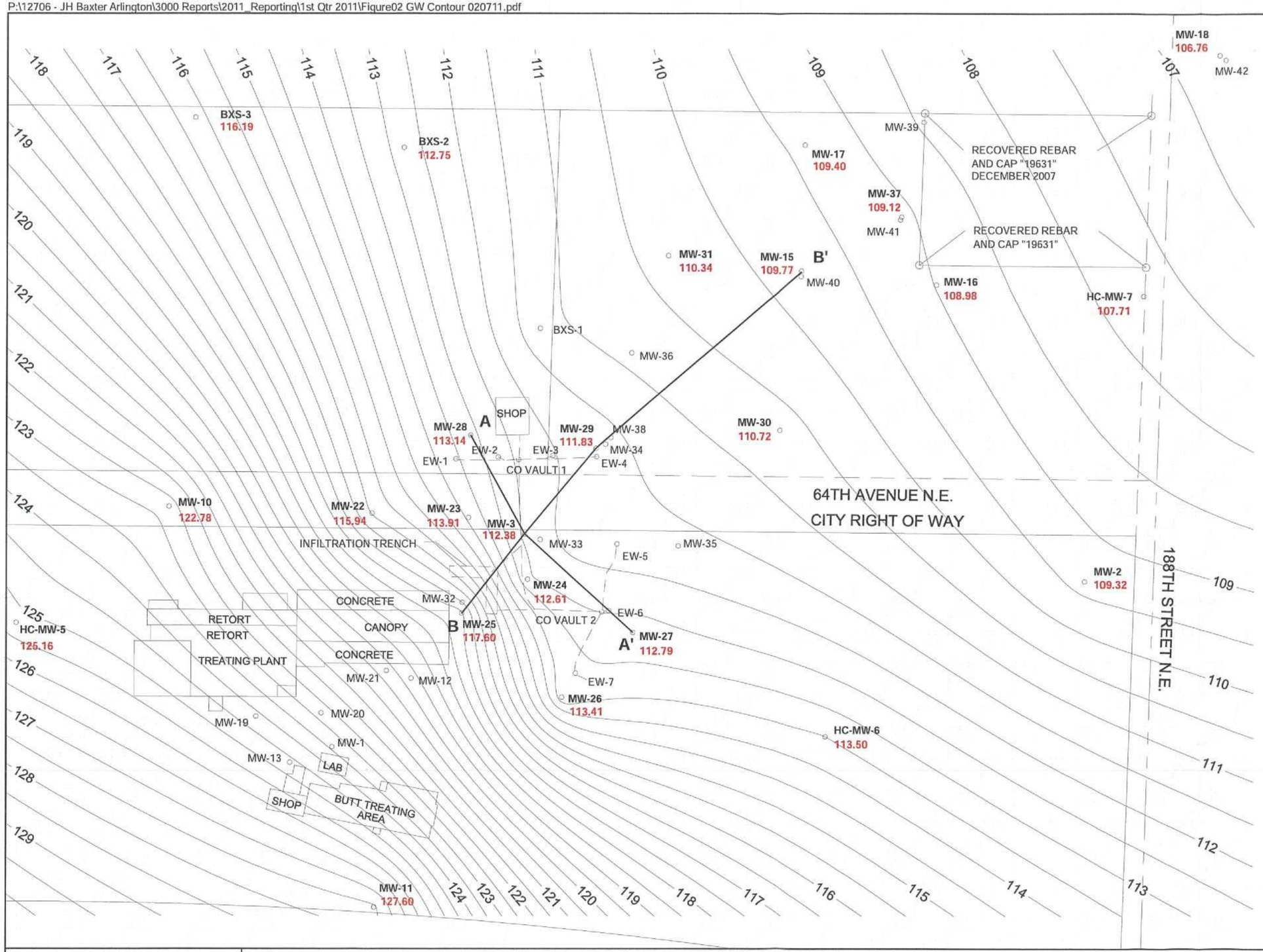
AUGUST MONITORING EVENT (AUGUST 16, 2010) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 11/17/10	Figure E.30

S:\12706\2010_Reporting\3rd Qtr 10\Images\Figure03 GW Contour 0111510.pdf



AMEC Geomatrix	FOURTH QUARTER 2010 (NOVEMBER 15, 2010) GROUNDWATER ELEVATION CONTOUR MAP Former J.H. Baxter and Co. Wood Treating Facility Arlington, Washington	Prepared By: RLW	Project No. 12706
		Date: 12/1/10	Figure E.31



LEGEND:

MW-15 109.77	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

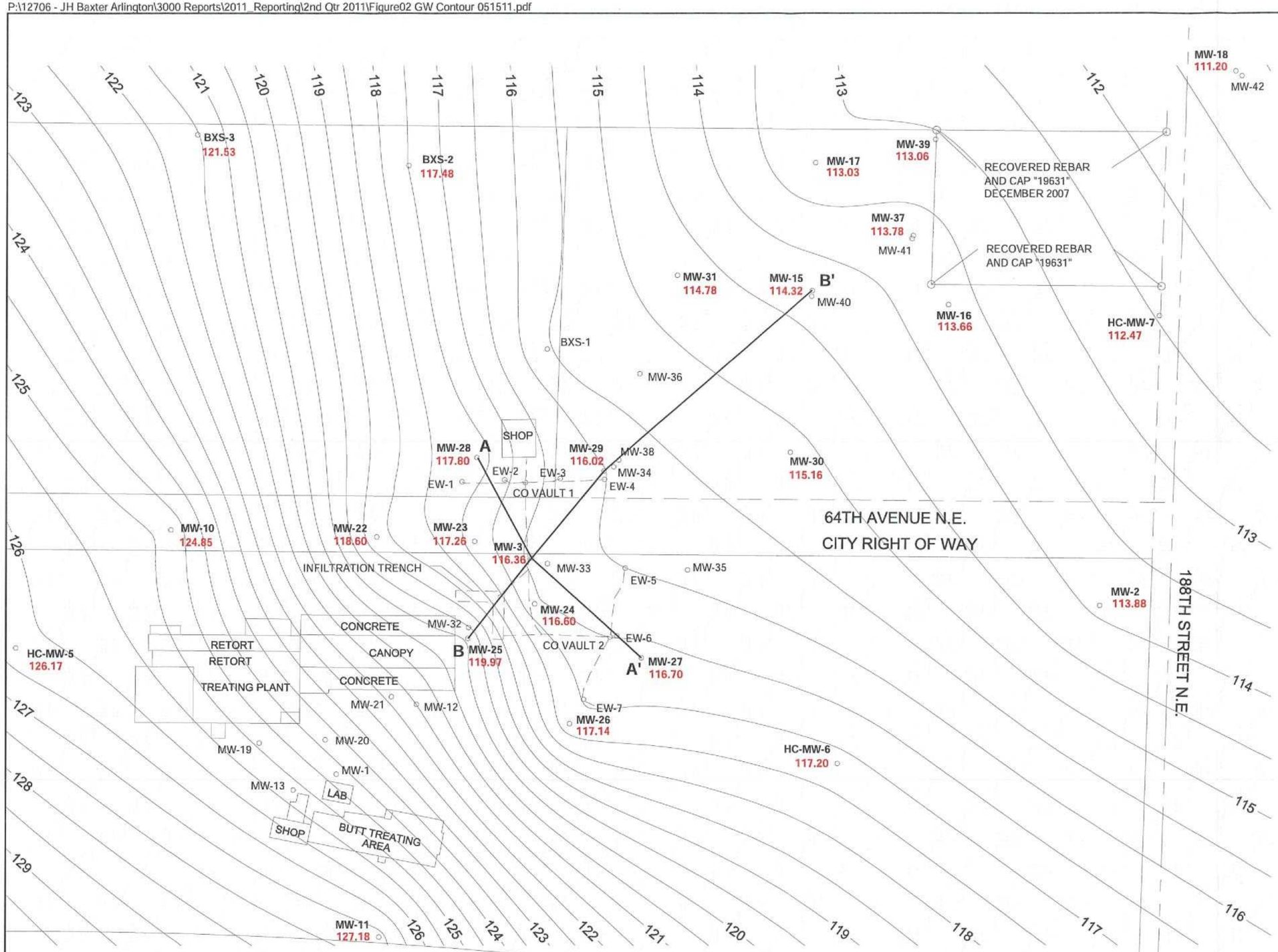
6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

0 50 100
APPROXIMATE SCALE IN FEET

AMEC Geomatrix

FIRST QUARTER 2011 (FEBRUARY 7, 2011) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 2/24/10	Figure E.32



LEGEND:

MW-17 113.03	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

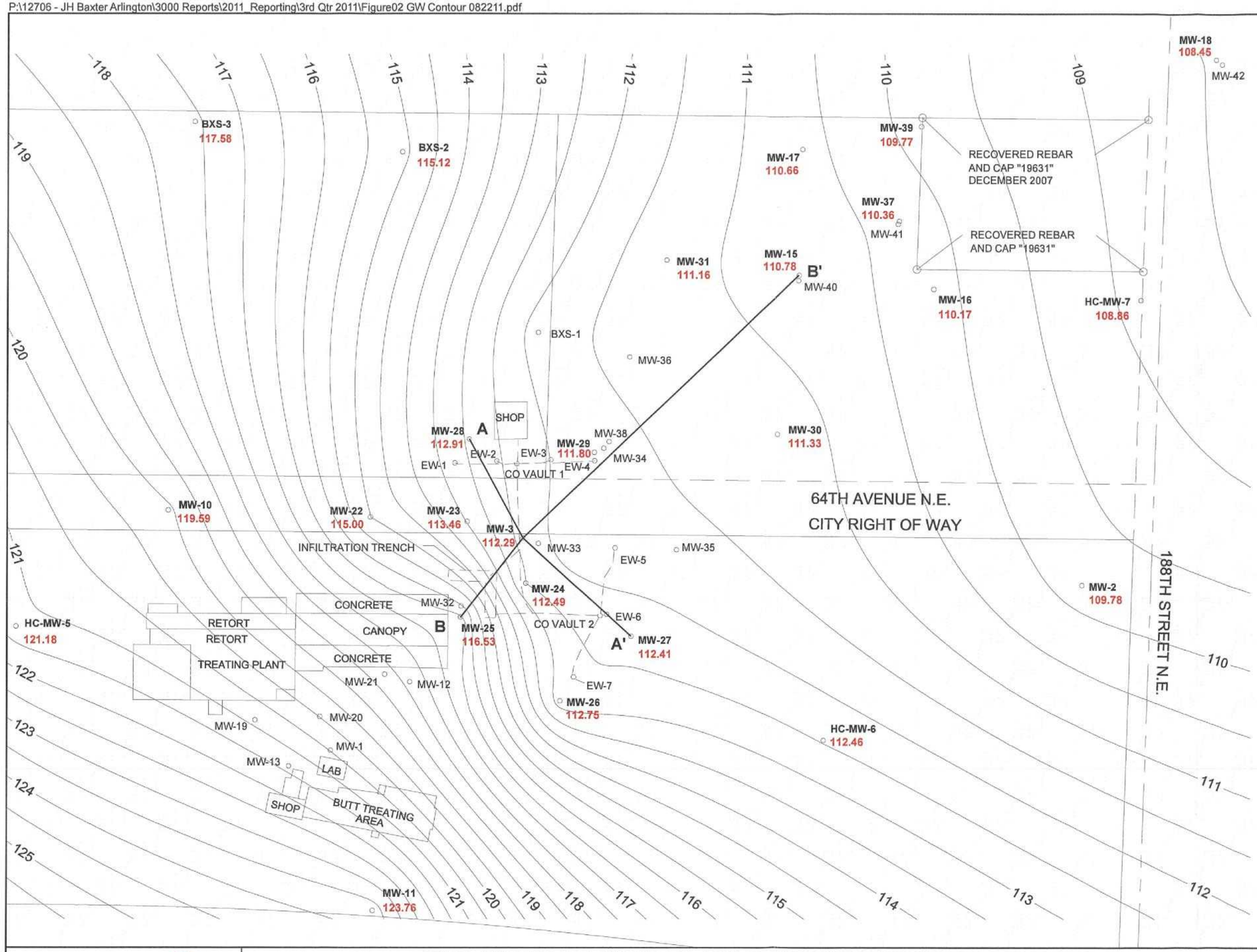
7. A suspected incorrect depth to water measurement occurred at MW-15. Therefore, the groundwater elevation at MW-15 was estimated by calculating the average elevation difference between MW-15 and MW-40 for the 3rd Quarter 2010 through the 1st Quarter 2011 and adding this difference to the 2nd Quarter 2011 groundwater elevation measured at MW-40.

0 50 100
APPROXIMATE SCALE IN FEET

amec

SECOND QUARTER 2011 (MAY 2011) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 7/20/11	Figure E.33



LEGEND:

MW-17 110.66	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

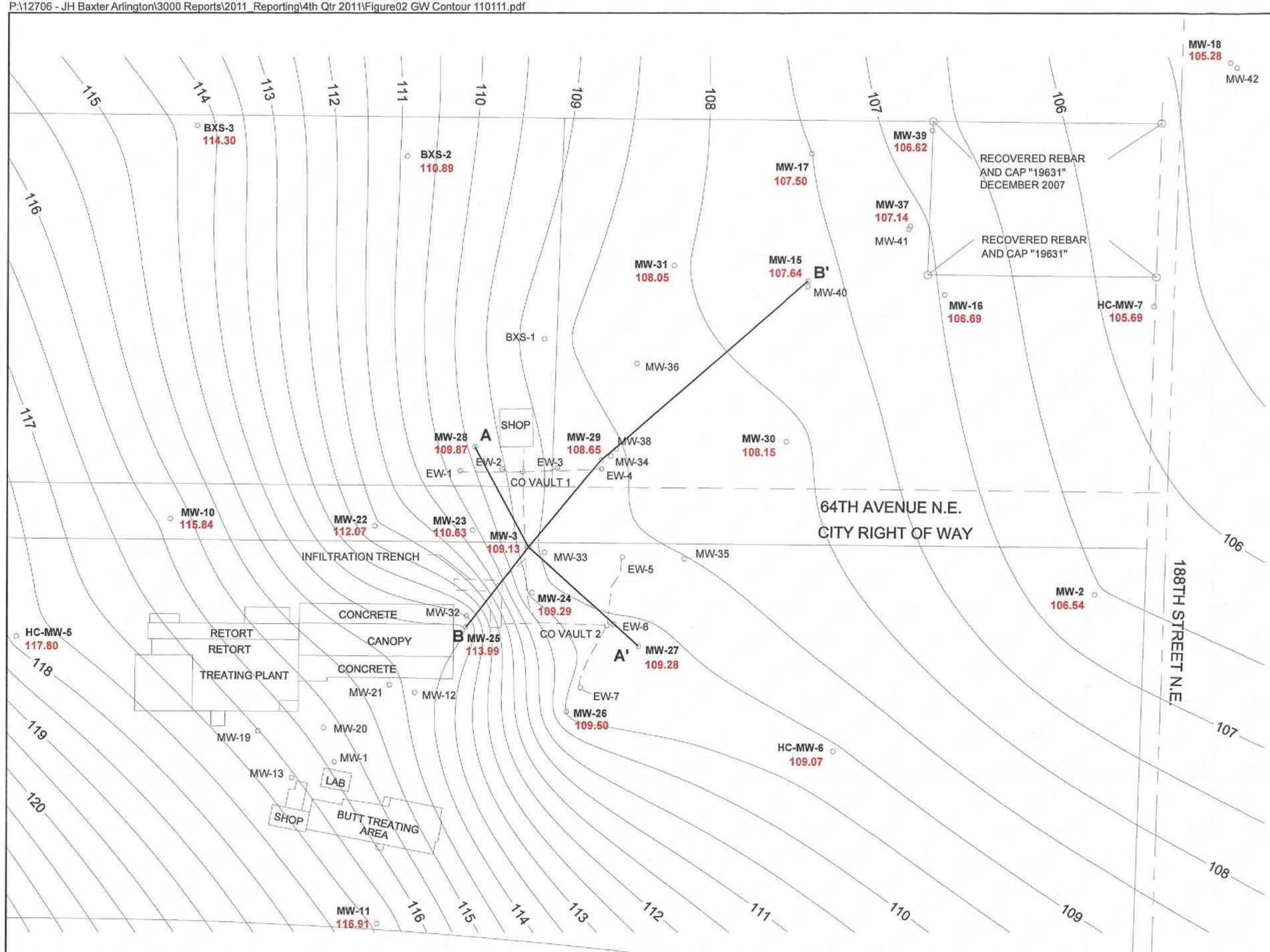
6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

0 50 100
APPROXIMATE SCALE IN FEET

amec

THIRD QUARTER 2011 (AUGUST 22, 2011) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 10/9/11	Figure E.34



LEGEND:

MW-17 107.50	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

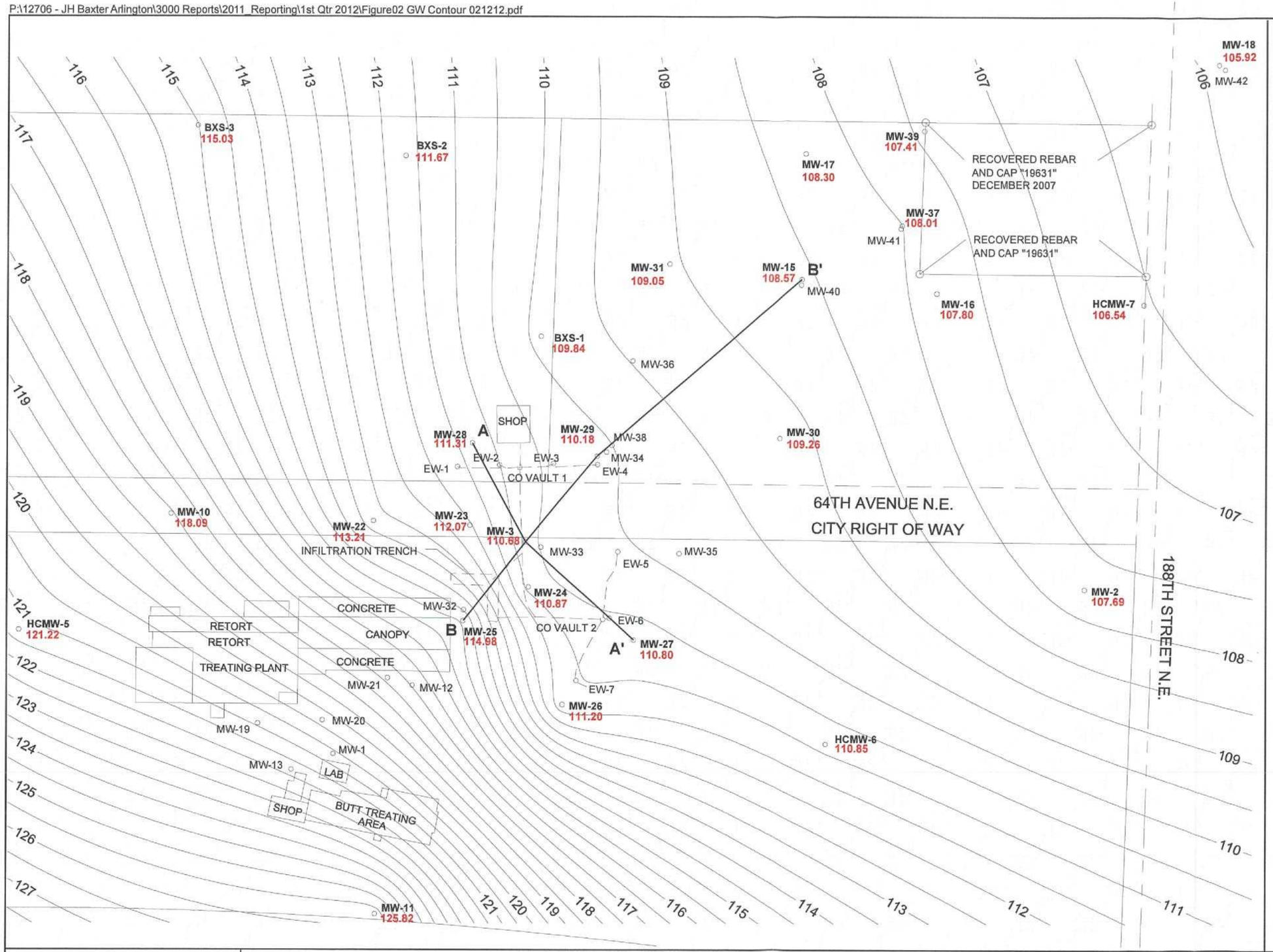
7. The groundwater elevation indicated for MW-15 was raised by 1 foot from the value recorded in the field due to a suspected error in field recording.

0 50 100
APPROXIMATE SCALE IN FEET

amec

FOURTH QUARTER 2011 (NOVEMBER 1, 2011) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 12/1/11	Figure E.35



LEGEND:

MW-17 108.30	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

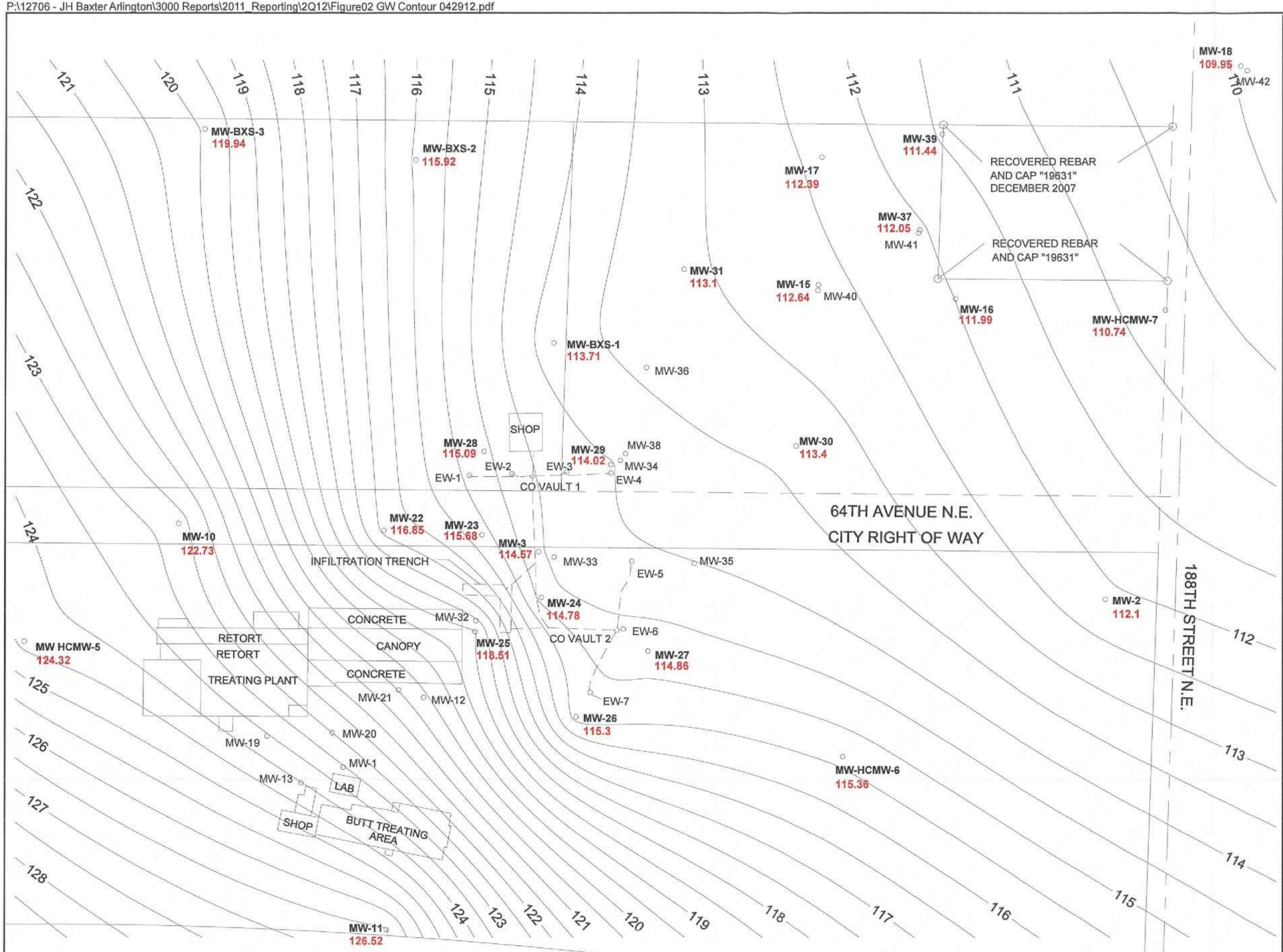
6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

0 50 100
APPROXIMATE SCALE IN FEET

amec

FIRST QUARTER 2012 (FEBRUARY 12, 2012) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: RLW	Project No. 12706
Date: 3/19/12	Figure E.36



LEGEND:

MW-17 108.30	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

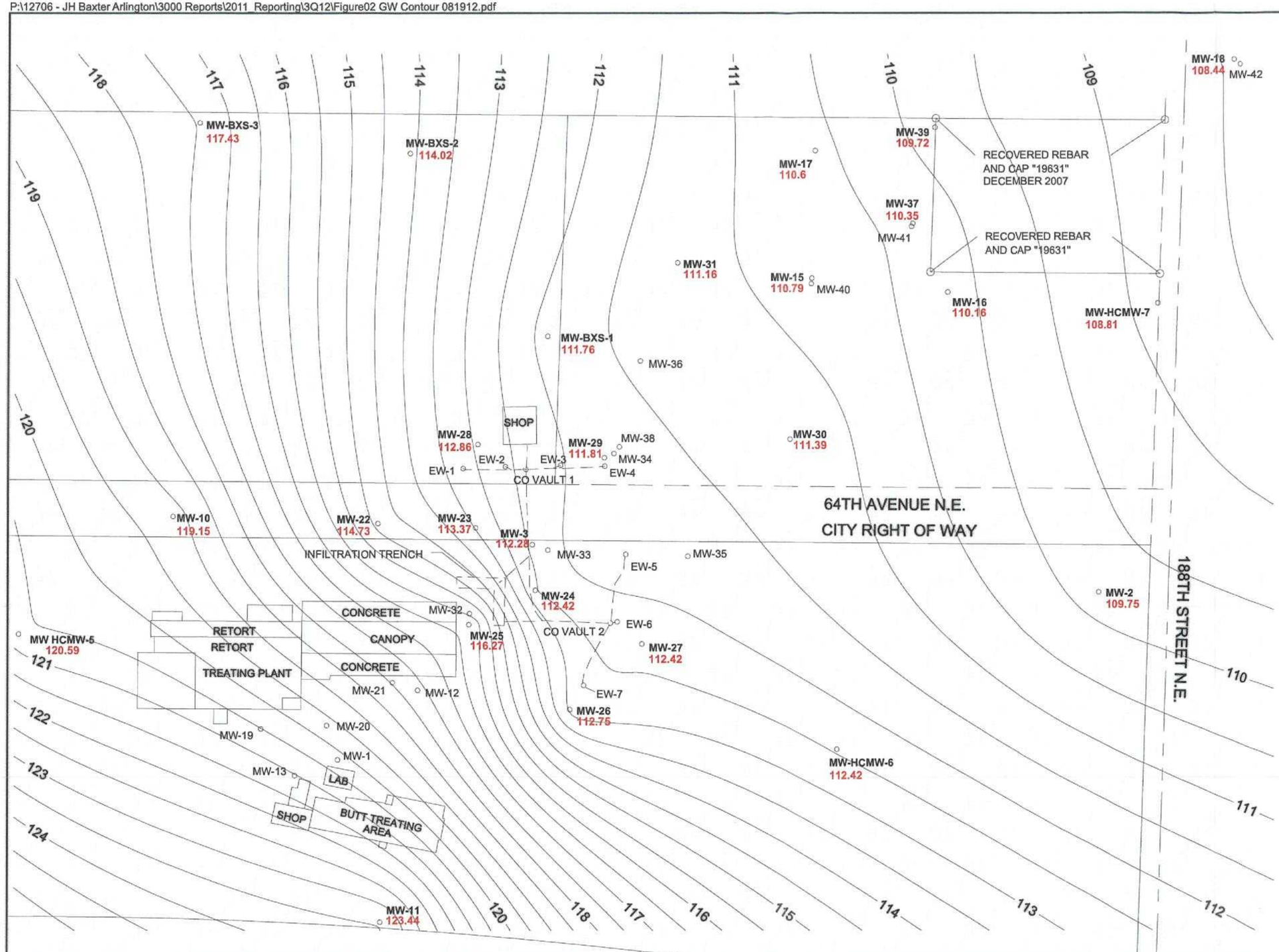
6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

0 50 100
APPROXIMATE SCALE IN FEET

amec

SECOND QUARTER 2012 (APRIL 29, 2012) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: EO	Project No. 12706
Date: 5/18/12	Figure E.37



LEGEND:

MW-17 108.30	Monitoring Well Identification and Groundwater Elevation (ft.)
108	Groundwater Elevation Contour (ft.)
EW-1	Extraction Well Identification
CO VAULT 1	Clean Out Vault Identification

NOTES:

1. N.A.V.D. 88 Groundwater Datum

2. Groundwater elevation contours interpolated at 0.5 ft intervals using kriging geostatistical methodology.

3. Monitoring wells without groundwater elevations were not used in development of contour lines due to deeper screen interval.

4. Wells BXS-4, MW-4, MW-14, and MW-43 are located outside the area shown and were also used to generate contours.

5. Monitoring wells MW-12, MW-13, MW-19, MW-20, and MW-21 are used for LNAPL recovery.

6. For well pairs and well triplets, groundwater elevation from the well with the highest screen elevation was used for contouring.

0 50 100
APPROXIMATE SCALE IN FEET

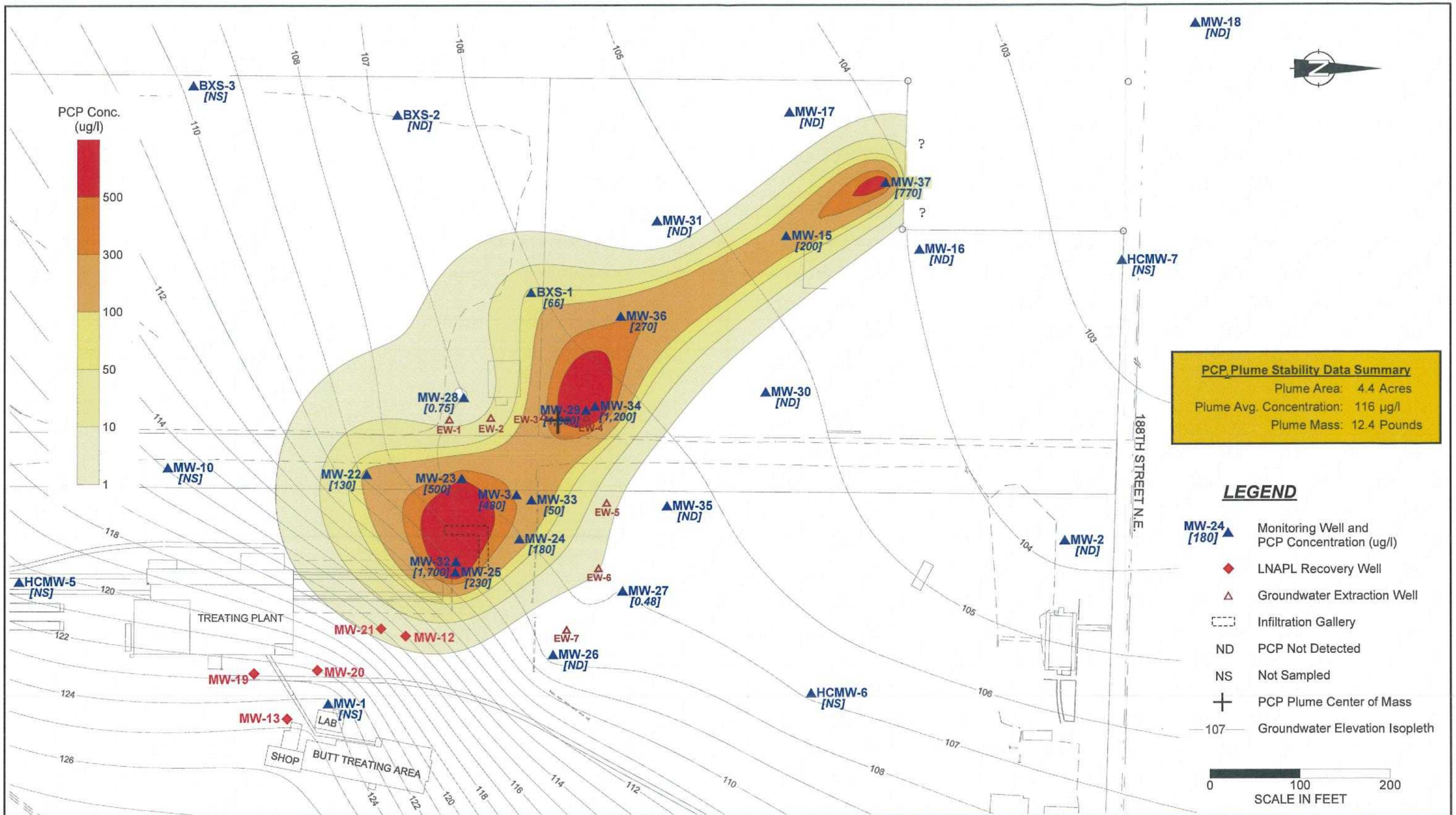
amec

THIRD QUARTER 2012 (AUGUST 19, 2012) GROUNDWATER ELEVATION CONTOUR MAP
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: EO	Project No. 12706
Date: 9/26/12	Figure E.38

APPENDIX F

Pentachlorophenol Isopleth Maps



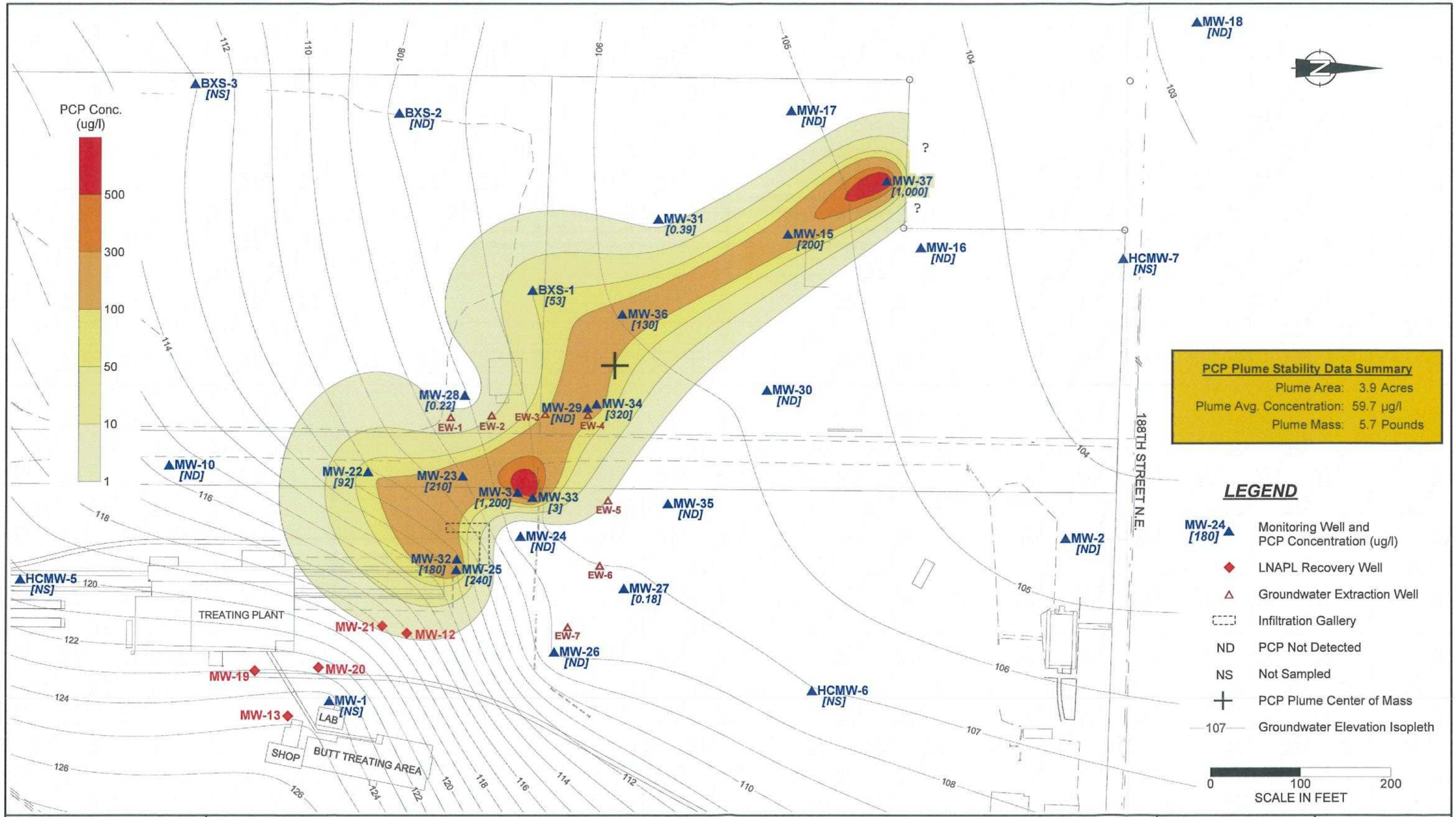
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - JANUARY 2008
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 02/06/09

F-1



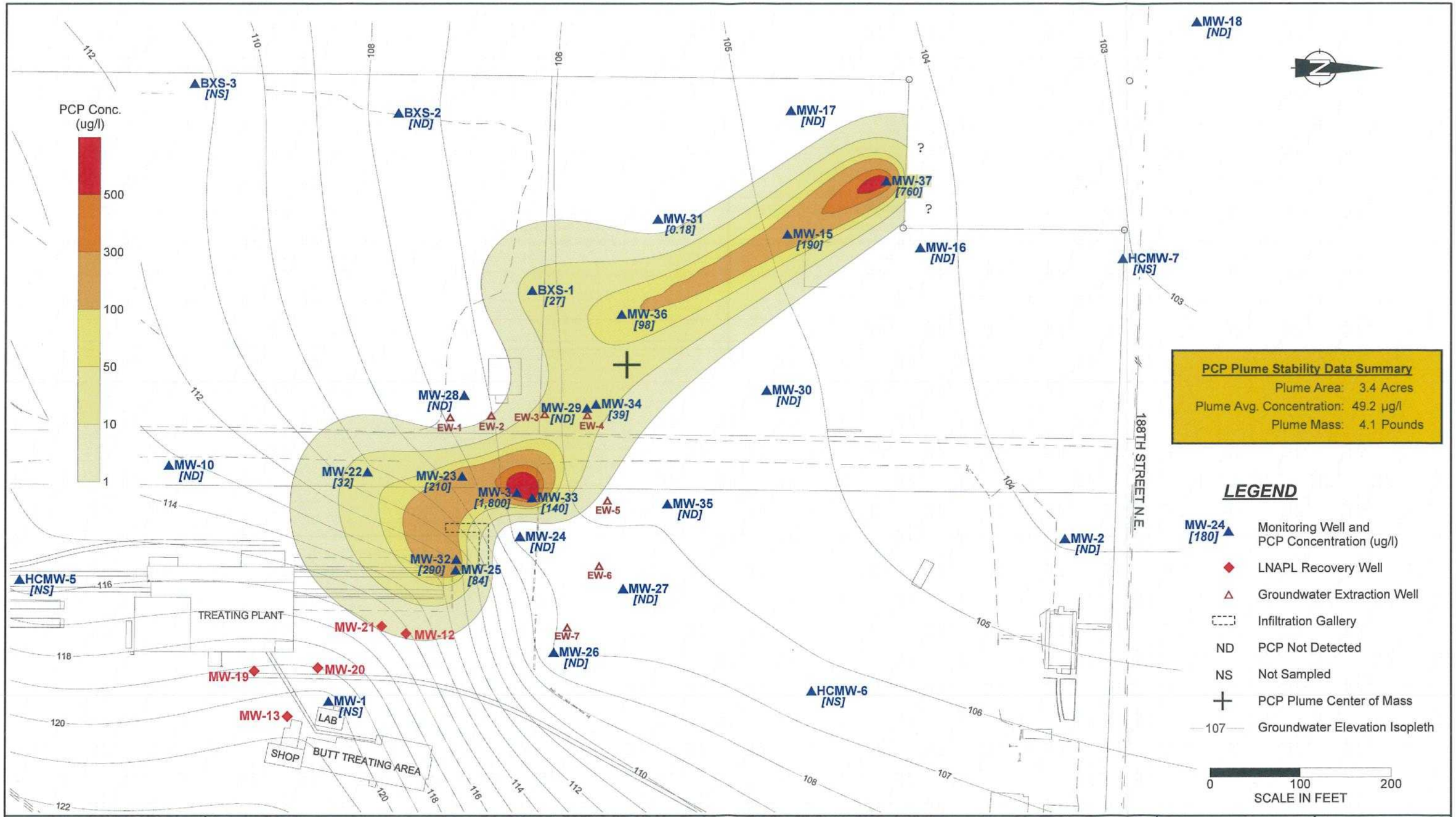
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - APRIL 2008
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 02/06/09

F-2



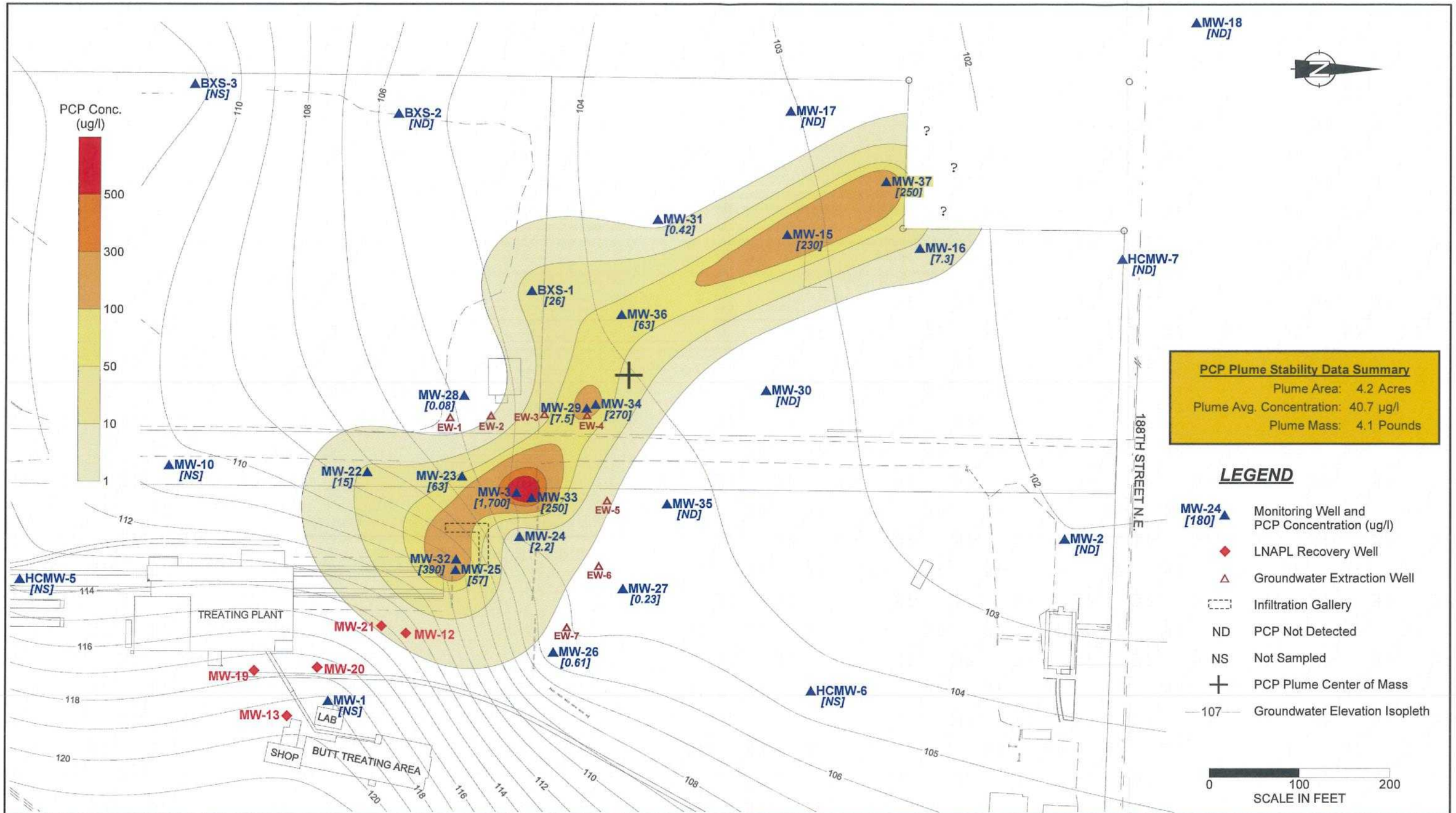
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - JULY 2008
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 02/06/09

F-3



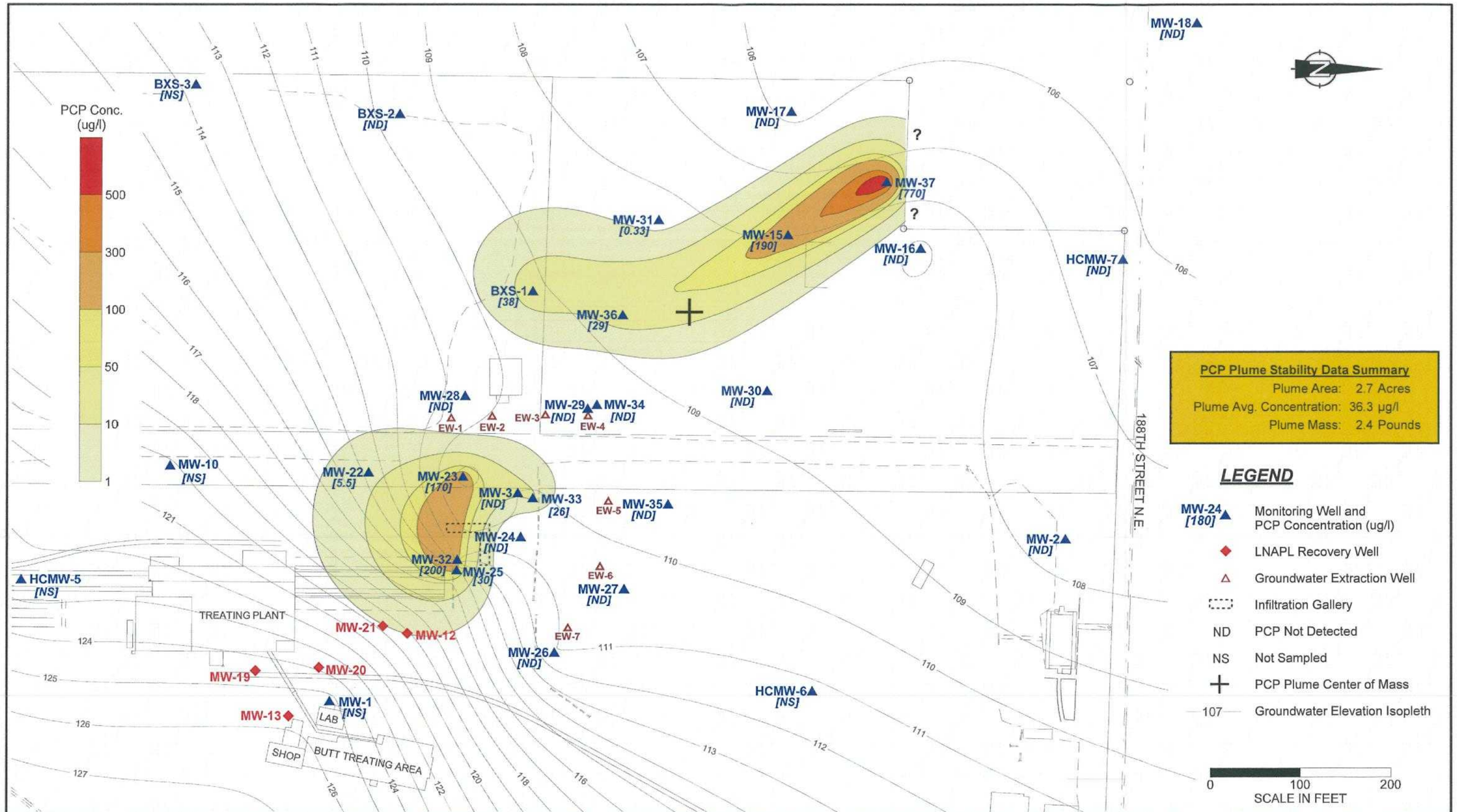
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - OCTOBER 2008
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 02/06/09

F-4



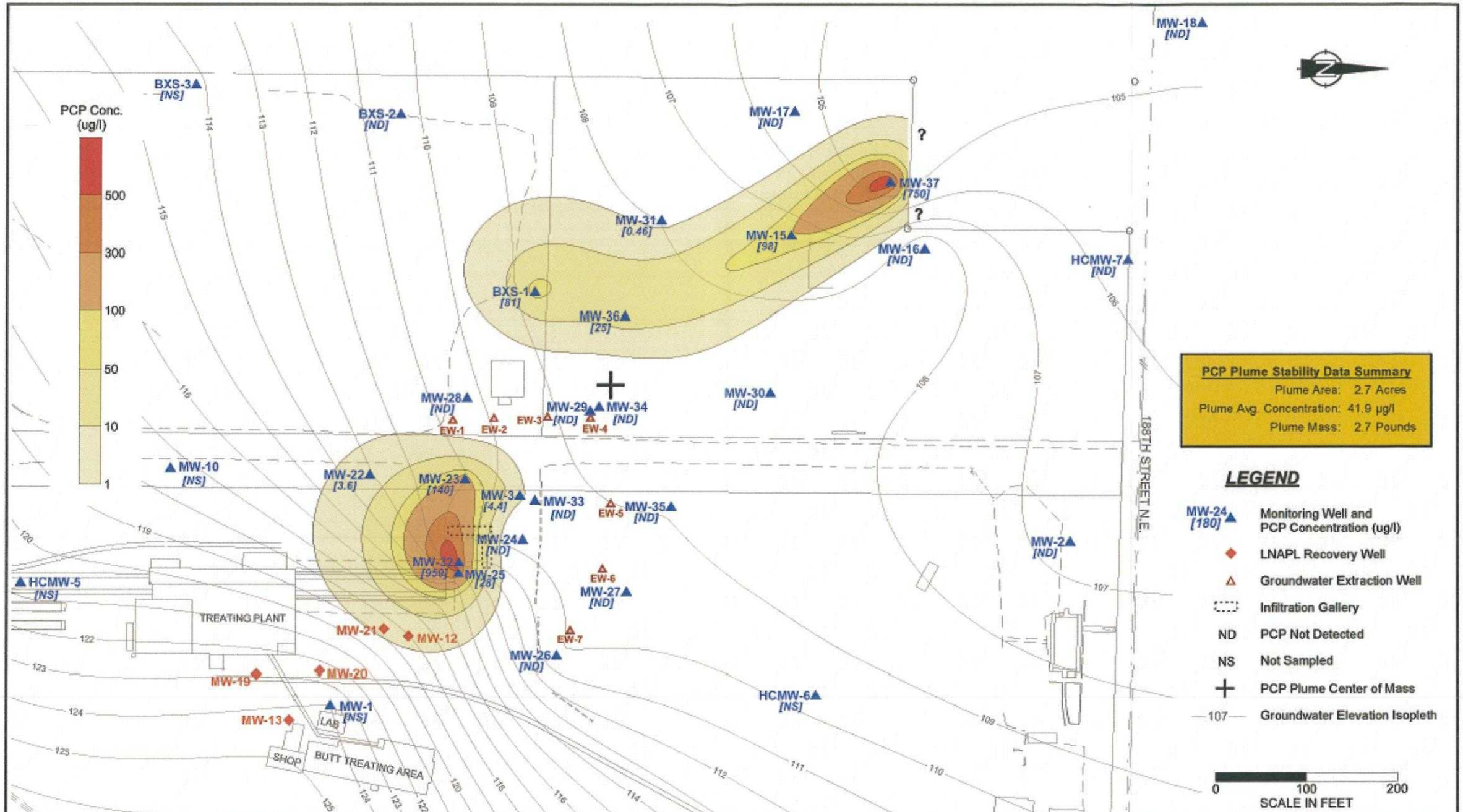
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - FEBRUARY 2009
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 05/13/09

F-5



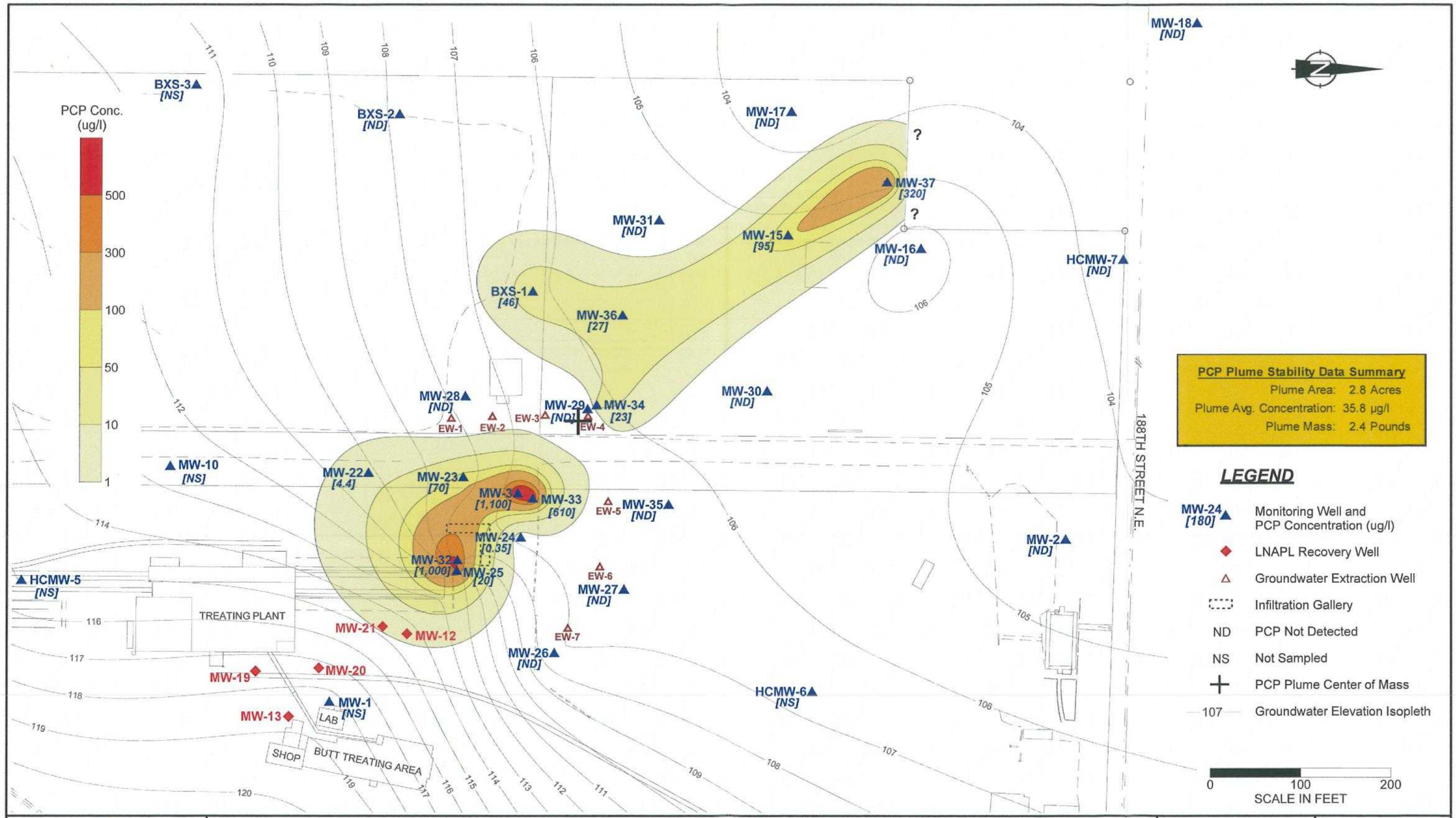
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - May 2009
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 07/20/09

F-6



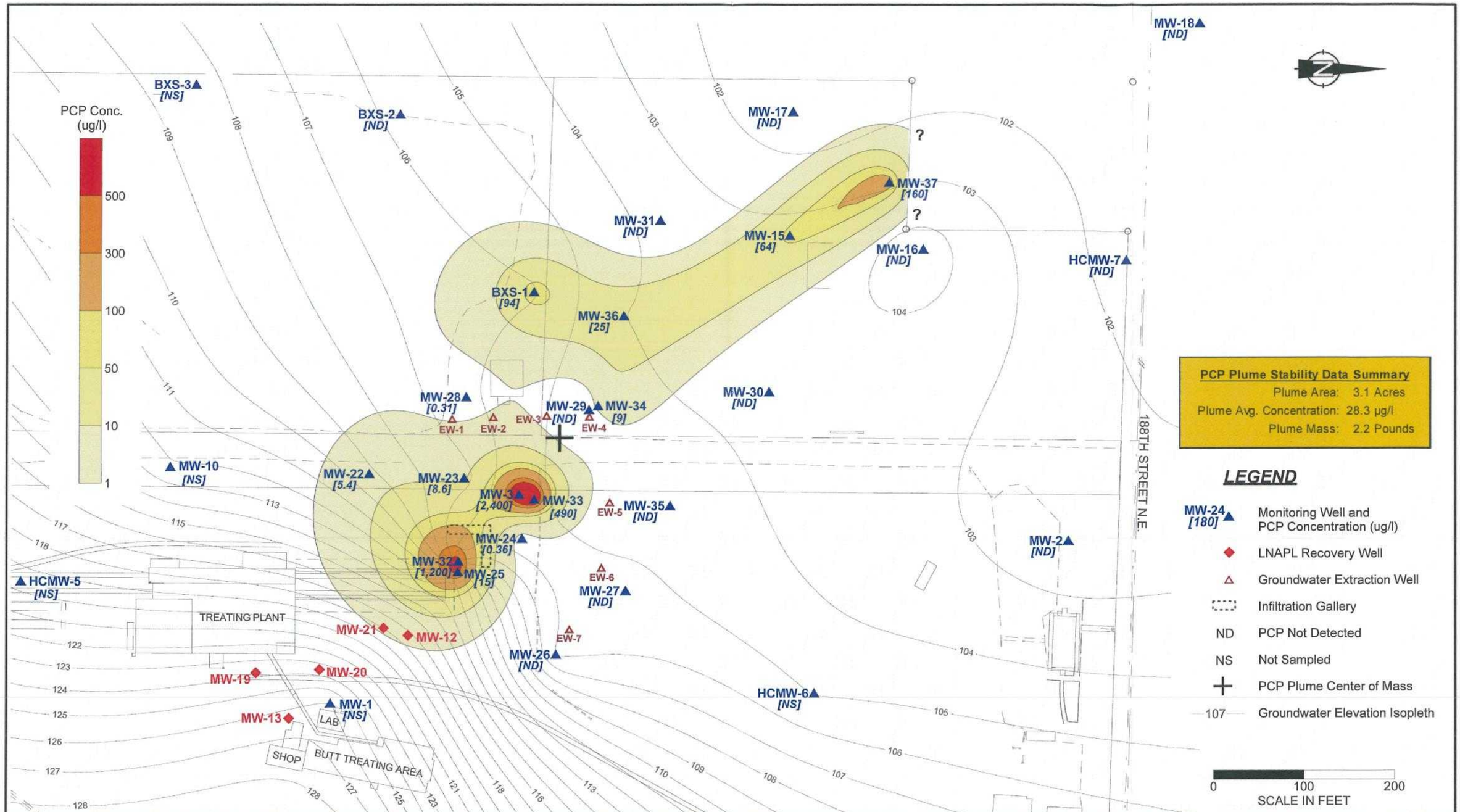
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - August 2009
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 10/7/09

F-7



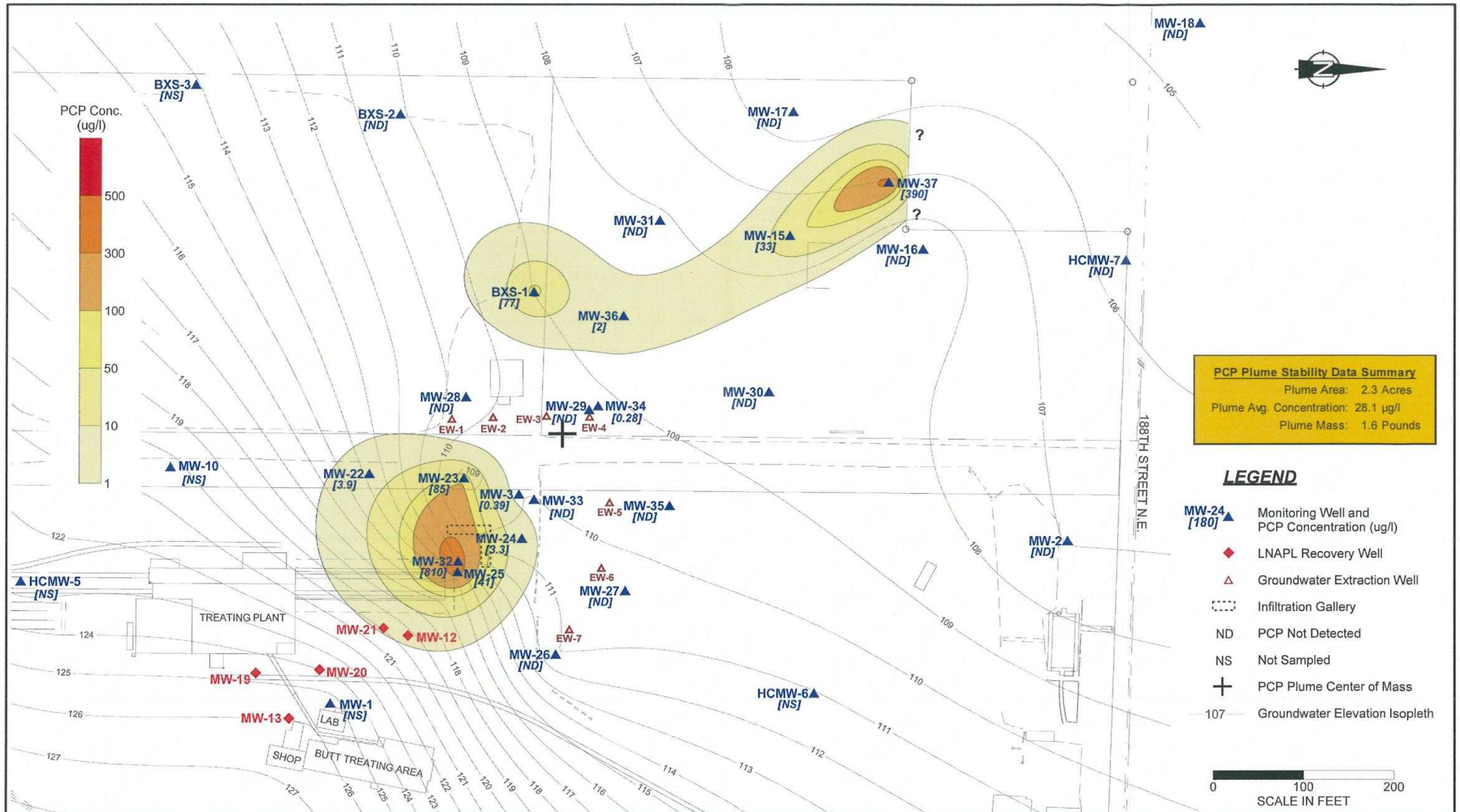
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - November 2009
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 1/26/10

F-8



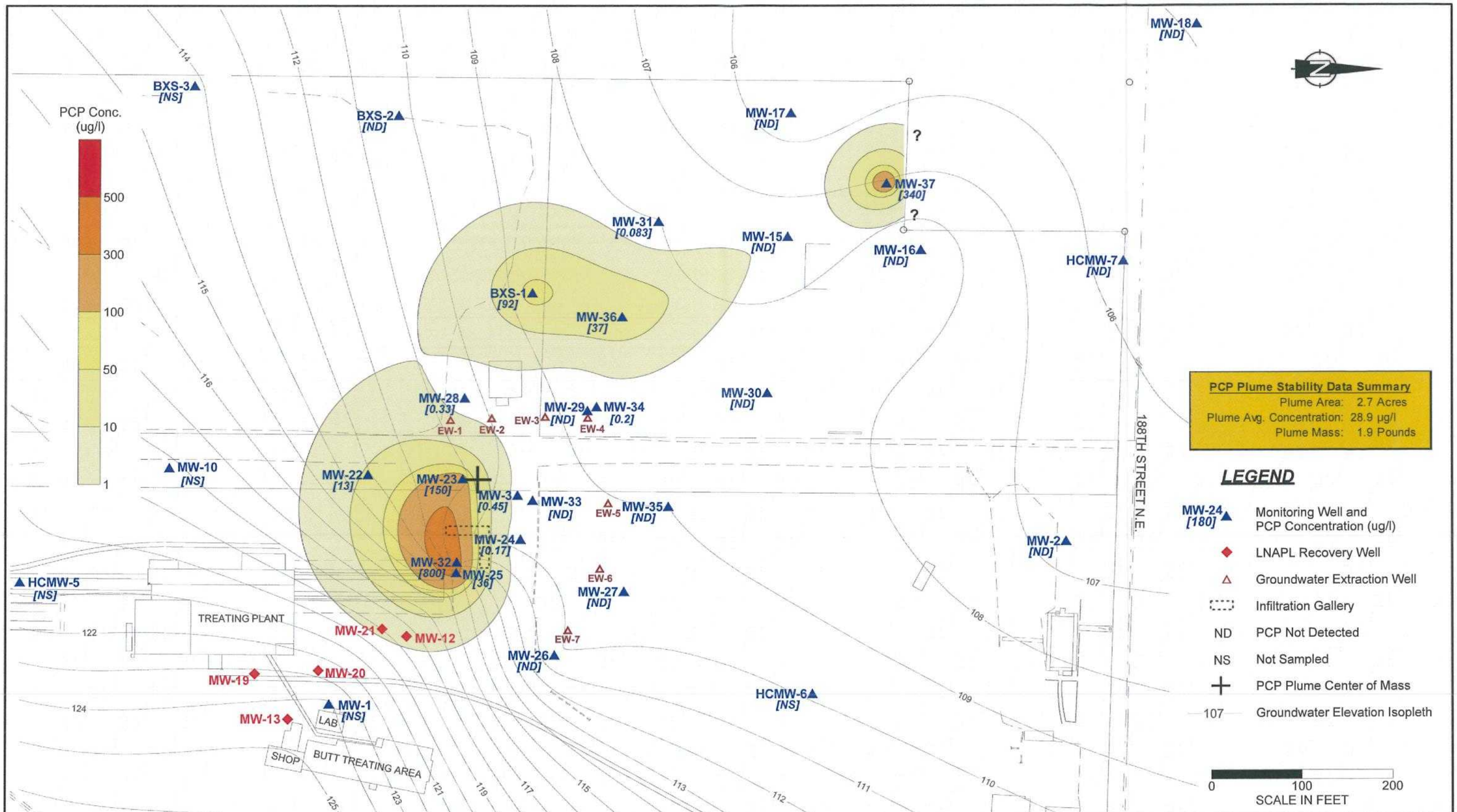
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - February 2010
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 4/30/10

F-9



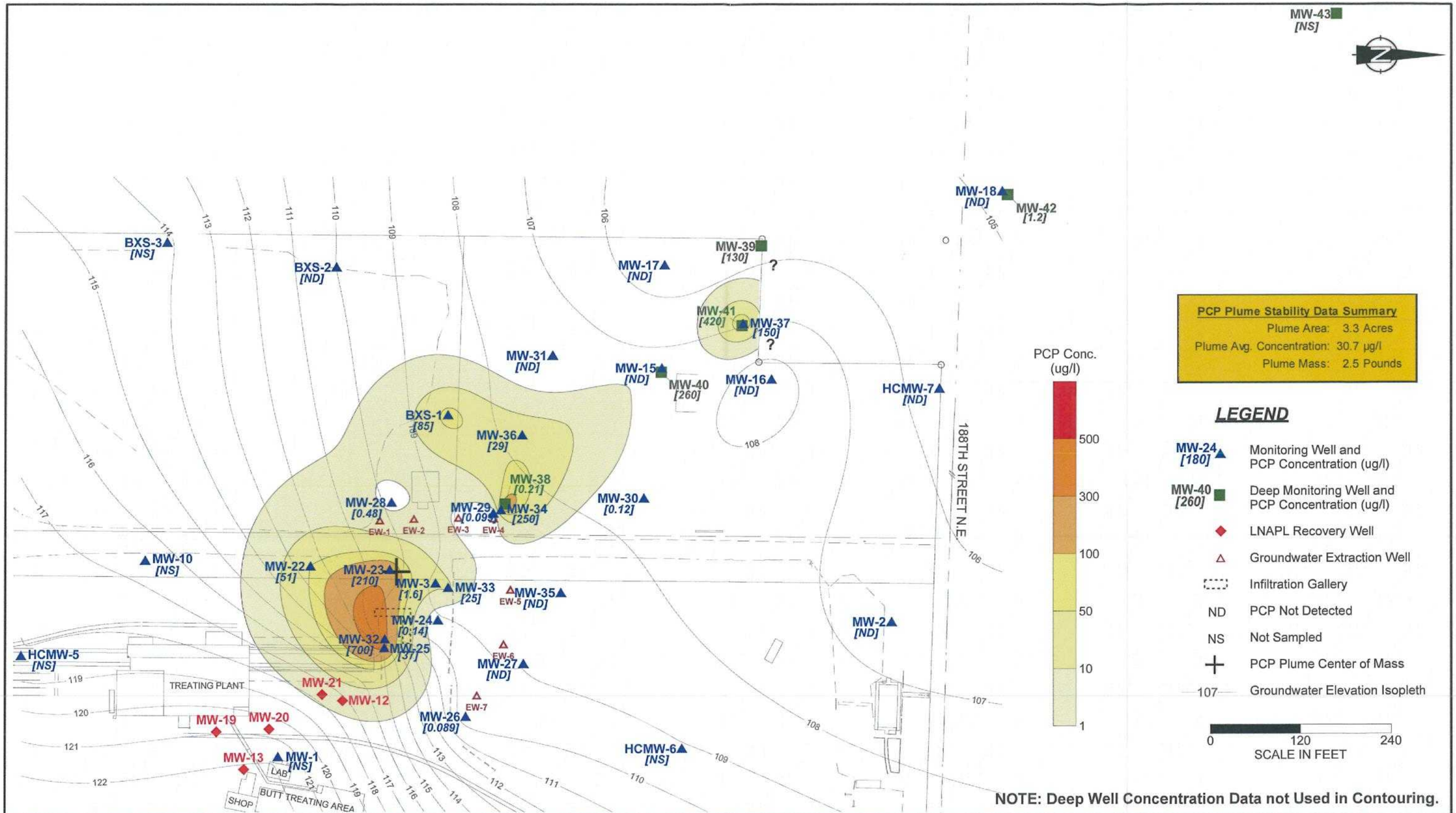
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - May 2010
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 8/26/10

F-10



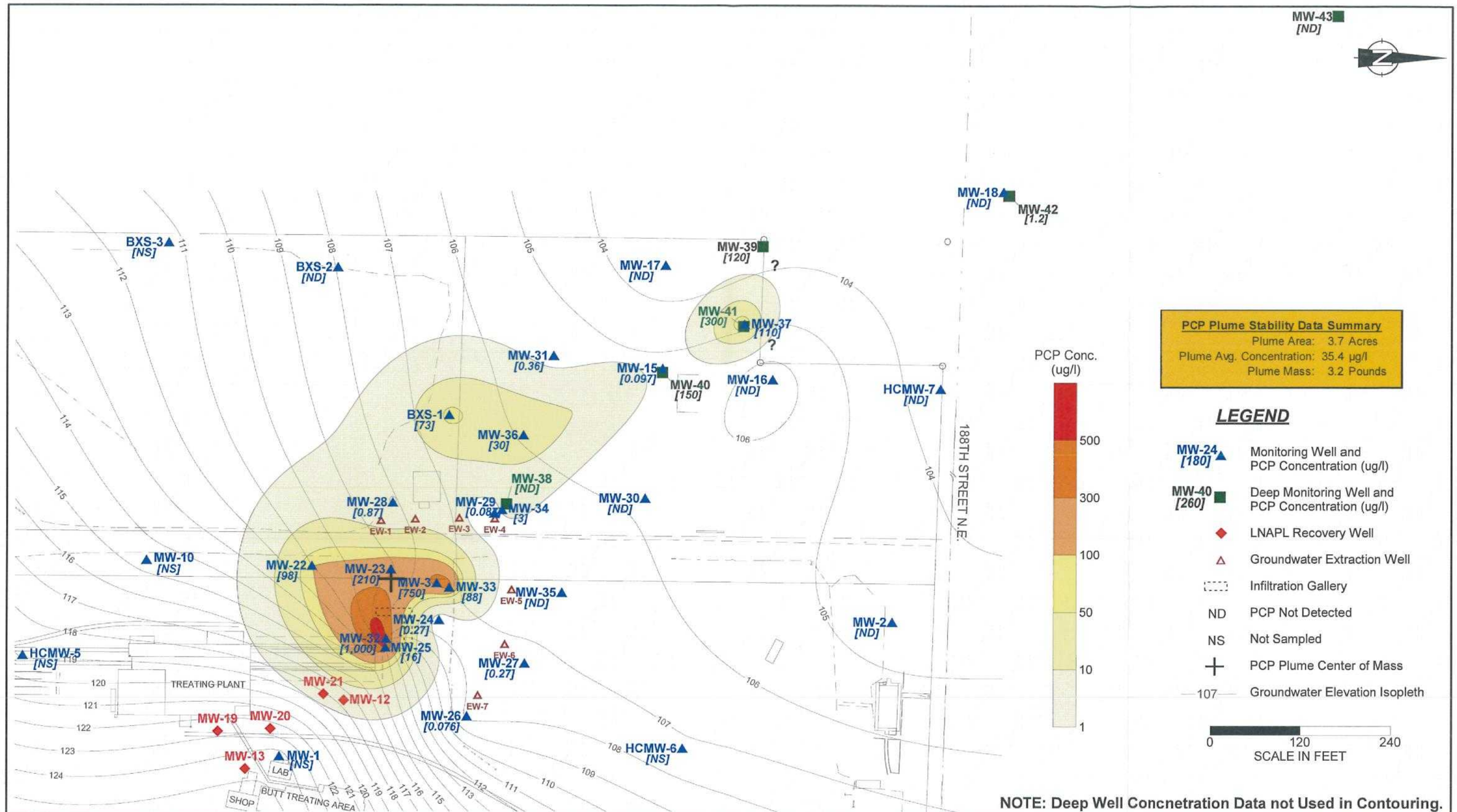
PREMIER ENVIRONMENTAL SERVICES, INC

PENTACHLOROPHENOL ISOPLETH MAP - August 2010
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 11/19/10

F-11



NOTE: Deep Well Concnetration Data not Used in Contouring.

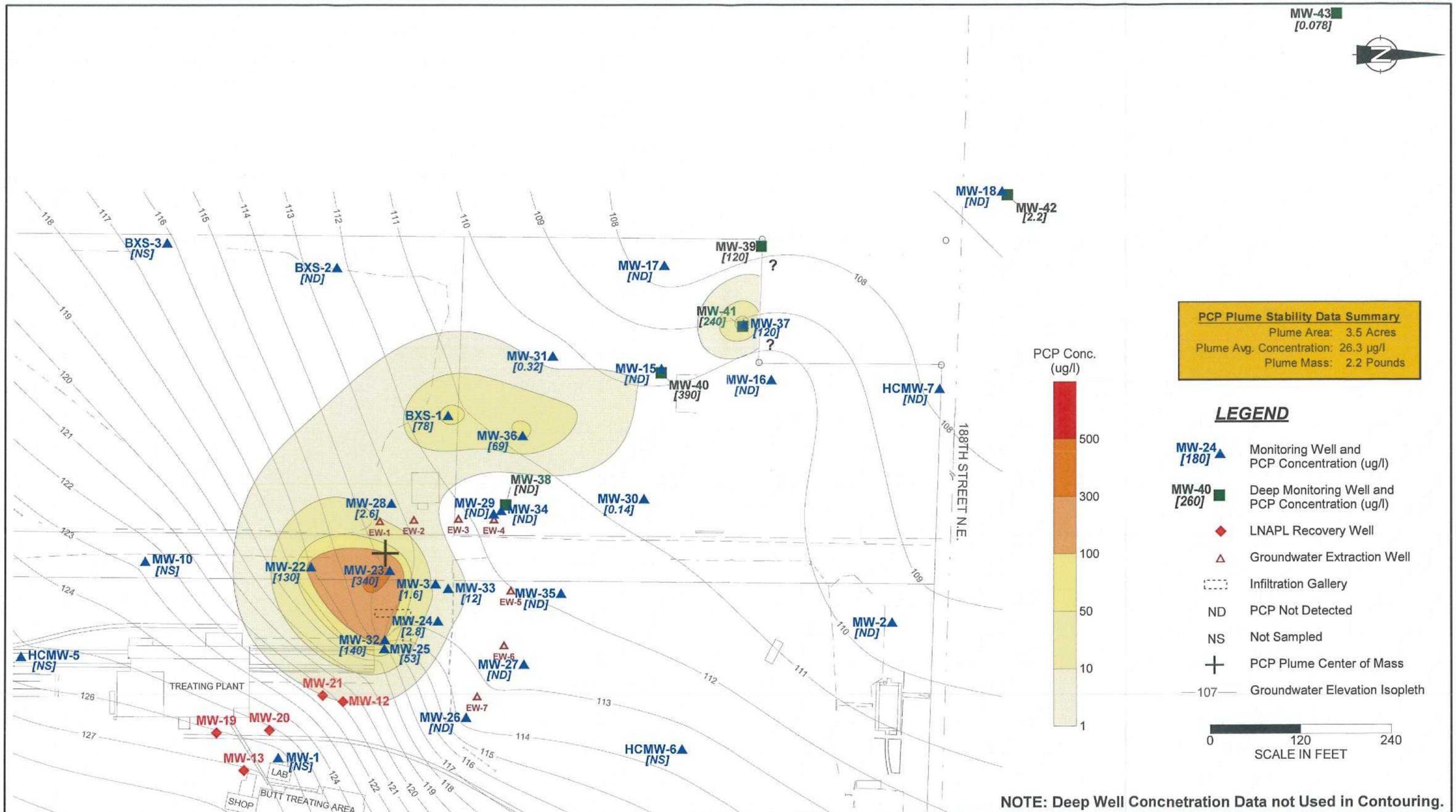
EARTHCON
Environmental Challenges
BUSINESS SOLUTIONS

PENTACHLOROPHENOL ISOPLETH MAP - November 2010
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: KMG

Date: 12/2/2011

F-12



NOTE: Deep Well Concnetration Data not Used in Contouring.

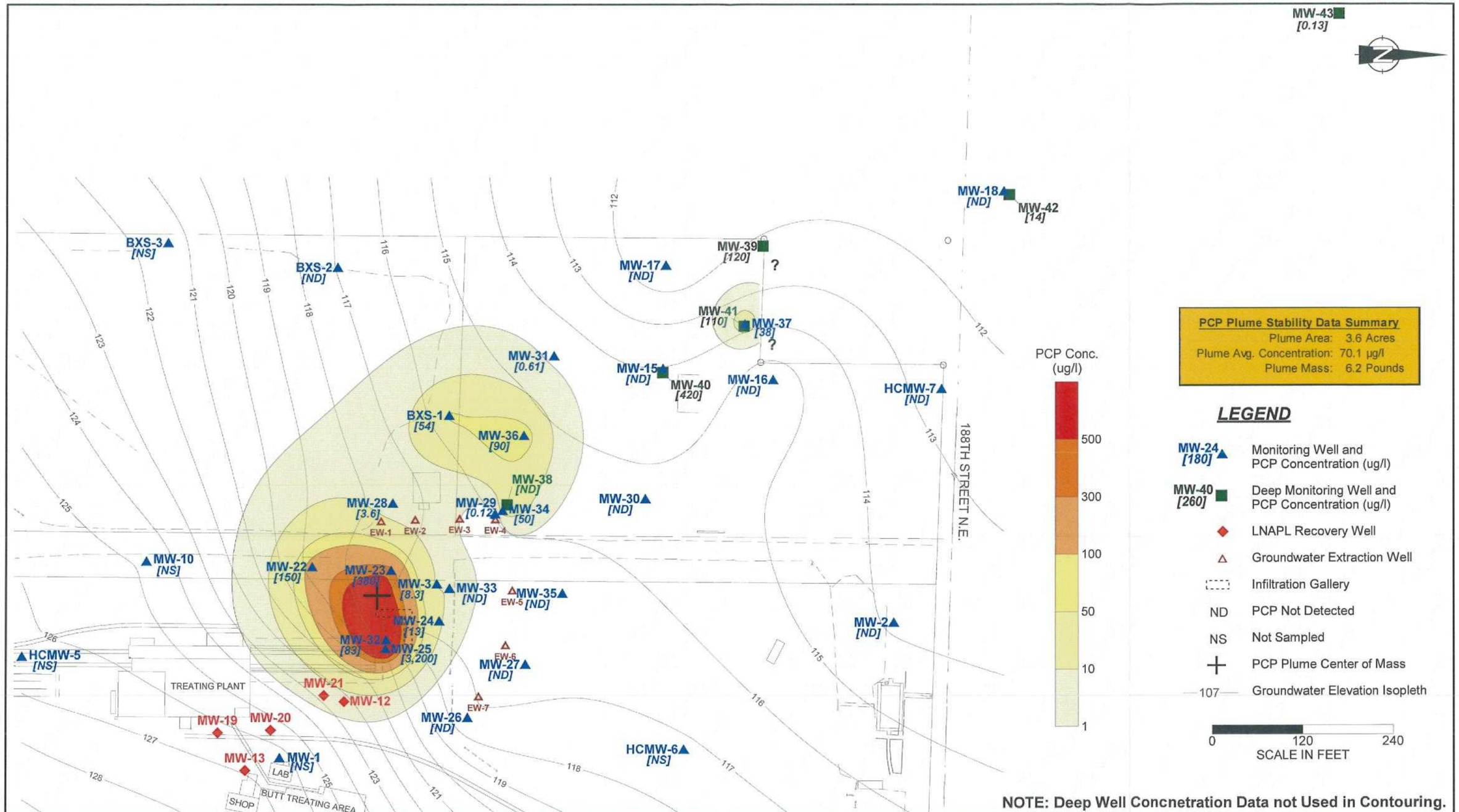
EARTHCON
Environmental Challenges
BUSINESS SOLUTIONS

PENTACHLOROPHENOL ISOPLETH MAP - February 2011
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: KMG

Date: 12/2/2011

F-13



NOTE: Deep Well Concnetration Data not Used in Contouring.

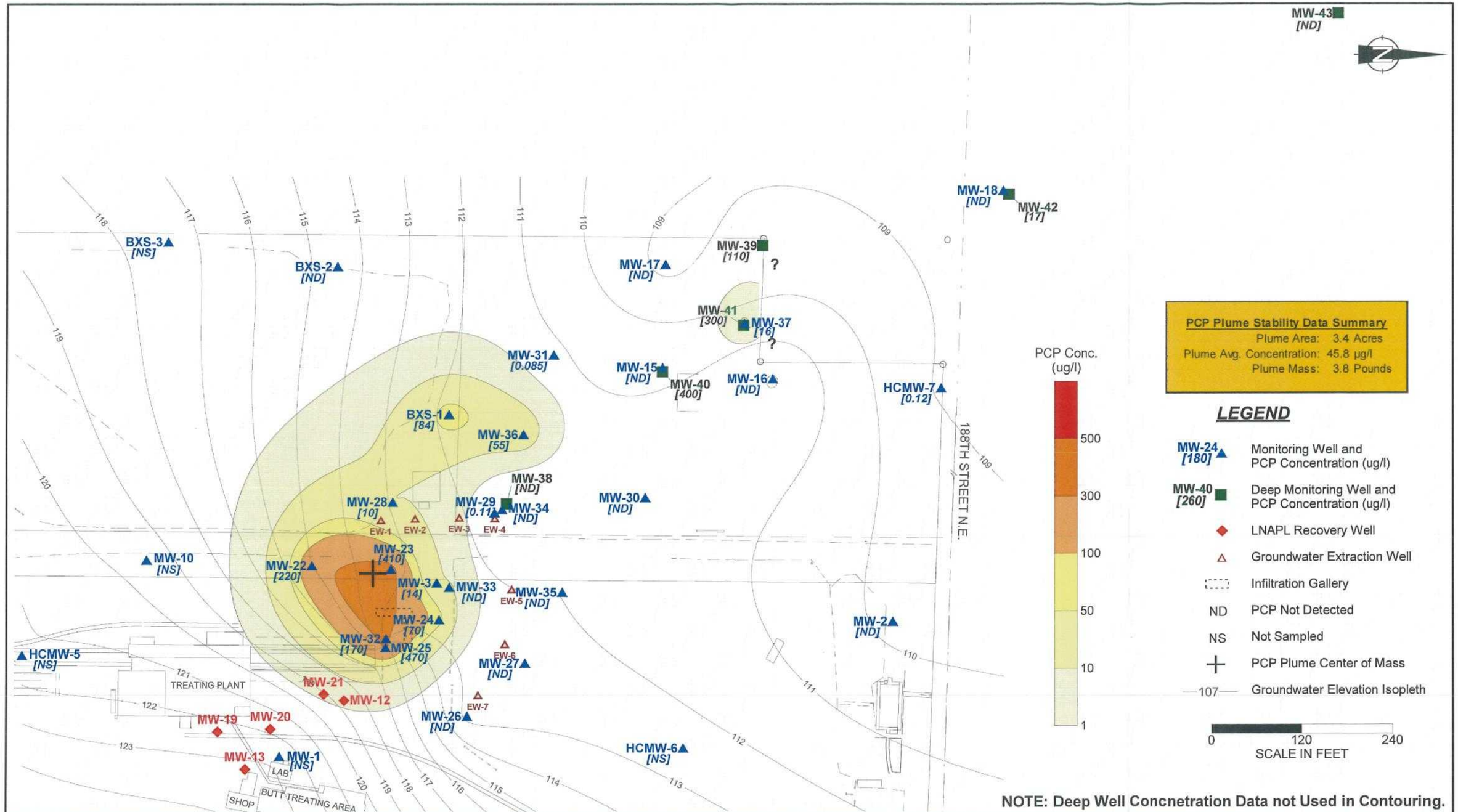
EARTHCON
Environmental Challenges
BUSINESS SOLUTIONS

PENTACHLOROPHENOL ISOPLETH MAP - May 2011
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: JAR

Date: 10/18/11

F-14



EARTHCON
Environmental Challenges
BUSINESS SOLUTIONS

PENTACHLOROPHENOL ISOPLETH MAP - August 2011
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

Prepared By: KMG

Date: 11/28/11

F-15

NOTES:

UNITS	µg/L
ND	Undetected
NA	Not Analyzed

CLIENT: J.H. BAXTER

AMEC
7376 S.W. Durham Road
Portland, OR. U.S.A. 97224

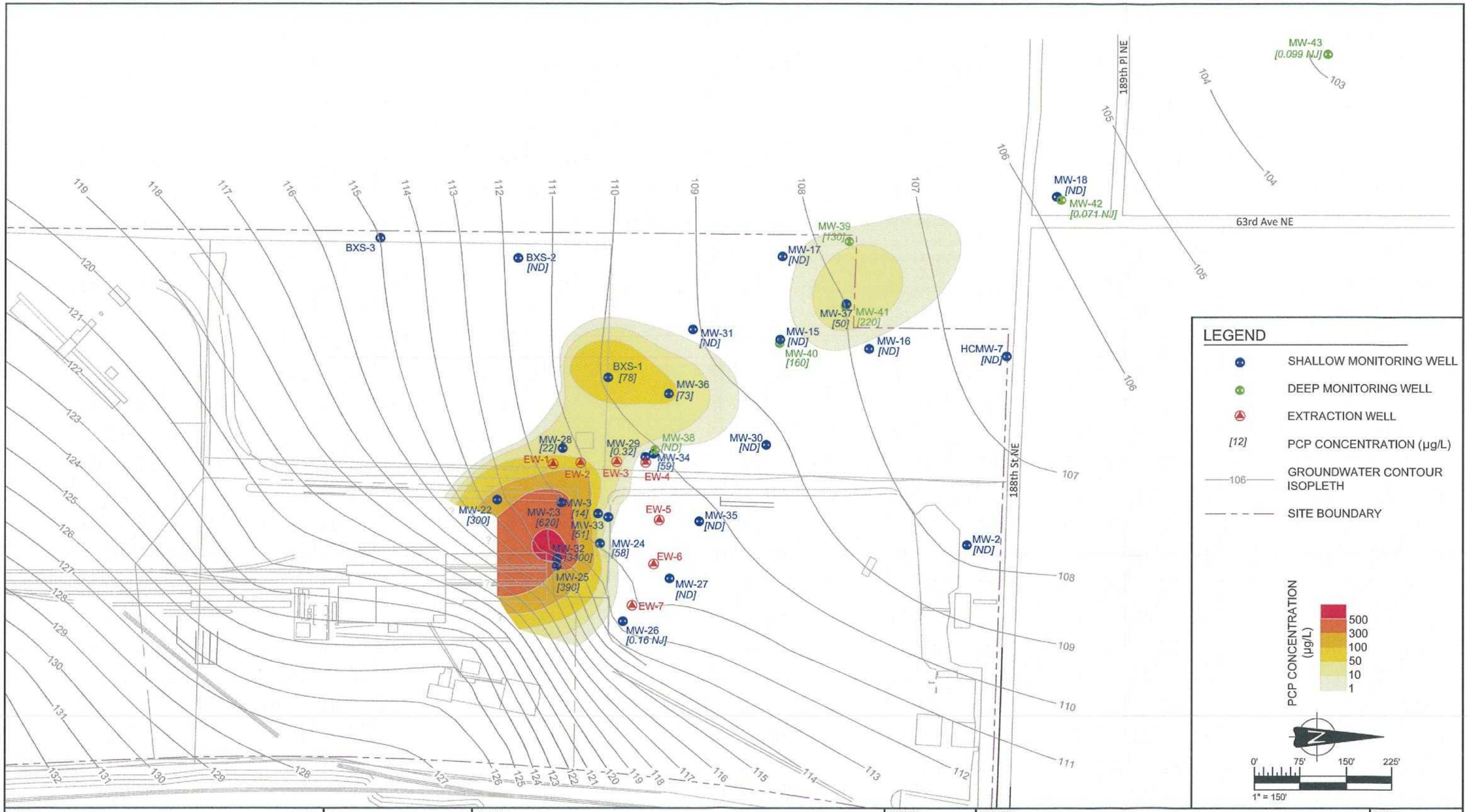
DWN BY:	PM
CHK'D BY:	SB
DATUM:	-
PROJECTION:	-
SCALE:	1"=150'

PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA

TITLE: PENTACHLOROPHENOL ISOPLETH MAP NOVEMBER 2011

DATE:	NOVEMBER 2012
PROJECT NO.:	161M125610
REV. NO.:	A
FIGURE NO:	F-16

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-16 – PCP Isopleth Map – Nov2011.dwg – – – Mar. 29, 2013 10:07am – patrick.mccarthy



NOTES:

UNITS	µg/L
ND	Undetected
NJ	Tentatively Identified Analyte; Estimated Value

CLIENT: J.H. BAXTER

AMEC
7376 S.W. Durham Road
Portland, OR. U.S.A. 97224

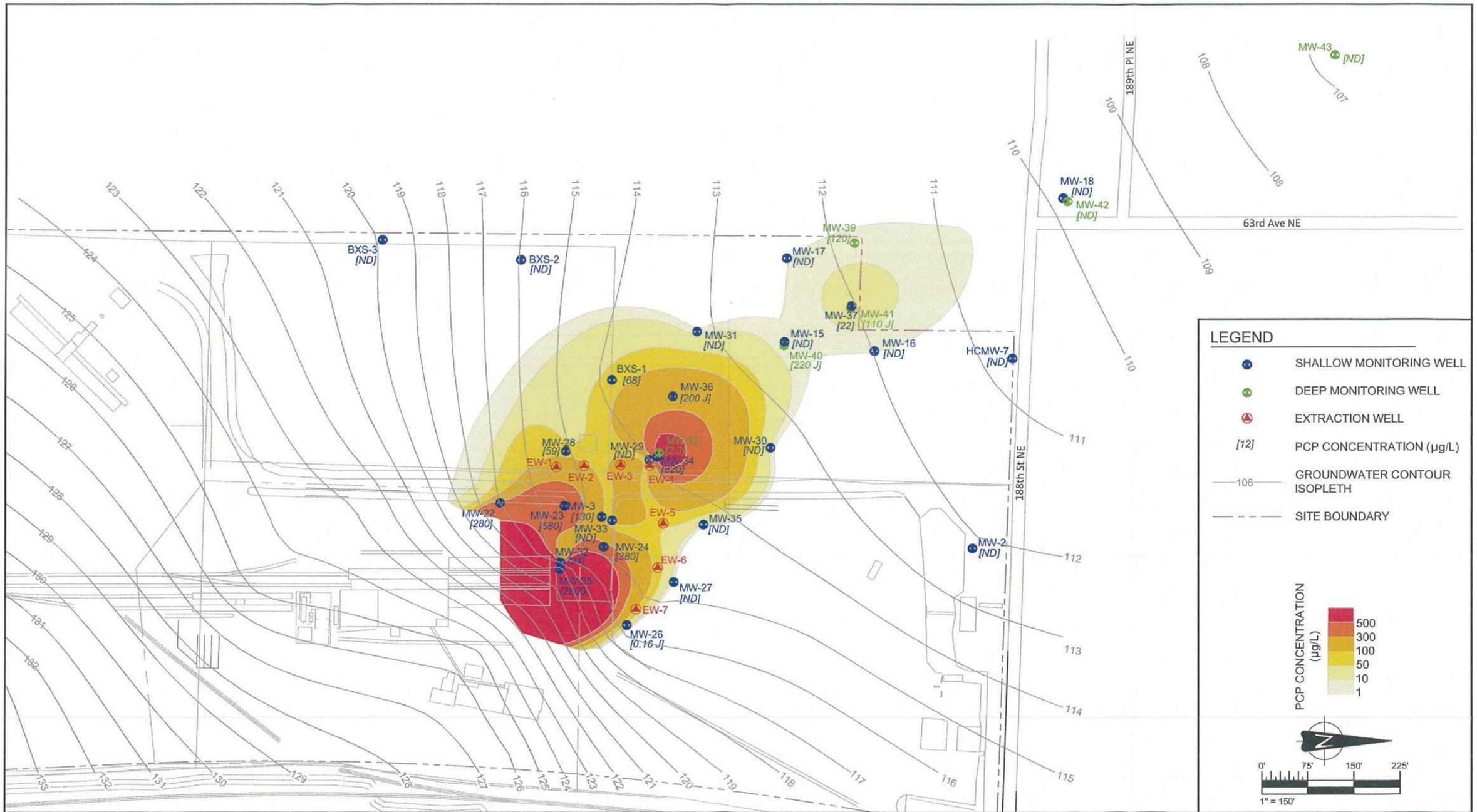
DWN BY:	PM
CHK'D BY:	SB
DATUM:	-
PROJECTION:	-
SCALE:	1"=150'

PROJECT: FORMER J.H. BAXTER AND CO.
WOOD TREATING FACILITY
ARLINGTON, WA

TITLE: PENTACHLOROPHENOL ISOPLETH MAP
FEBRUARY 2012

DATE:	NOVEMBER 2012
PROJECT NO.:	161M125610
REV. NO.:	A
FIGURE NO.:	F-17

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-17 – PCP Isopleth Map – February 2012.dwg – – – Mar. 29, 2013 10:13am – patrick.mccarthy



NOTES:

UNITS	µg/L
ND	Undetected
NJ	Tentatively Identified Analyte; Estimated Value

CLIENT: J.H. BAXTER

AMEC
7376 S.W. Durham Road
Portland, OR. U.S.A. 97224

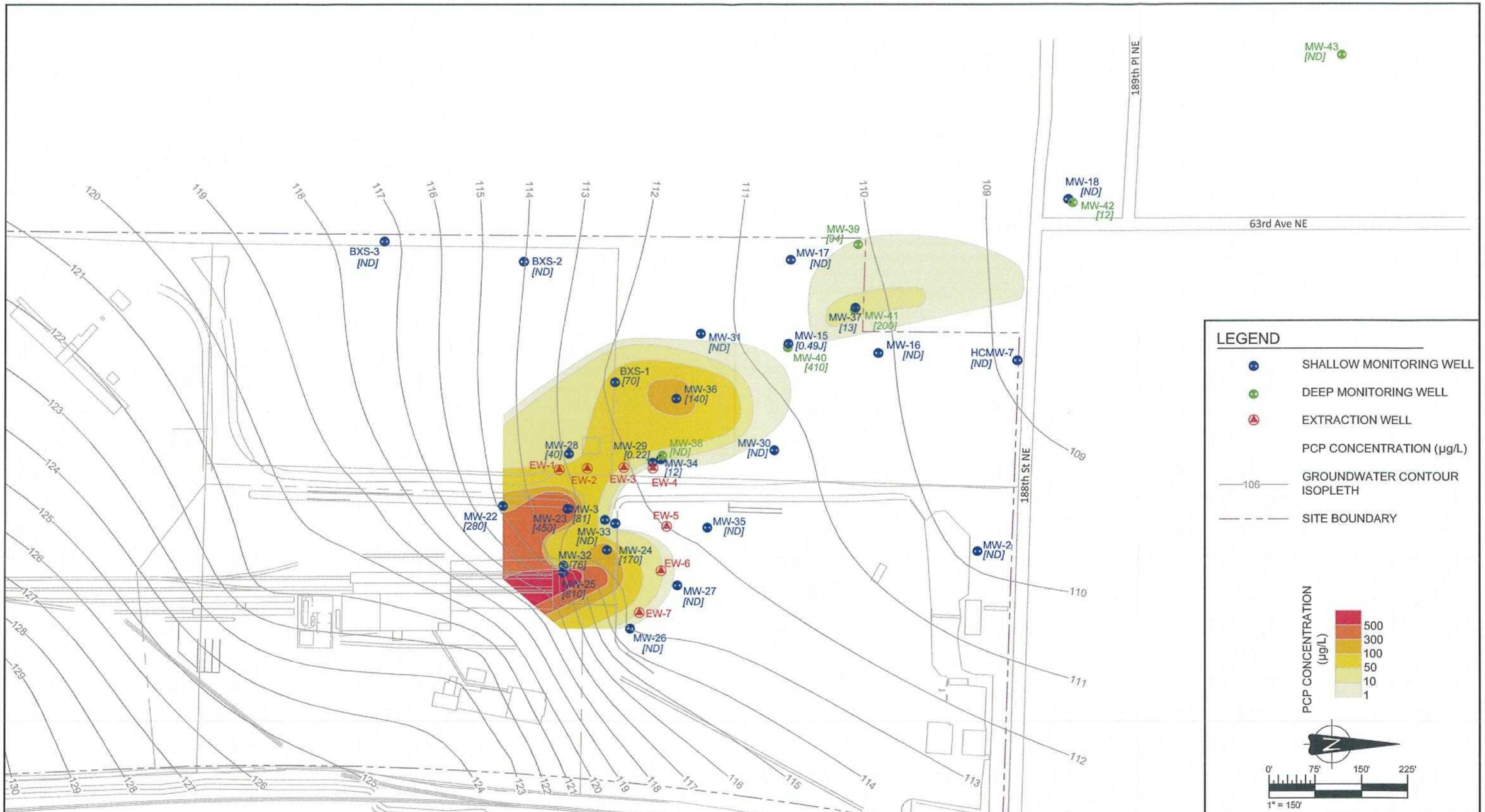
DWN BY:	PM
CHK'D BY:	SB
DATUM:	-
PROJECTION:	-
SCALE:	1"=150'

PROJECT: FORMER J.H. BAXTER AND CO.
WOOD TREATING FACILITY
ARLINGTON, WA

TITLE: PENTACHLOROPHENOL ISOPLETH MAP
MAY 2012

DATE:	NOVEMBER 2012
PROJECT NO.:	161M125610
REV. NO.:	A
FIGURE NO.:	F-18

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-18 – PCP Isopleth Map – May 2012.dwg – – – Mar. 29, 2013 10:13am – patrick.mccarthy



NOTES:

UNITS	µg/L
ND	Undetected
NJ	Tentatively Identified Analyte; Estimated Value

JH Baxter

CLIENT: J.H. BAXTER

AMEC
7376 S.W. Durham Road
Portland, OR. U.S.A. 97224

amec

DWN BY:	PM
CHK'D BY:	SB
DATUM:	-
PROJECTION:	-
SCALE:	1"=150'

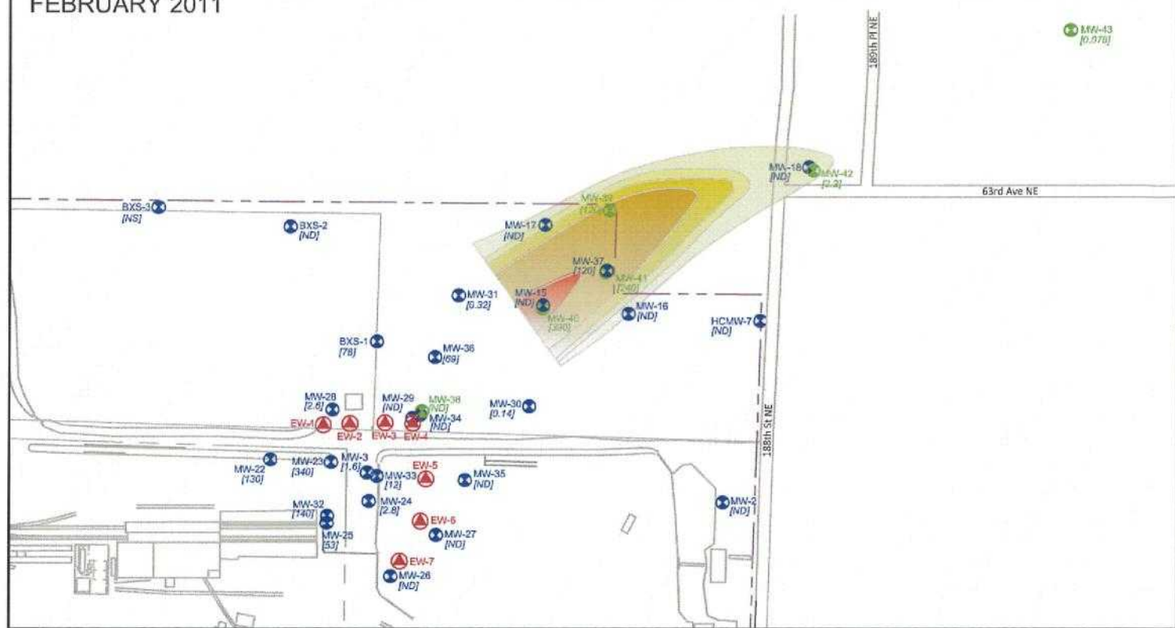
PROJECT: FORMER J.H. BAXTER AND CO.
WOOD TREATING FACILITY
ARLINGTON, WA

TITLE: PENTACHLOROPHENOL ISOPLETH MAP
AUGUST 2012

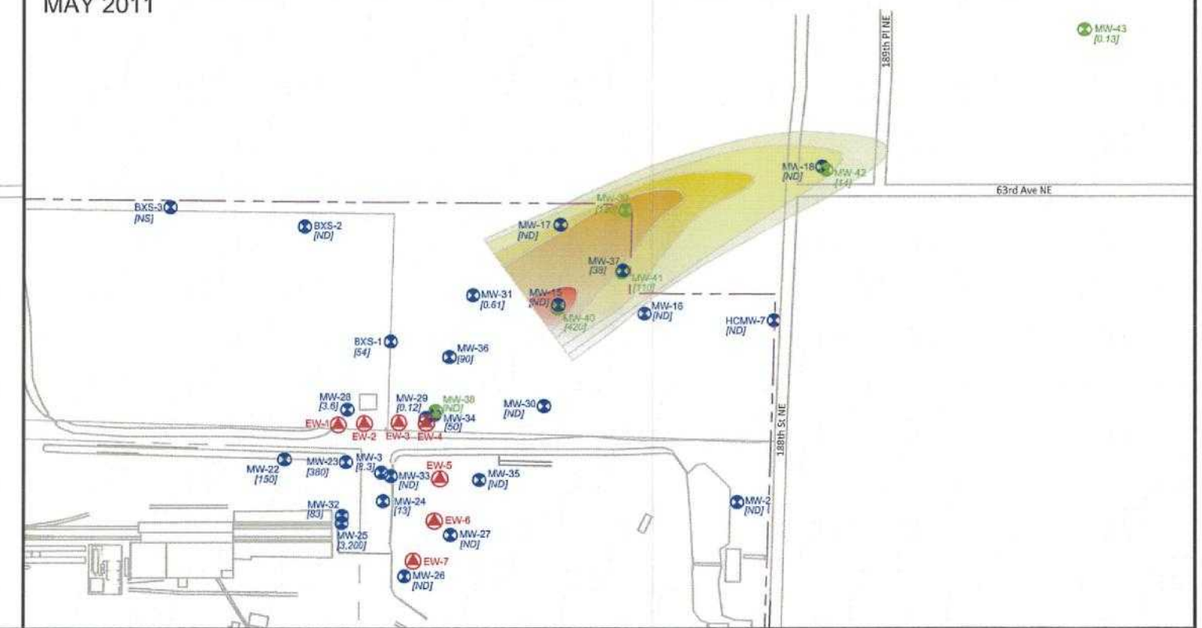
DATE:	NOVEMBER 2012
PROJECT NO.:	161M125610
REV. NO.:	A
FIGURE NO.:	F-19

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-19 – PCP Isopleth Map – August 2012.dwg – – – Mar. 29, 2013 10:12am – patrick.mccarthy

FEBRUARY 2011



MAY 2011



AUGUST 2011

LEGEND

- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- EXTRACTION WELL
- [12] PCP CONCENTRATION (µg/L)
- SITE BOUNDARY

NOTES:

UNITS	µg/L
ND	Undetected
NA	Not Analyzed

PCP CONCENTRATION (µg/L)

500
300
100
50
10
1

N

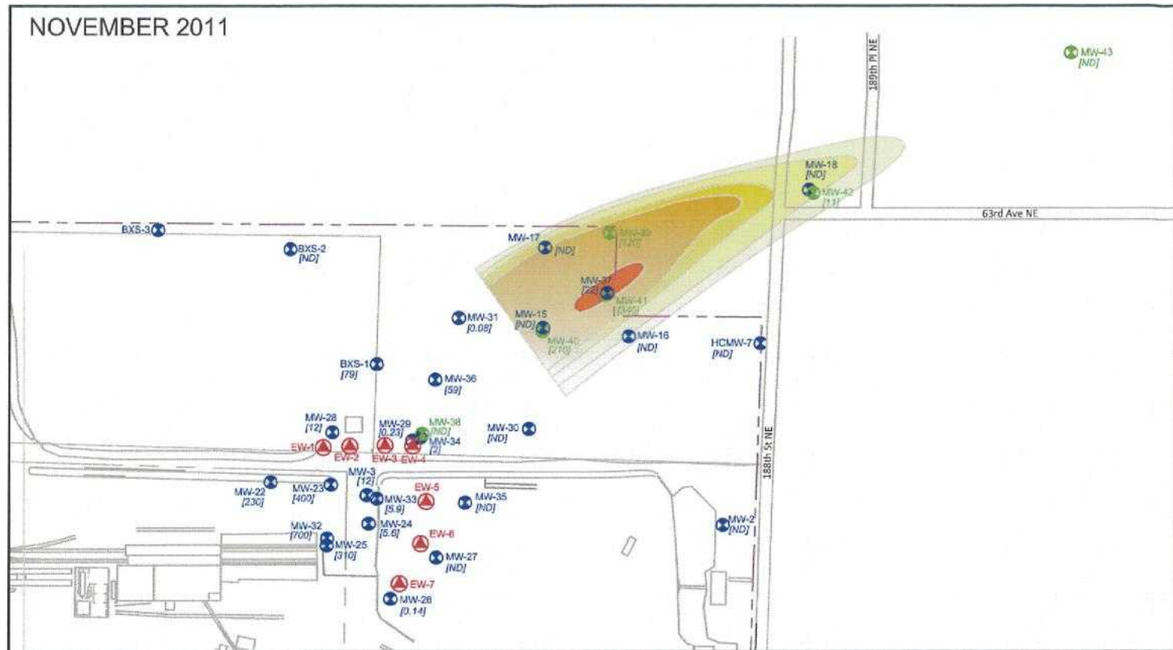
0' 175' 250' 325'

1" = 250'

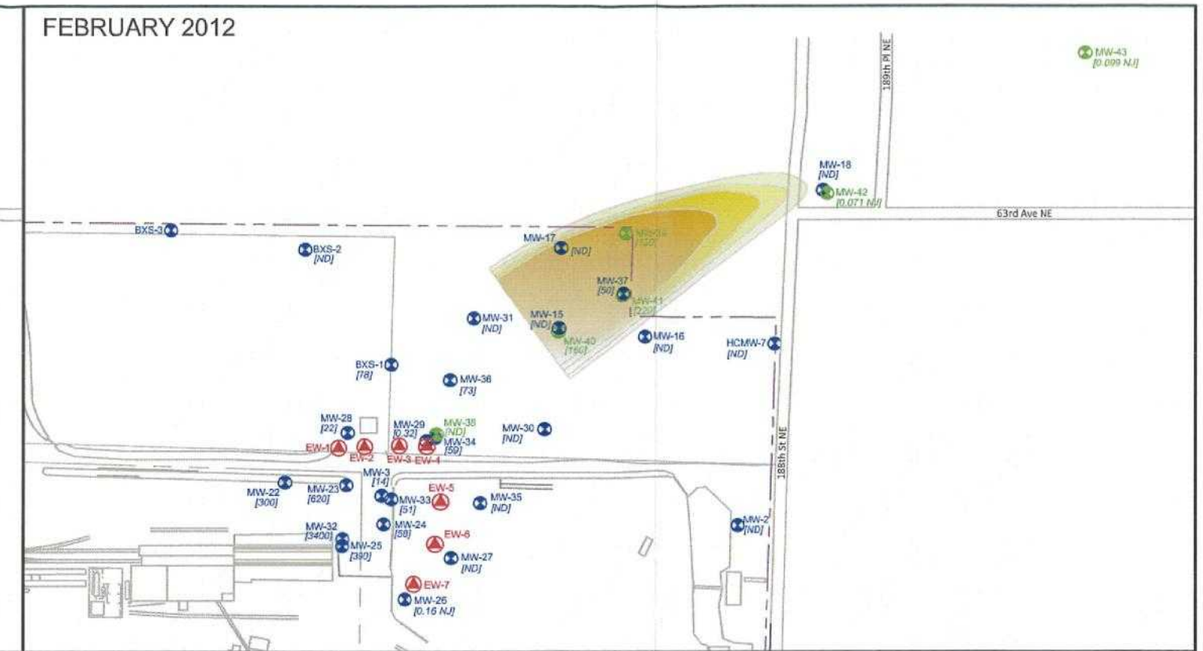
CLIENT: J.H. BAXTER	DWN BY: PM/SD	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: NOVEMBER 2012
	CHK'D BY: SB		PROJECT NO.: 161M125610
	DATUM: -	TITLE: PENTACHLOROPHENOL ISOPLETH MAP FEBRUARY, MAY & NOVEMBER 2011 DEEPER ZONE ONLY	REV. NO.: A
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	PROJECTION: -		FIGURE NO.: F-20
	SCALE: 1"=250'		

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-20 – PCP Concentration – 2011.dwg – – – Mar. 29, 2013 10:12am – patrick.mccarthy

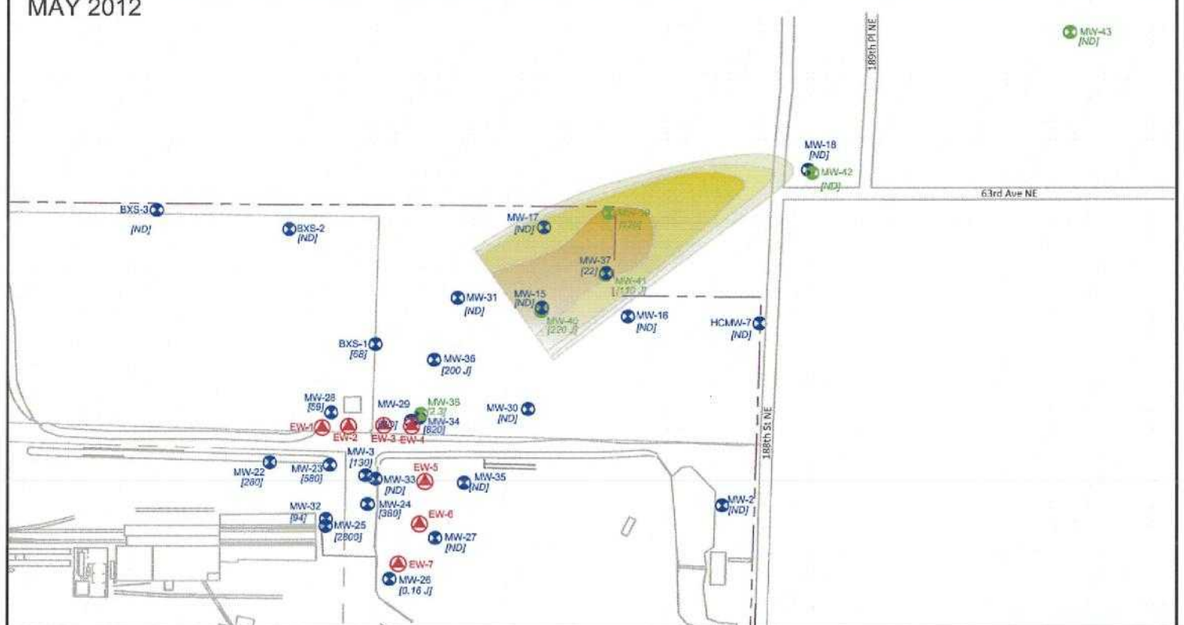
NOVEMBER 2011



FEBRUARY 2012



MAY 2012



LEGEND

- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- EXTRACTION WELL
- [12] PCP CONCENTRATION (µg/L)
- SITE BOUNDARY

NOTES:

UNITS	µg/L
ND	Undetected
NA	Not Analyzed

PCP CONCENTRATION (µg/L)

500
300
100
50
10
1

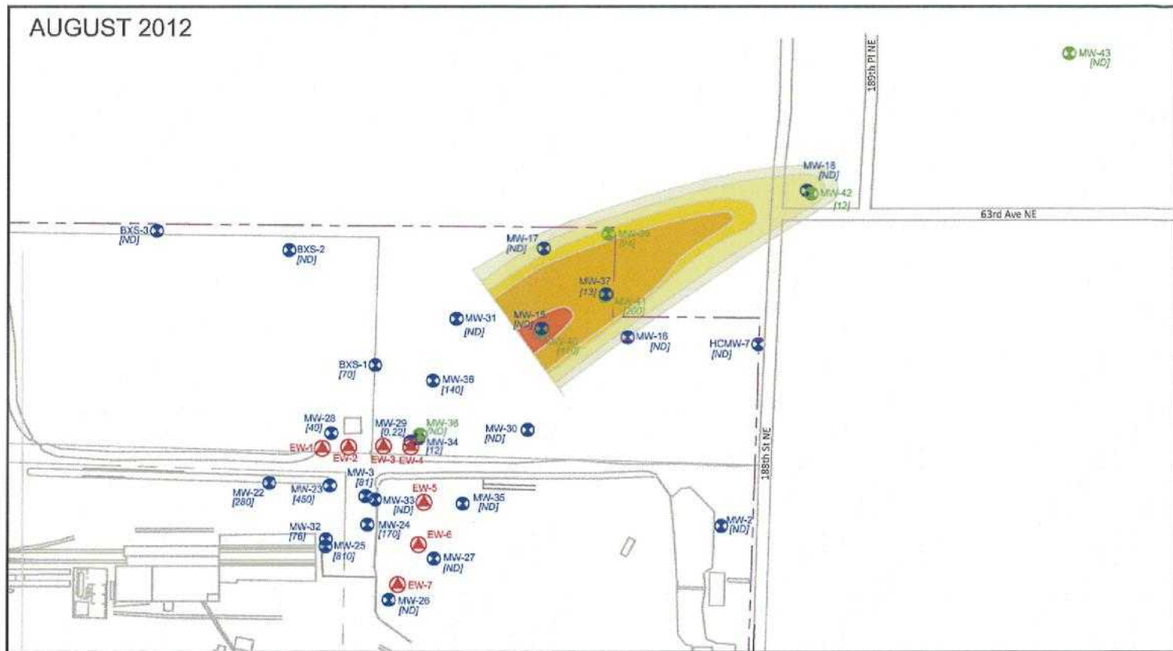
0' 175' 250' 325'

1" = 250'

CLIENT: J.H. BAXTER	DWN BY: PM/SD	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: NOVEMBER 2012
	CHK'D BY: SB		PROJECT NO.: 161M125610
	DATUM: -	TITLE: PENTACHLOROPHENOL ISOPLETH MAP NOVEMBER 2011 & FEBRUARY & MAY 2012 DEEPER ZONE ONLY	REV. NO.: A
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	PROJECTION: -		FIGURE NO.: F-21
	SCALE: 1"=250'		

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-21 – PCP Concentration – 2012.dwg – – – Mar. 29, 2013 10:11am – patrick.mccarthy

AUGUST 2012



LEGEND

- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- EXTRACTION WELL
- PCP CONCENTRATION (µg/L)
- SITE BOUNDARY

PCP CONCENTRATION (µg/L)

500
300
100
50
10
1

NOTES:

UNITS	µg/L
ND	Undetected
NA	Not Analyzed

N

0' 175' 250' 325'

1" = 250'

CLIENT: J.H. BAXTER	DWN BY: PM/SD	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: NOVEMBER 2012
	CHK'D BY: SB		PROJECT NO.: 161M125610
AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	DATUM: -	TITLE: PENTACHLOROPHENOL ISOPLETH MAP AUGUST 2012 DEEPER ZONE ONLY	REV. NO.: A
	PROJECTION: -		FIGURE NO.: F-22
	SCALE: 1"=250'		

K:\12000\12500\12561\125610\DWG\Appendix F\Figure F-22 – PCP Concentration – Aug 2012.dwg – – – Mar. 29, 2013 10:11am – patrick.mccarthy

APPENDIX G

Groundwater Flow Modeling

Appendix G

Groundwater Flow Modeling

Former J.H. Baxter & Co. Wood Treating Facility

Arlington, Washington

Prepared for:

J.H. Baxter & Co.
Arlington, Washington

Prepared by:

AMEC Environment & Infrastructure, Inc.
600 University Street, Suite 600
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April 2013

Project No. 3-61M-125611

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GROUNDWATER FLOW MODELING

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

G1.0 INTRODUCTION

This report describes groundwater flow modeling work performed by AMEC Environment & Infrastructure, In. (AMEC) for the former J.H. Baxter & Co. (Baxter) wood treating facility in Arlington, Washington (facility or site). The objective of the modeling effort is to quantify the reduction of groundwater flux through the source zone by a subsurface barrier wall. The modeling results suggest that (1) a 50-foot deep barrier wall is more effective than a 40-foot deep barrier wall; (2) the reduction in groundwater flux through the source zone by a 50-foot deep barrier wall ranges from 15% to 60%, depending on the barrier wall's horizontal alignment and vertical anisotropy for hydraulic conductivity.

The conceptual model for groundwater flow is described in Section G2, followed by numerical model development and calibration (Section G3). The predictive simulations and results are presented in Section G4.

G2.0 CONCEPTUAL MODEL

The area around the facility is underlain by approximately 100 ft of recessional outwash deposits, which are underlain by till. The recessional outwash deposits consist mostly of sand, with some fine gravel, silt and clay. Fill material is present in some places on the facility. In this report, the entire 100 ft of shallow subsurface is treated as one aquifer.

A groundwater divide is present approximately one mile south of the facility. North of the groundwater divide, groundwater in the recessional outwash flows toward the north and northwest and discharges to Portage Creek, which lies approximately 5000 ft north and northwest of the facility. On the east of the facility, groundwater in the recessional outwash is recharged by groundwater in the advanced outwash deposits beneath the Getchell Hill upland.

G3.0 NUMERICAL MODEL DEVELOPMENT

A numerical model was developed to simulate the flow of shallow groundwater underneath the facility. The model was calibrated under steady state condition to match the average groundwater elevations at monitoring wells on the facility between 2004 and 2007.

G3.1 CODE AND SOFTWARE

The numerical model was developed using the United States Geologic Survey's MODFLOW-2000 code. The commercial graphical-user-interface software Groundwater Vistas (Version 6.26 Build 21 32-bit; Environmental Simulations, Inc., Reinholds, Pennsylvania) was used for pre- and post-processing.

G3.2 DOMAIN AND GRID

Figure G-1 shows the horizontal extent of model domain. Groundwater along the northern boundary of the model domain discharges to Portage Creek. The southern boundary was along the groundwater divide, approximately one mile south of the facility. The western boundary was approximately 3,000 ft west of the JHB facility where groundwater flow direction is due north. The eastern boundary was along the contact between the recessional outwash and advanced outwash underneath the Getchell Hill upland. Vertically, the domain extends to 100 feet below ground surface.

The model grid has 186 rows, 409 columns, and 4 layers. The grid cell dimension was 200 ft by 200 ft along model boundary. The grid over the facility was refined to a dimension of 10 ft by 10 ft. Figure G-2 shows the refinement of model grid.

All layers were set as flat. The top elevation of layer 1 was set at 143 ft, which is the average ground surface elevation on the facility. The thickness of the four layers was 30, 10, 10, and 50 ft, from top to bottom. The bottom elevation of layer 4 was set at 43 ft.

G3.3 BOUNDARY CONDITION

The four layers have the same types of boundary conditions. Constant head boundary was set along the northern boundary to represent Portage Creek. The constant head was set at 75 ft. No-flow boundary was set along the southern and western boundaries. General head boundary (GHB) was set along the eastern boundary to represent the incoming groundwater flow from advanced outwash underneath the Getchell Hill upland. The GHB head was set at approximately 135 ft based on groundwater elevations on the Getchell Hill upland.

The domain was divided into a paved zone and vegetated zone based on aerial photo. Recharge rate was set as zero for the paved zone and 0.0035 ft/day (equivalent to 15 inches per year) for the vegetated zone.

G3.4 HYDRAULIC PARAMETER

The hydraulic conductivity zonation and values were the same in all four layers, and were obtained through model calibration. The background horizontal hydraulic conductivity value was 20 ft/day,

while the values vary between 1 and 75 ft/day within the domain. Storage parameters were not used because the model is steady state.

Because the model treats the 100-ft thickness as one aquifer, vertical hydraulic conductivity was not calibrated. Vertical anisotropy, which is the ratio of vertical hydraulic conductivity to horizontal hydraulic conductivity) typically ranges between 10 and 100.

G3.5 CALIBRATION

The model was calibrated under steady state condition to average groundwater elevations between 2004 and 2007. The zonation and values of hydraulic conductivity were adjusted to achieve a reasonable match between simulated groundwater elevations and calibration targets. The calibration targets, simulated groundwater elevations, and residual statistics are shown in Table G-1. Simulated groundwater elevation contours and residuals are shown on Figure G-3.

G4.0 PREDICTIVE SIMULATION RESULTS

Predictive simulations were performed to quantify the reduction of groundwater flux through the source zone by a subsurface barrier wall. Two horizontal alignments of the barrier wall, two barrier wall depths, and two values of vertical anisotropy were evaluated. Therefore, a total of eight predictive scenarios were simulated. The two alignments evaluated were shown in Figures G-4 and G-5. Alignment A is approximately 390 ft long, while Alignment B is approximately 720 ft long. The two barrier wall depths evaluated were 40 ft and 50 ft. The two vertical anisotropy values evaluated were 10 and 100; i.e. vertical hydraulic conductivity was $1/10^{th}$ or $1/100^{th}$ of horizontal hydraulic conductivity.

The model used in predictive simulations was the same as the calibrated model, except that the hydraulic flow boundary (HFB) package was added to represent the barrier wall. The properties of the HFB package include thickness of 3 ft and hydraulic conductivity of 1×10^{-7} cm/sec (0.00028 ft/day).

Each predictive simulation was run in steady state. The groundwater flux through the source zone was extracted from model output. The source zone was represented in the models as a vertical column of grid cells. Approximate horizontal footprint of the source zone is shown on Figures G-4 and G-5. Vertically, the source zone includes grid cells in layers 1 and 2 under the footprint. The percent reduction of groundwater flux through the source zone, using the calibrated model as baseline, was calculated. The simulation results for the eight scenarios are summarized in Table G-2.

The modeling results suggest that (1) a 50-foot deep barrier wall is more effective than a 40-foot deep barrier wall; (2) the reduction in groundwater flux through the source zone by a 50-foot deep barrier

wall ranges from 15% to 60%, depending on the barrier wall's horizontal alignment and vertical anisotropy for hydraulic conductivity.

TABLES

TABLE G-1

STEADY-STATE CALIBRATION STATISTICS

Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Monitoring Well	Observed Head (feet)	Computed Head (feet)	Residual (feet)
BXS-1	107.36	107.61	-0.25
BXS-2	107.65	108.31	-0.66
BXS-3	110.70	109.71	0.99
BXS-4	130.49	129.42	1.07
MW-1	121.52	121.62	-0.10
MW-2	104.54	105.48	-0.94
MW-3	107.46	107.84	-0.38
MW-4	133.59	132.65	0.94
HCMW-5	117.98	117.63	0.35
HCMW-6	107.15	107.45	-0.30
HCMW-7	103.44	104.04	-0.60
MW-10	112.60	111.76	0.84
MW-11	123.71	123.44	0.27
MW-14	117.41	116.82	0.59
MW-15	105.36	105.81	-0.45
MW-16	105.16	105.26	-0.10
MW-17	104.44	105.51	-1.07
MW-18	102.84	102.73	0.11

Residual Mean	0.02
Absolute Residual Mean	0.56
Residual Standard Deviation	0.65
Root Mean Square Error	0.65
Minimum Residual	-1.07
Maximum Residual	1.07
Range in Observations	31
Residual Standard Deviation/Range	2.1%
Absolute Residual Mean/Range	1.8%

TABLE G-2

SUMMARY OF PREDICTIVE SIMULATION RESULTS

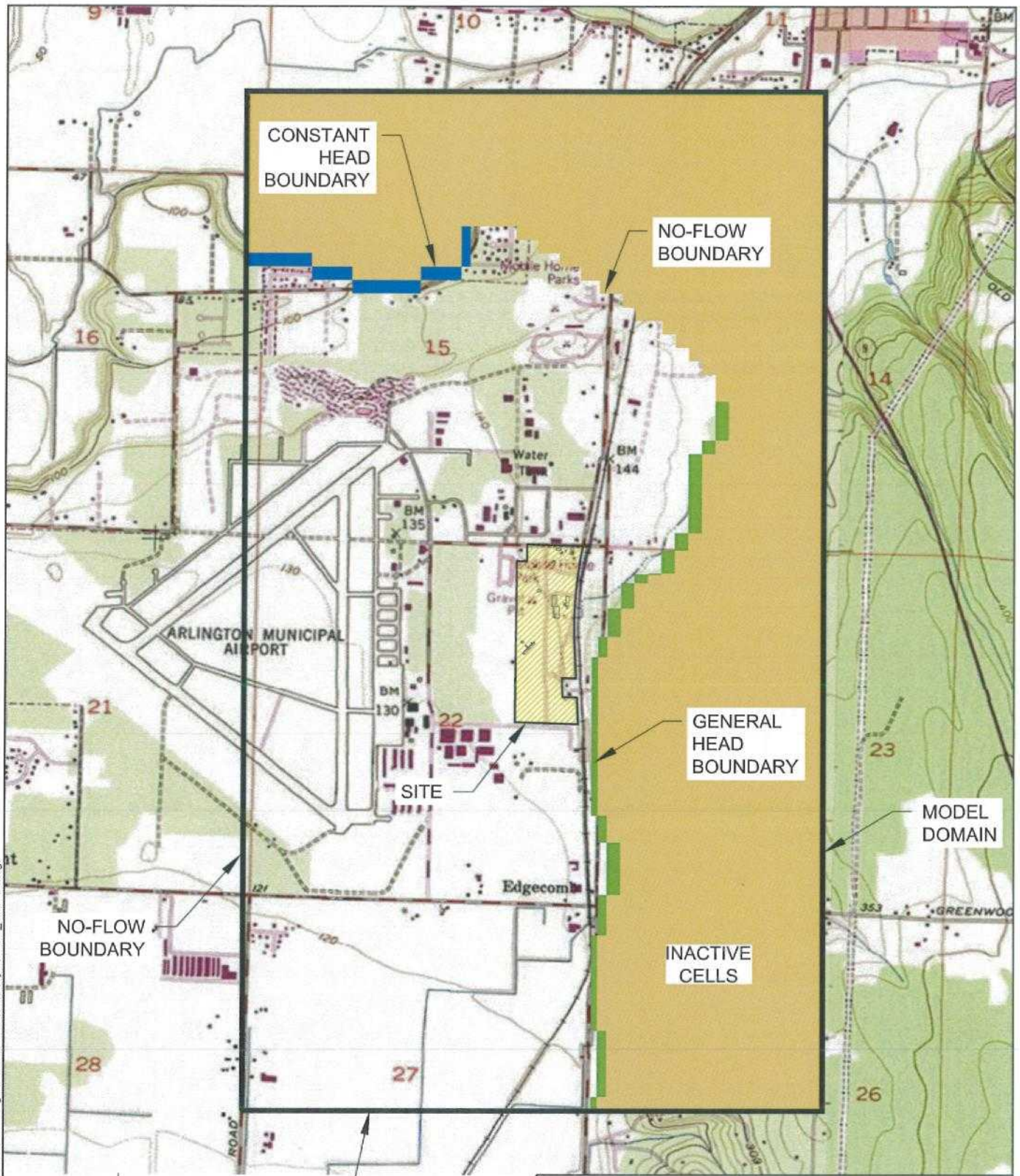
Former J.H. Baxter & Co. Wood Treating Facility
Arlington, Washington

Vertical Anisotropy	Barrier Wall Depth	Barrier Wall Alignment A	Barrier Wall Alignment B
10	40 ft	7%	5%
	50 ft	17%	15%
100	40 ft	25%	26%
	50 ft	48%	60%

Notes:

1. The percentages shown are predicted percent reduction in groundwater flux through source zone.
2. Vertical anisotropy is the ratio of vertical hydraulic conductivity to horizontal hydraulic conductivity.
3. Barrier wall alignments A and B are shown on Figures G-4 and G-5, respectively.

FIGURES



0 1,000 2,000
APPROXIMATE SCALE IN FEET

SITE VICINITY AND MODEL DOMAIN
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

By: APS	Date: 03/01/13	Project No. 12706
amec		Figure G-1

Plot Date: 03/01/13 - 1:06pm, Plotted by: adam.stenberg
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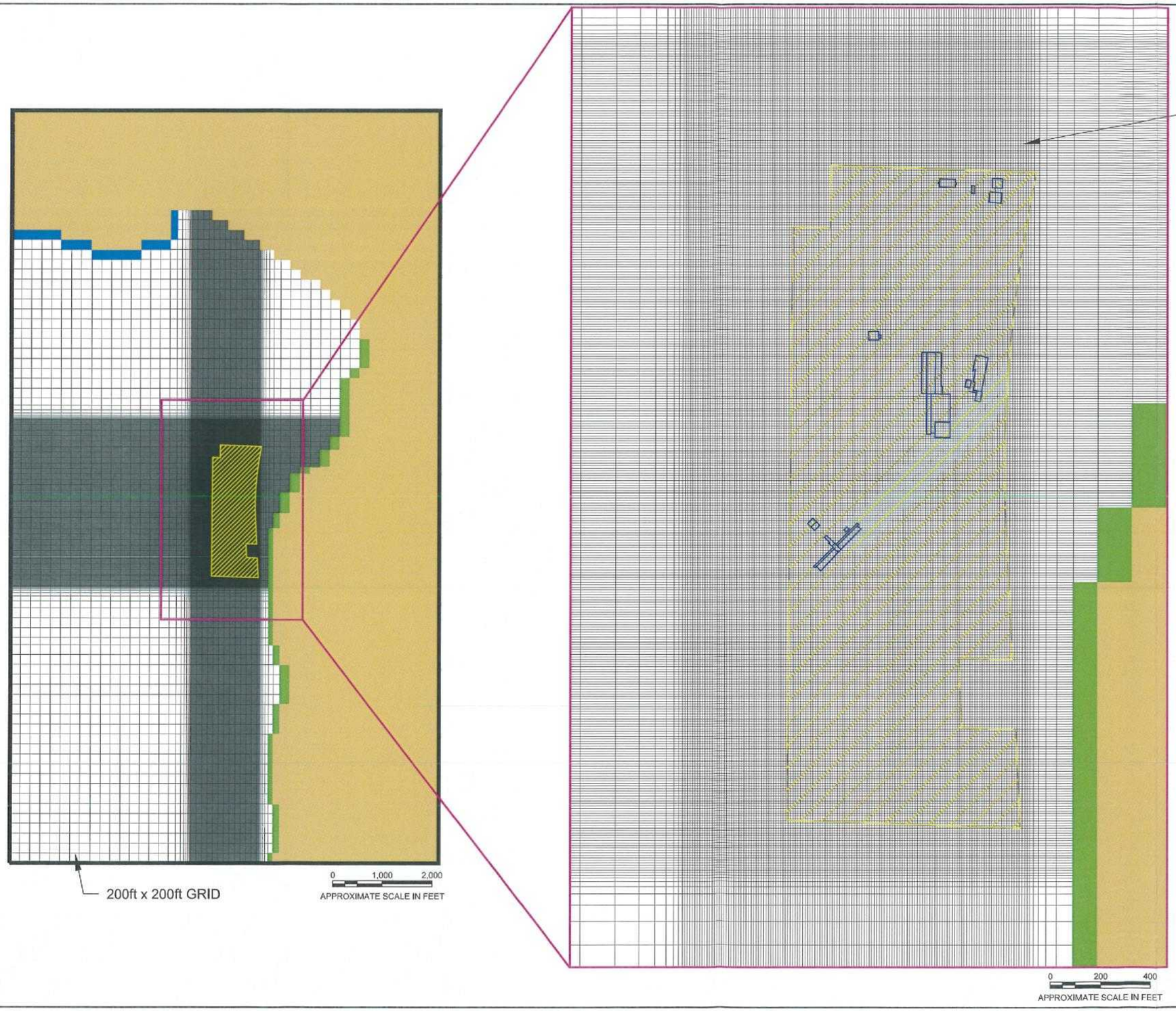

MODEL GRID
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

By: APS	Date: 03/01/13	Project No. 12706
amec		Figure G-2

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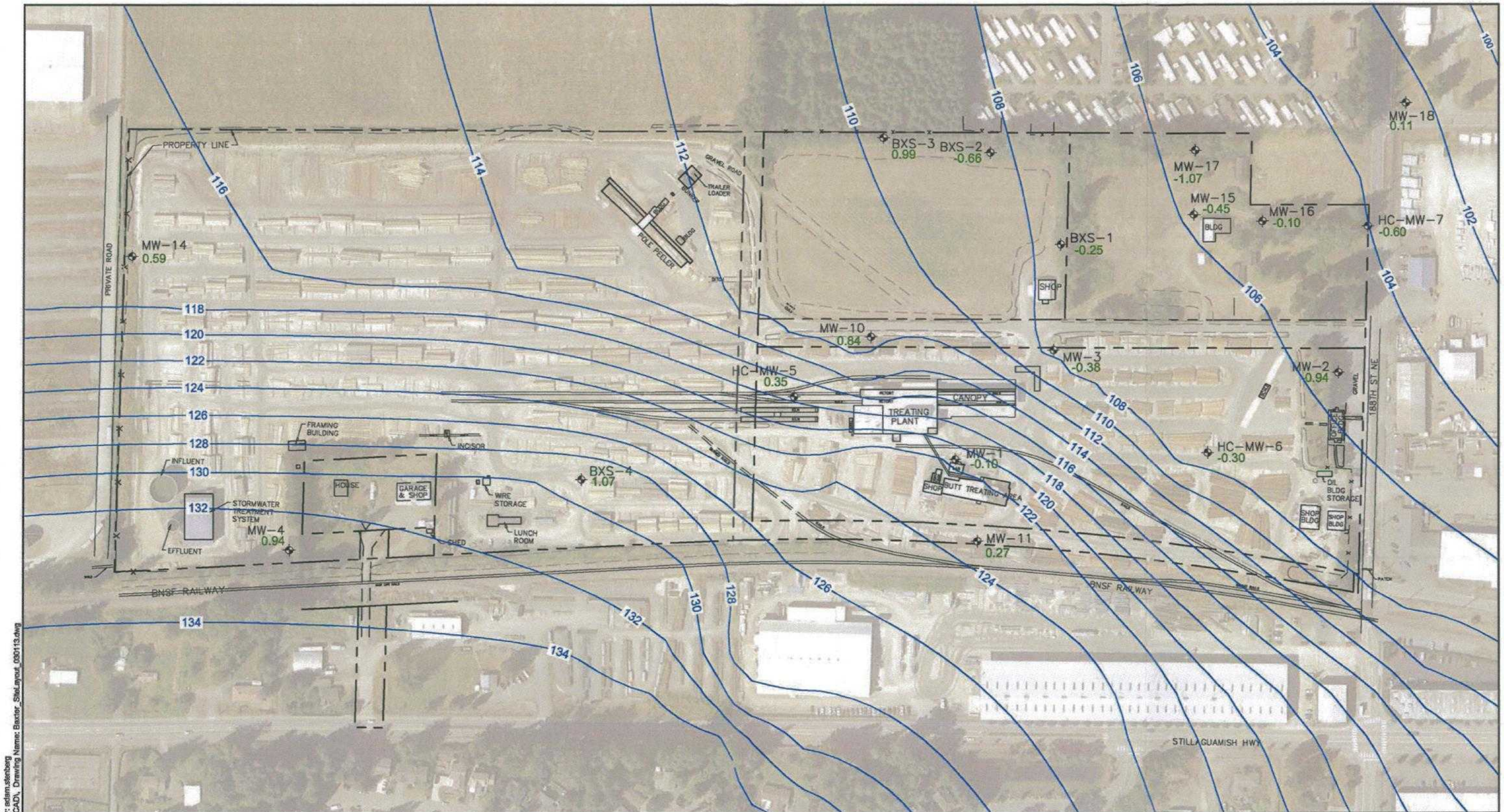


AERIAL: AUGUST 2011, GOOGLE

LEGEND

MW-1 ◆	MONITORING WELL
-0.10	RESIDUAL (FT.)
—128—	SIMULATED GROUNDWATER CONTOUR (FT.)
— — —	APPROXIMATE SITE BOUNDARY

N

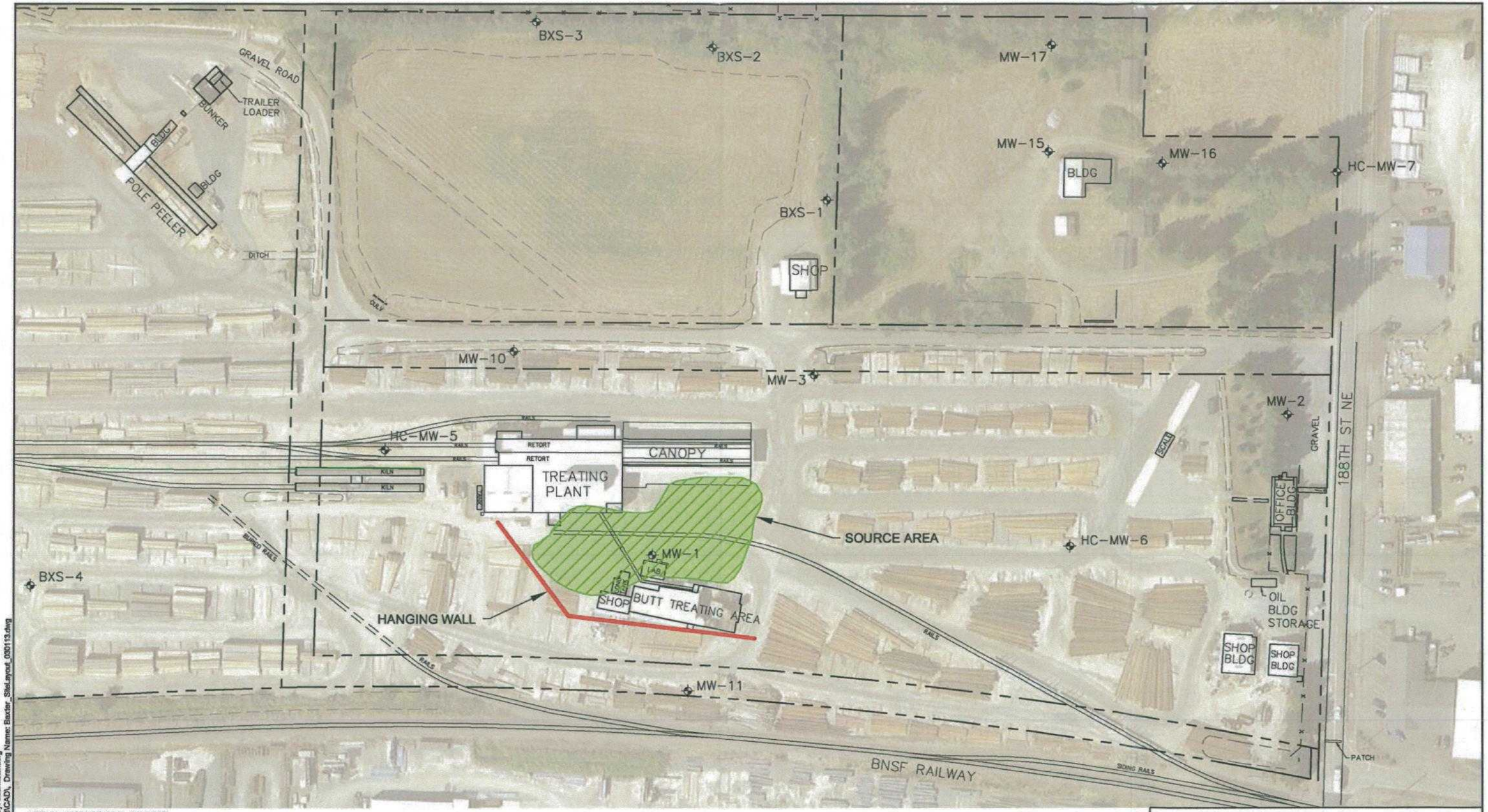
0 100 200

APPROXIMATE SCALE IN FEET

Plot Date: 03/01/13 - 3:22pm, Plotted by: adam.stenberg
Drawing Path: S:\12706\017_Model\Grid\CADL, Drawing Name: Baxter_SiteLayout_030113.dwg

SIMULATED GROUNDWATER ELEVATION CONTOURS AND RESIDUALS
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

By: APS	Date: 03/01/13	Project No. 12706
amec		Figure G-3



AERIAL: AUGUST 2011, GOOGLE

LEGEND

MW-1 MONITORING WELL

APPROXIMATE SITE BOUNDARY

N

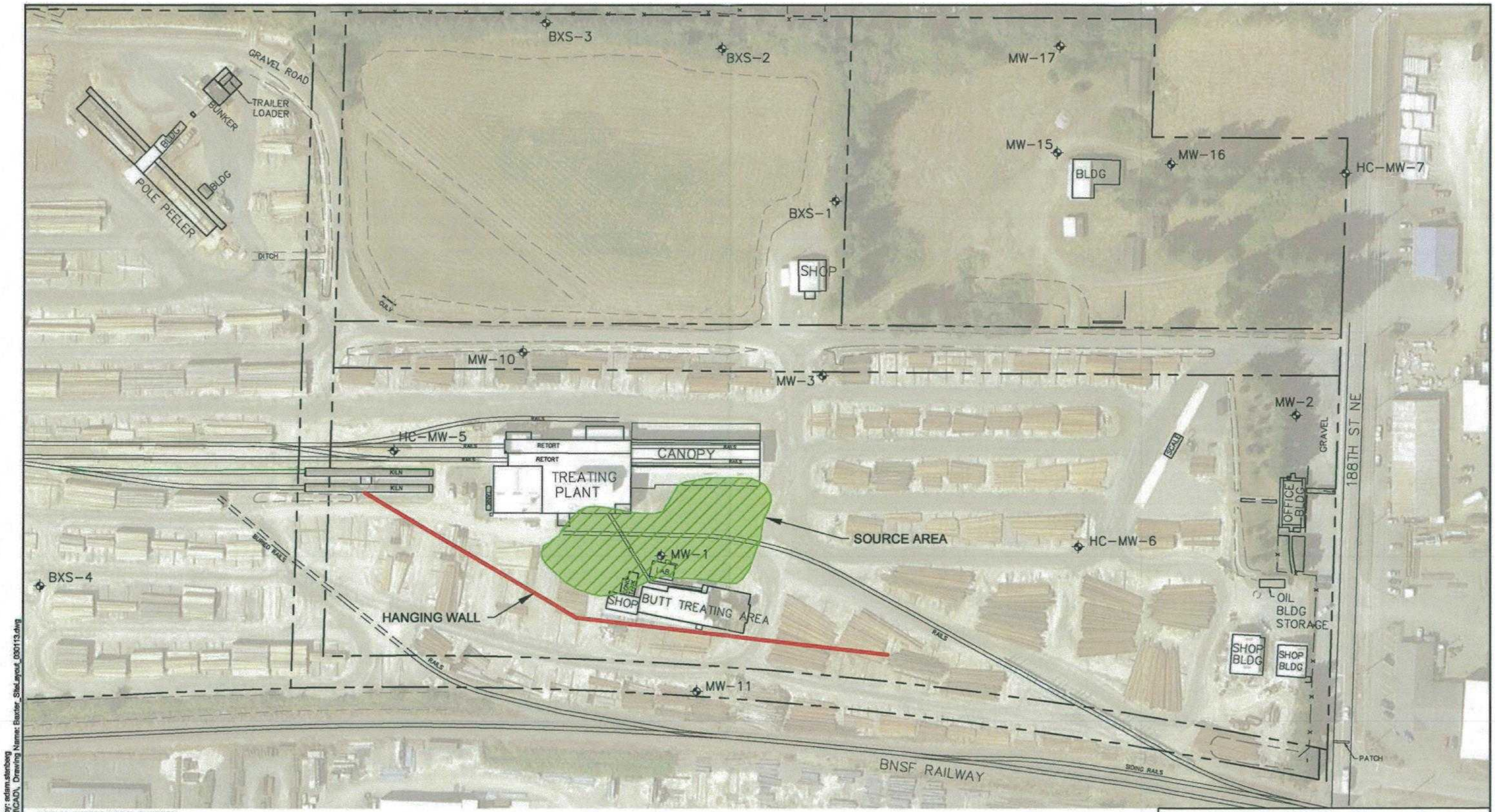
0 60 120

APPROXIMATE SCALE IN FEET

Plot Date: 03/01/13 - 3:31pm, Plotted by: adam.sterberg
Drawing Path: S:\12706\017_Model\Grid\CAD\, Drawing Name: Baxter_SiteLayout_030113.dwg

HANGING WALL ALIGNMENT A
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

By: APS	Date: 03/01/13	Project No. 12706
amec		Figure G-4



AERIAL: AUGUST 2011, GOOGLE

LEGEND

MW-1 MONITORING WELL

APPROXIMATE SITE BOUNDARY

0 60 120

APPROXIMATE SCALE IN FEET

Plot Date: 03/01/13 - 3:41pm, Plotted by: adam.stenberg
Drawing Path: S:\12706\017_Model\Grid\CAD\, Drawing Name: Baxter_SiteLayout_030113.dwg

HANGING WALL ALIGNMENT B
Former J.H. Baxter and Co. Wood Treating Facility
Arlington, Washington

By: APS	Date: 03/01/13	Project No. 12706
amec		Figure G-5

WA3019
11A
disk in
15E

Corrective Measures Study - Revision 3

Former J.H. Baxter & Co. Wood Treating Facility

Arlington, Washington

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Office of Air, Waste & Toxics

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U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by:

AMEC Environment & Infrastructure, Inc.
7376 SW Durham Road
Portland, Oregon 97224
(503) 639-3400

April 2013

Project No. 3-61M-125611