DRAFT FOCUSED FEASIBILITY STUDY REPORT
Oconomowoc Electroplating Company, Inc.
Ashippun, Wisconsin

Focused Feasibility Study

WA No. 066-TATA-05M8/Contract No. EP-S5-06-01

July 2010

Executive Summary

This focused feasibility study (FS) report presents the results of the remedial action objectives (RAOs) development, technology screening, and alternatives development and evaluation completed for the Oconomowoc Electroplating Company Inc. site, in Ashippun, Wisconsin. The objective of the focused FS is to develop and evaluate additional remedial actions that may be needed prior to the State of Wisconsin assuming responsibility for operations and maintenance.

RAOs were developed for the media of concern at the Site to protect human health and the environment based on the nature and extent of the contamination, resources that are currently and potentially threatened, and potential for human and environmental exposure as determined by the human health and ecological risk evaluations. The media of concern for existing contamination at the Site is limited to groundwater; however, due to the potential for remedial actions to impact surface water, this media is also included in RAO development. To meet the RAOs, preliminary remediation goals (PRGs) were developed to define the extent of contaminated media requiring remedial action or for prevention of future adverse affects.

Consistent with the RAOs and PRGs, remedial technologies and process options were identified and screened. Remedial technologies and process options that remained following screening were assembled into a range of alternatives. The potential alternatives encompass, as specified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume or wastes, but vary in degree to which long-term management of residuals or untreated waste is required.

Based on the risks present at the site and the remaining remedial technologies and process options available after completion of the screening, the following alternatives were assembled and then evaluated against the seven criteria identified in the NCP:

- Alternative 1—No Further Action
- Alternative 2—Monitored Natural Attenuation (MNA)
- Alternative 3—Source Zone Removal/In Situ Treatment and MNA
- Alternative 4—Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring
- Alternative 5—Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA

The No Further Action Alternative is not considered protective of human health and the environment because it does not include groundwater or surface water monitoring. The remaining alternatives pass the threshold criteria evaluation and are considered protective of human health and the environment because they all include, at a minimum, groundwater monitoring for compliance and to verify natural attenuation is occurring.

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Acronyms and Abbreviations

μg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-Dichloroethene
COC	chemical of concern
CVOC	chlorinated volatile organic compound
cis-1,2-DCE	cis-1,2-Dichloroethene
trans-1,2-DCE	trans-1,2-Dichloroethene
EO	Executive Order
EW	Extraction Well
FS	feasibility study
LDR	land disposal restriction
MCL	maximum contaminant level
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
OECI	Oconomowoc Electroplating Company, Inc.
OU	Operable Unit
PRG	preliminary remediation goal
PAL	Preventive Action Limit
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
TBC	to be considered
1,1,1-TCA	1,1,1-Trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TM	Technical Memorandum
TMV	toxicity, mobility, or volume
USEPA	U.S. Environmental Protection Agency

VC	vinyl chloride
VOC	volatile organic compound
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
yd^3	cubic yards

SECTION 1

Introduction

1.1 Purpose

This focused feasibility study (FS) report presents the results of the remedial action objectives (RAOs) development, technology screening, and alternatives development and evaluation completed for the Oconomowoc Electroplating Company Inc. (OECI) site, in Ashippun, Wisconsin. The objective of the focused FS is to develop and evaluate additional remedial actions that may be needed prior to the State of Wisconsin assuming responsibility for operations and maintenance of the site. The work is being performed for the U.S. Environmental Protection Agency (USEPA) in accordance with the statement of work (SOW) dated February 22, 2010 and Work Assignment No. 066-TATA-05M8 under Contract No. EP-S5-06-01.

As described in the SOW, alternatives were evaluated that will remediate or control contaminated media remaining at the site to provide adequate protection of human health and the environment. The potential alternatives encompass, as specified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume (TMV) of wastes, but vary in the degree to which long-term management of residuals or untreated waste is required.

The general objectives of this FS include the following:

- Identify site-specific RAOs
- Develop general response actions
- Identify and screen applicable remedial technologies for effectiveness, implementability, and cost
- Develop remedial alternatives
- Analyze the alternatives in accordance with the seven NCP criteria

1.2 Organization

This focused FS report consists of six sections. Section 1 provides an introduction and summarizes background information, such as site physical description, previous removal actions, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, and the human health and ecological risks.

Section 2 presents the development of RAOs and preliminary remediation goals (PRGs). Chemical-specific remedial goals were developed based on risk associated with the various concentrations of contaminants in the media of concern, the applicable or relevant and appropriate requirements (ARARs), and background concentrations when applicable. A detailed review of ARARs for this site is provided in Appendix A.

Section 3 contains information about the general response actions that address the RAOs and introduces the identification and screening of the technology types and process options. Remedial technologies were screened to focus the detailed analysis on only those technologies most applicable to the site.

In Section 4, the screened technologies were assembled into remedial alternatives that achieve the RAOs, provide a range of levels of remediation, and support development of a corresponding range of costs.

A detailed analysis of the alternatives is presented in Section 5. The detailed analysis addresses the NCP evaluation criteria. Two additional criteria to be used in the evaluation of alternatives and the selection of remedy—state/federal acceptance and community acceptance—will be addressed following public comment on the focused FS report. The detailed cost estimates for the alternatives are provided in Appendix B.

Reference documents used during the alternatives screening and preparation of this memorandum are listed in Section 6.

1.3 Site Description

The following sections briefly describe the physical location of the site; its operational history; the geologic, hydrogeologic, and ecological setting; the nature and extent of contamination; contaminant fate and transport; and summary of human health and ecological risks.

1.3.1 Site Location

The site is in southeastern Wisconsin in Dodge County, roughly 40 miles west-northwest of Milwaukee. The site is located in the northwest quarter of the southeast quarter of Section 30 Township 9 North, Range 17 East. The 10-acre site comprises the former 4-acre OECI facility bounded by Elm, Oak, and Eva Streets, and the Town of Ashippun Municipal garage) located at 2573 Oak Street in Ashippun, Wisconsin, and 6 acres of a wet, low-lying area (referred to as a wetland area) located adjacent to the southwest portion of the former site (Figures 1 and 2).

Nearby surface water bodies include Davy Creek (flowing through the wetland area), located a few hundred feet to the southwest of the site, and Rock River, located approximately 1 mile west of the site. The site slopes gently toward Davy Creek to the southwest. Landscaped linear berms bound the site at its northwestern, northeastern, and southeastern perimeters, with approximate heights above the surrounding ground surface ranging from 3 to 4 feet. The former OECI buildings have been demolished at the site. The building housing the former groundwater treatment plant is located in the northeast portion of the site.

1.3.2 Background

Various onsite metal cleaning and electroplating processes were performed at OECI since operations began in 1957. Operation materials included chlorinated solvents, cyanide, chromium, cadmium, copper, nickel, tin, and zinc. Degreasing operations were performed at the site using unknown compounds (Ebasco 1990). OECI ceased operation in 1990 due to financial hardship. Buildings at the site were demolished in May 1992.

The site was listed on the National Priorities List on September 21, 1984. The U.S. Environmental Protection Agency (USEPA), in consultation with the Wisconsin Department of Natural Resources (WDNR), conducted a remedial investigation (RI) and FS at the site from April 1987 through September 1990. The RI determined that soils associated with the OECI facility were contaminated with organic chemicals and metals, and that various chemical contaminants had leached into the groundwater and were moving southwest toward Davy Creek.

The Record of Decision (ROD) was signed September 20, 1990. The selected remedy and two subsequent Explanations of Significant Differences required lagoon closure, excavation of contaminated soil, dredging and restoration of Davy Creek and surrounding wetlands, demolition and removal of the former facility, and extraction and treatment of contaminated groundwater. The groundwater extraction and treatment facility was in operation from 1996 until 2004. A study conducted in 2004 to evaluate the performance of the treatment facility concluded that pumping and treating extracted groundwater had substantially reduced the contaminants to consistent concentrations and that further groundwater treatment would not likely be effective (RMT 2004).

Groundwater and surface water monitoring was conducted at the site from 2004 until 2009. Groundwater monitoring data supports that natural attenuation is occurring. Chlorinated compounds continue to be detected in groundwater collected from downgradient bedrock wells and water supply wells. Concentrations of volatile organic compounds (VOCs) in water supply wells are low (all below the WDNR NR 140 Enforcement Standard and many below the NR 140 Preventive Action Limit [PAL]), but detections have persisted since CH2M HILL began sampling the water supply wells in July 2005. Overall, in water supply wells with detections of chlorinated volatile organic compound (CVOCs), the parent compounds are either absent or relatively stable, with degradation products increasing.

The Long-Term Response Action for the site expired May 7, 2009, ten years after the site was pronounced Operational and Functional. The site requires a ROD amendment before the state will assume responsibility for operations and maintenance.

1.4 Previous Investigations and Remedial Actions

A USEPA Field Investigation Team performed a preliminary assessment of the OECI facility property in 1983. As a result of this preliminary assessment, the site was placed on the National Priorities List (Ebasco 1990). The WDNR and Wisconsin Geologic and Natural History Survey conducted preliminary groundwater sampling efforts at the site from 1983 to 1987. The results of this sampling identified chlorinated solvents (primarily trichloroethene [TCE] and 1,1,1-trichloroethane [1,1,1-TCA] and their associated degradation products) and metals in groundwater (RMT 2004).

USEPA, in consultation with the WDNR, conducted a RI/FS at the site from April 1987 to September 1990. The RI determined that soils were contaminated with organic chemicals and metals, and that various chemical contaminants had leached into the shallow groundwater as a result of hazardous waste disposal at the site. The concentrations of chemicals identified in the groundwater and soils were found to present unacceptable potential risk levels to human and/or environmental receptors based on a baseline risk assessment (Ebasco 1990).

For the purposes of the 1990 FS, the site was divided into the following four operable units (OUs): OU1—the lagoons, OU2—the contaminated soil, OU3—the contaminated groundwater, and OU4—the Davy Creek wetland area sediment.

USEPA issued a ROD in 1990 that declared the following remedies for each OU:

- OU1—The excavation and disposal of lagoon sludge and surrounding soils
- OU2—The excavation and disposal of non-lagoon contaminated soils and debris (including an abandoned electroplating building)
- OU3—The extraction and treatment of groundwater to meet state groundwater quality standards
- OU4—The excavation and offsite disposal of metals-contaminated sediments from the wetland area adjacent to Davy Creek

Remedial actions for OU1 (removal of 650 cubic yards [yd^3] of lagoon sludge/soil), OU2 (removal of 700 yd^3 of soil), and OU4 (removal of 6,000 yd^3 of creek sediment) have been completed in accordance with the approved remedial design. In 1996, USEPA constructed a treatment system to treat groundwater extracted by five wells (Figure 2) that was operated on behalf of USEPA by the U.S. Army Corps of Engineers. The extraction system was shut down in July 2004 because groundwater concentrations from the extraction wells were no longer decreasing with continued operation, or were decreasing at a very low rate.

A subsequent study conducted by RMT, Inc. of Madison, Wisconsin, (on behalf of the WDNR) used both ground/surface water sampling and three-dimensional groundwater flow and contaminant transport modeling to evaluate the effectiveness of the groundwater treatment system. The results of the study were documented by RMT and further details are included in the *Hydrogeologic Investigation and Groundwater Extraction System Evaluation* (RMT 2004).

RMT evaluated historical trends of several monitoring and extraction wells and noted initial rapidly decreasing concentrations of TCE and vinyl chloride (VC), which slowed and eventually leveled off (RMT 2004). RMT modeling results suggested that a possible reason for the stabilized concentrations in groundwater was the presence of nonaqueous phase liquids that remained sorbed to the organic material deposited within soil. Historic soil gas data collected onsite indicated elevated VOCs in the southeast area. When the soil gas data was compared directly to the planned excavation areas identified in the FS, a potential for contaminated soil that was not removed during OU2 activities remains. Furthermore, lithologic data indicates clay deposits present in the southeast area (source zone) from the surface to 7 feet below ground surface, potentially creating opportunities for remaining contamination to persist and contribute to the elevated VOC concentrations in nearby wells.

Additional modeling conducted by RMT indicated that further extraction of groundwater would not reduce the time to reach the regulatory target concentrations if the sorbed contaminants were present. As a result, the treatment plant was shut down in July 2004. Details of the shutdown are found in the *Groundwater Treatment Facility Shutdown Plan* (CH2M HILL 2004).

Groundwater samples were collected in October 2004 from a subset of existing Site monitoring wells. The data supported that natural attenuation of CVOCs was occurring at downgradient edges of contamination. October 2004 concentrations (post system shutdown) were similar to those measured in the previous sampling round (April 2003) when the system was operating, indicating overall stability in the CVOC distribution. Quarterly groundwater data collected in 2005 through 2009 by CH2M HILL further indicated that natural attenuation of CVOCs was occurring at downgradient portions of the contaminated zone (CH2M HILL 2009). Groundwater collected from several water supply wells was found to contain VC above the Wisconsin Administrative Code (WAC) NR 140 PAL since CH2M HILL began sampling the water supply wells in July 2005. The VC detected in the groundwater collected from the water supply wells was present at concentrations just above the detection limits. However, the detection limit for VC in samples collected since 2005 is lower than historical VC detection limits; therefore, it is possible that the compound was present in groundwater at these locations prior to 2005 water supply well sampling.

1.4.1 Physical Site Characteristics

Physical site characteristics and a conceptual model including geologic and hydrogeologic information as well as groundwater flow interpretations are included in Figure 3.

Geologic Setting

The regional geology beneath the site is comprised of unconsolidated Quaternary- and/or Holocene-aged deposits, which, in turn, are underlain by a succession of bedrock units. The rock units are described herein using an oldest to youngest (and deepest to most shallow) sequence.

The deepest rock unit, Precambrian crystalline basement rock, is overlain in succession by Cambrian sandstone, then Ordovician deposits. The Cambrian and Ordovician units are all sedimentary in origin and regionally dip to the east and southeast. A preglacial and glacial erosional surface unconformity separates the Ordovician bedrock surface from the overlying unconsolidated deposits.

The unconsolidated deposits beneath the site range in thickness from 28 feet directly beneath the former OECI facility to 55 feet at the southwestern edge of the site (RMT 2004). Silt and clay fill is sporadically present in the upper 4 to 10 feet of unconsolidated material at several locations at and near the former Site. The unconsolidated glacial material consists of gray-brown and yellow-brown sand, silty sand, and clay. The silt content in the glacial material varies from trace amounts to greater than 50 percent. Discontinuous lenses of silt and clay were observed to be present within the sands in several borings across the site. Compacted clay up to 8 feet thick is present directly above the top of bedrock in some locations (RMT 2004).

Hydrogeologic Units

Two bedrock aquifers (units capable of yielding water to supply wells) are present beneath the site at depth: the Ordovician Galena-Platteville dolomite and St. Peter Sandstone. The Maquoketa shale (also Ordovician in age), which sits above these bedrock aquifers and is the uppermost bedrock unit encountered at the site, is considered to be an aquitard unit on a regional basis. However, it does contain some dolomite interlayers and fractures that are capable of yielding sufficient quantities of water for residential use.

Groundwater is present in the unconsolidated silty sand and clay that sits above the Maquoketa shale at the site, although it is not considered to be part of a regional sand and gravel aquifer because of its higher silt content. The water table in this unconfined water-bearing unit roughly parallels the ground surface topography (the groundwater is assumed to be under atmospheric pressure [Devaul et al. 1983]).

Groundwater monitoring wells are installed at the site in the shallow and deep portions of the unconsolidated deposits and in the upper bedrock. Nested wells are installed in the unconsolidated deposits, with the shallow wells monitoring the upper water table portion and the deep wells monitoring the lower portion.

Interpreted Groundwater Flow Directions

Groundwater flow directions were determined for shallow and deep unconsolidated units and for the bedrock unit based on groundwater data collected during a January 2009 groundwater sampling event (CH2M HILL 2009). Flow directions in the unconsolidated unit indicate flow at the water table appears to be mostly toward the southwest, with southern components. The flow direction in the shallow and deep unconsolidated units (Figures 4 and 5, respectively) is toward the location of Davy Creek, south and southwest of the site.

Groundwater elevations measured in the bedrock aquifer indicate a local groundwater high near the center and the eastern portion of the site. The apparent groundwater flow pattern indicated by the potentiometric surface shows a dominant flow to the west with a somewhat radial flow pattern toward the southwest and northwest (Figure 6). Residential water use to the west of the site appears to be influencing the local flow regime in this aquifer unit indicated by the strong horizontal gradient to the west, possibly due to the number of actively pumping bedrock water supply wells located in this area.

Vertical Gradients

Based on the January 2009 data, vertical gradients between the shallow and deep unconsolidated units indicate the potential for upward flow. Upward gradients are present for well nests that are situated along Davy Creek, indicating the potential for the shallow groundwater to be discharging to Davy Creek. Vertical gradients between the unconsolidated unit and the bedrock unit indicate the potential for downward flow except for nests MW-101 and MW-105, where the flow appears to be slightly upward. This indicates that the unconsolidated unit and bedrock have the capacity to exchange water.

Ecological Setting

The most significant ecological feature includes Davy Creek and its associated wetland area, which is located approximately 500 feet south of the site and is a tributary to the Rock River. Davy Creek and its associated wetland area are likely connected to unconsolidated groundwater in the area. Transport of soluble organic contamination away from the site via the shallow groundwater appears to be occurring in the direction of the wetlands area.

1.4.2 Nature and Extent of Contamination

Based on the information obtained from previous investigations and reports, the following conclusions were made:

1. Several previous reports indicate a potential CVOC source remaining in the vicinity of the southeast operations area (source zone) that continues to contribute to dissolved constituents at the site. This conclusion is based on numeric modeling, evaluation of concentration trends over time at monitoring and extraction wells, and analysis of historic source zone soil removal efforts compared to soil gas data. In particular, extraction well Extraction Well (EW) 5 is believed to be nearest the source zone and analysis of concentration trends over time indicate an initial rapid decline in VOC concentrations followed by reaching a level stabilized concentration. This observed trend indicates a potential continuing source contributing to the VOC concentrations in this area and downgradient.
2. Chlorinated compounds, including TCE and VC, continue to be detected in groundwater from downgradient bedrock wells and water supply wells. Although concentrations of VOCs in water supply wells are low (all below the Enforcement Standard and many below the PAL), detections have persisted since CH2M HILL began sampling the water supply wells in July 2005.
3. The CVOC extent does not appear to be migrating in the shallow and deep unconsolidated units beyond its previous extent. Trends at the water supply wells with detections of CVOCs appear to show that parent compounds are generally absent or stable at low concentrations, with degradation products increasing.
4. Chlorinated compounds were found at two surface water sampling locations. Surface water at location SG-2 is at the discharge zone for contaminated groundwater from the site and SG-3 is located about 1,000 feet downstream. VOCs detected at these locations are believed to be a result of groundwater discharge from the site. The upstream sample location SG-3 does not exhibit detections of VOCs.
5. The first and second lines of evidence for supporting natural attenuation, as outlined in OSWER Directive 9200.4-17P (OSWER 1999), are present to support that natural attenuation is ongoing at the site. The first line of evidence is a documented loss of primary contaminants at the field scale—TCE concentrations are steady overall, and degradation products such as cis-1,2-Dichloroethene (cis-1,2-DCE) and VC are present in all three hydrogeologic units. The second line of evidence is the documented presence and distribution of geochemical and biochemical indicators of natural attenuation including conventional parameters such as chloride, dissolved iron, methane, and field parameters such as oxidation reduction potential, dissolved oxygen, and pH. Additional information is available in the *Annual Groundwater Report* (CH2M HILL 2009).
6. Screening for evidence of anaerobic biodegradation processes based on the method of Wiedemeier et al. (1998) was performed for this Site, and screening results indicate that adequate evidence for natural attenuation by anaerobic biodegradation is present within all three hydrogeologic units that comprise the impacted groundwater flow system (shallow unconsolidated, deep unconsolidated, and bedrock units). However, biodegradation capacities of these hydrogeologic units appear to have been reduced on a sitewide basis when compared to historical data. Additional information is available in the *Annual Groundwater Report* (CH2M HILL 2009).

1.4.3 Contaminant Fate and Transport

The primary contaminant release and transport mechanisms occurring at the Site include the following:

- Leaching of contaminants from source materials into groundwater and subsequent dissolved phase transport to the groundwater discharge areas along Davy Creek.
- Contaminant migration from groundwater into surface waters may occur through groundwater discharge. Upon reaching surface water, the contaminants may remain in the water column or volatilize.
- Volatilization of organic compounds from the groundwater and migration offsite through the atmosphere. Based on physical properties of site contaminants, discharge area properties, and seasonal influences if subsurface groundwater is brought to the surface, volatilization of these contaminants of concern could be an important release mechanism.

1.4.4 Human Health Risk Assessment

A human health risk assessment was prepared by USEPA based on the highest historical concentration of VOCs detected in each water supply well (USEPA 2010). Ingestion of well water and inhalation of VOCs during daily showering were both evaluated in the assessment.

Results of the assessment indicate of the 10 residential water supply wells evaluated, 8 had detected exceedances of the WAC NR 140 PAL. Wells PW-04, PW-05, PW-07, PW-08, PW-09, and PW-11 had multiple historical exceedances of VC. Well PW-03 had multiple historical exceedances of TCE. Well PW-01 had a single exceedance of methylene chloride in April of 2007.

USEPA determines probability of a non-cancer detrimental health effect to occur by calculating a hazard index. The hazard index is a ratio of a single substance exposure level over a specified period of time to a reference dose of the same substance derived from a similar exposure period. It is recommended that the hazard index of an exposure to a chemical of concern (COC) be below or equal to 1, which is the level at which no adverse human health effects are expected to occur. For cancer risk, USEPA recommends a screening level that would equate to a one in a million ($1x10^{-6}$) or greater lifetime risk of developing cancer from exposure to a contaminant.

All of the historical exceedances in the water supply wells are well below the USEPA recommended non-cancer and cancer risk screening levels. Therefore, the low levels of VOCs detected in the water supply wells should not contribute to any detrimental health effects based on drinking or bathing exposures.

1.4.5 Ecological Risk Assessment

The ecological risk assessment previously conducted during the RI/FS evaluated whether contaminants present at the site and surrounding areas represent a potential risk to exposed ecological receptors. The assessment determined the site is located in an area that has generally been developed with residential dwellings, commercial/industrial facilities, and recreational complexes. Because of this development, these areas are not the habitats of any significant plant or animal populations. The only natural area of significant size was determined to be the Davy Creek wetlands area southwest of the site.

Based on extent of contamination, a relatively insignificant migration of contaminants from the site is occurring compared to the previous large, direct deposition of contaminants into the wetlands area. Although immediate risks to the Davy Creek wetlands area were not identified, horizontal transport of soluble organic contamination away from the site via the shallow groundwater was determined to be occurring and a potential threat. The RI/FS recommended minimizing the quantity of Site contamination that could migrate to the wetlands area during remediation efforts in order to minimize ecological impact.

SECTION 2

Development and Identification of ARARs, RAOs, and PRGs

2.1 Summary of ARARs

Remedial actions must be protective of public health and the environment. Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect public health and the environment.

The following are definitions of the ARARs and to be considered (TBC) criteria:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which, while not applicable, address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, and address that their use is well-suited (appropriate) to the particular site.
- TBC criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing a remedial action, or are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include USEPA drinking water health advisories, reference doses, and cancer slope factors.

Another factor in determining which requirements must be addressed is whether the requirement is substantive or administrative. Onsite CERCLA response actions must comply with the substantive requirements but not with the administrative requirements of environmental laws and regulations as specified in the NCP, 40 Code of Federal Regulations (CFR) 300.5, definitions of ARARs and as discussed in 55 Federal Register 8756. Substantive requirements are those pertaining directly to actions or conditions in the environment. Administrative requirements are mechanisms that facilitate the implementation of the substantive requirements of an environmental law or regulation. In general, administrative requirements prescribe methods and procedures (for example, fees, permitting, inspection, reporting requirements) by which substantive requirements are made effective for the purposes of a particular environmental or public health program.

ARARs are grouped into three types: chemical-specific, location-specific, and action-specific. Appendix A includes the chemical-specific, location-specific, and action-specific ARARs for the Site. The most important ARARs are discussed below. All potential ARARs are listed in Appendix A along with an analysis of the ARAR status relative to remediation of the Site.

2.1.1 Chemical-specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. The chemical-specific ARARs for the Site can be classified into three categories: (1) residual concentrations of compounds that can remain at the site without presenting a threat to human health and the environment; (2) characteristic hazardous waste standards for defining hazardous waste and land disposal restriction (LDR) concentrations that must be achieved if the contaminated media that either is a characteristic hazardous waste or contains a listed hazardous waste is excavated or extracted and later land disposed; and (3) effluent concentrations that must be achieved in treatment of groundwater for discharge to surface water or discharge to a publicly owned treatment works, and surface water quality standards that must be met in streams such as Davy Creek are ARARs.

Residual Concentrations

For groundwater, Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and the State of Wisconsin Enforcement Standards (NR 140) and PALs are ARARs.

Characteristic Hazardous Waste and LDR Concentrations

The Resource Conservation and Recovery Act (RCRA) LDRs would apply to remedial actions performed at the Site if waste generated by the remedial action (for example, contaminated soil) contains a RCRA hazardous waste or is itself a characteristic hazardous waste. Listed hazardous wastes are not known to have been disposed at the Site. As a result, excavated soils would not be required to be managed as listed hazardous wastes. If excavated and removed from the area of contamination (that is, where the soil is "generated"), the soil may be a characteristic hazardous waste, such as a D040 toxicity characteristic hazardous waste for TCE (toxicity characteristic leaching procedure [TCLP] greater than 0.5 milligram per liter).

Based on historical soil concentrations of TCE in the potential source area, it is unlikely the contaminated soils would be characterized as a hazardous waste. However, until characterization is completed, the potential remains. Any generated soils that exceed the TCLP limit must be managed as hazardous wastes and must meet the LDR treatment standards for contaminated soil (40 CFR 268.49). The treatment standard for contaminated soil is the higher of a 90 percent reduction in constituent concentrations or 10 times the Universal Treatment Standards. Treatment is required for the constituent (such as TCE) for which the soil is a characteristic hazardous waste as well as other underlying hazardous constituents. Generators of contaminated soil can apply reasonable knowledge of the likely contaminants present to select constituents for monitoring (USEPA 1998).

2.1.2 Action-specific ARARs

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. The most important action-specific ARAR that may affect the RAOs and the development of remedial action alternatives is RCRA regulation.

Resource Conservation and Recovery Act

RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives that generate waste that would be moved to a location outside the area of contamination. Such alternatives could include excavation of materials (for example, soil). Requirements include waste accumulation, record keeping, container storage, manifesting, transportation, and disposal.

As discussed above, portions of the soil at the Site may be characteristic hazardous waste. If the soil is characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA prior to disposal, including treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a). The most likely LDR that would have to be met is the treatment of characteristic hazardous waste soil to the higher of a 90 percent reduction in TCE concentration or 60 milligrams per kilogram prior to disposal in an RCRA Subtitle C landfill. If the soil has no other underlying hazardous constituents, it could be treated to below the TCLP limit, rendering it nonhazardous, and disposed in a Subtitle D landfill. Nonhazardous waste soil would be disposed in accordance with RCRA solid waste disposal requirements.

2.1.3 Location-specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the Site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. The most important location-specific ARARs for the OECI site are the following:

- Fish and Wildlife Coordination Act—Enacted to protect fish and wildlife when actions result in the control or structural modification of a natural stream or body of water. The statute requires that any action takes into consideration the effect that water-related projects would have on fish and wildlife, and that it takes action to prevent loss or damage to the resources. Alternatives including groundwater extraction need to be evaluated to determine whether water levels in the adjacent wetland would be affected.
- Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands), 50 CFR § 6 Appendix A—TBC criteria that set forth USEPA policy for carrying out the provisions of Executive Orders (EOs) 11988 and 11990. EO 11988 requires that actions be taken to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. EO 11990 requires that actions at the site be conducted in ways that minimize the destruction, loss, or degradation of wetlands. Wetland areas are present to the southwest of the site near Davy Creek.

2.2 Remedial Action Objectives

USEPA Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (USEPA 1988) and the NCP define RAOs as medium-specific or site-specific goals for protecting human health and the environment that are established on the basis of the nature and extent of the contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. PRGs are site-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. The PRGs are developed and used in the focused FS, and they will be finalized in the ROD for the Site.

In this section, RAOs are developed for the media of concern at the Site. The media of concern for existing contamination at the Site is limited to groundwater; however, due to the potential for remedial actions to impact surface water, this media is also included in RAO development.

Risks to current residential water supply well users from exposure to groundwater are within current acceptable levels. A potential for future unacceptable risk from residential exposure to groundwater onsite exists as a result of potential increasing concentrations in the wells or installation of new wells within the area of groundwater contamination.

The RAOs for remediation of groundwater at the Site include the following:

- Prevention of future residential exposure to groundwater that exceeds federal MCLs or Wisconsin State Enforcement Standards.
- Restoration of groundwater exceeding federal MCLs and Wisconsin State Enforcement Standards in a reasonable timeframe given the site-specific circumstances.

Although the RI and ROD did not identify adverse impacts to environmental receptors in the surface water of Davy Creek, there is a potential for future unacceptable environmental risk as a result of remedial actions. For example, injection of substrate for reductive dechlorination of TCE can result in increases in groundwater concentrations of cis-1,2-DCE and VC.

The RAO for potential future affects on surface water includes the prevention of future adverse affects to ecological receptors as a result of groundwater discharge to surface water of Davy Creek.

2.3 Preliminary Remediation Goals

To meet the RAOs defined in Section 2.2, PRGs were developed to define the extent of contaminated media requiring remedial action or for prevention of future adverse affects. This section presents the PRGs and defines the volumes of affected media that will be addressed during the FS process. In general, PRGs establish media-specific concentrations of COCs that will pose no unacceptable risk to human health and the environment. COCs are the list of chemicals that result in current or potential future unacceptable risk. The PRGs are developed considering the following:

- Chemical-specific ARARs including SDWA federal MCLs and State of Wisconsin Enforcement Standards for groundwater. The State of Wisconsin PALs for groundwater are used to indicate a potential exceedance of an Enforcement Standard. Action is not necessarily required for a PAL exceedance.
- The State of Wisconsin fresh water aquatic life criteria are included for surface water based on potential future risks as discussed previously. The federal National Oceanic and Atmospheric Administration (NOAA) fresh water aquatic life criteria are included for surface water as TBC criteria.

A summary of the PRGs for groundwater and surface water exposure pathways at the Site are included in Tables 1 and 2, respectively.

TABLE 1
Groundwater Preliminary Remediation Goals
OECI Focused Feasibility Study Report

Contaminant	Federal SDWA MCL[a] (μg/L)	WI State ES[b] (μg/L)	WI State PAL[b]* (μg/L)
Volatile organic compounds (VOCs)			
1,1,1-Trichloroethane	200	200	40
1,1-Dichloroethane	NA	850	85
1,1-Dichloroethene	7	7	0.7
cis-1,2-DCE	70	70	7
trans-1,2-DCE	100	100	20
TCE	5	5	0.5
VC	2	0.2	0.02

Notes:
[a] Source: http://www.epa.gov/safewater/contaminants/index.html
[b] Source: WAC NR 140.10
*PAL is used to indicate the potential for exceedance of an ES. Action is not necessarily required for a PAL exceedance.
SDWA – Safe Drinking Water Act
MCL – maximum contaminant level
ES – Enforcement Standard
PAL – Preventive Action Limit
NA – Not Available
μg/L–micrograms per liter

PRGs were developed for groundwater based on the RAOs discussed previously. The SDWA federal MCLs and State of Wisconsin Enforcement Standards were compared to develop the groundwater PRGs for identification of areas of groundwater where active remediation would be considered. The federal MCLs and the State of Wisconsin Enforcement Standards were the same for 1,1,1-TCA, 1,1-DCE, 1,2-DCE (cis and trans), and TCE. The federal MCLs do not include a value for 1,1-DCA, resulting in use of the Wisconsin Enforcement Standards. Finally, for VC, the State of Wisconsin Enforcement Standards value is an order of magnitude lower than the federal MCL and was therefore selected as the most conservative PRG. Wisconsin PALs are also PRGs and are used herein to identify areas of groundwater that require monitoring.

PRGs were also developed to address the RAO for potential future affects on surface water. These values apply to site-related chemicals previously detected in surface water or their degradation products as shown in Table 2. State of Wisconsin secondary chronic fresh water aquatic life criteria were calculated based on WAC NR 105 for constituents with adequate toxicity data available. These values were selected as the surface water PRGs. The Federal Freshwater Aquatic life values are TBCs only and are presented for comparison only.

2.4 Comparison of Contaminated Media to Preliminary Remediation Goals

The areas and depths of groundwater that exceed the PRGs were developed by comparing results with the lowest applicable PRG. The following sections discussion the comparisons.

TABLE 2
Surface Water Preliminary Remediation Goals
OECI Focused Feasibility Study Report

Contaminant*	Freshwater Aquatic Life[a] (µg/L)	Federal Freshwater Aquatic Life[b]** (µg/L)	
	Chronic	Acute	Chronic
1,1,1-Trichloroethane	1,335	200	11
1,1-Dichloroethane	NA	830	47
1,1-Dichloroethene	137	450	25
cis-1,2-DCE	NA	1,100	590
trans-1,2-DCE	571	1,100	590
TCE	646	NA	21
VC	NA	NA	930

Notes:
[a]Secondary chronic values calculated based on WAC NR 105.06(6).
[b]Source: Buchman, M.F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages. *Site-related chemicals previously detected in surface water or their degradation products
**Federal values included as TBC criteria
NA = Not Available; Adequate toxicity data were not available to develop secondary chronic values.
µg/L = micrograms per liter

2.4.1 Groundwater

The estimated area of contaminated groundwater in the unconsolidated shallow and deep extent is defined by the area exceeding the federal MCLs and State of Wisconsin Enforcement Standards values for tetrachloroethene, TCE, cis-1,2-DCE, VC, and 1,1,1-TCA (Figure 7). The area of groundwater exceeding the federal MCLs and Enforcement Standards values is estimated to be 4.79 acres. The full saturated thickness of the unconsolidated shallow and deep aquifers is assumed to be contaminated above federal MCLs and Enforcement Standards values in this area, with the exception of the western portion, which is limited to the deep aquifer.

Concentrations of COCs for the bedrock and water supply wells are included in Figure 8. There are no exceedances of federal MCLs or Enforcement Standards values.

2.4.2 Soil

Based on historic soil gas data, the potential source areas identified are approximately 4,500 square feet and 1,600 square feet with an estimated thickness of approximately 7 feet. The source area volume is estimated at 1,600 yd^3 of soil.

SECTION 3

Identification and Screening of Technologies

After the RAOs and PRGs were developed, general response actions consistent with these objectives were identified. General response actions are basic actions that might be undertaken to remediate a site (for example, no action, in situ treatment, or excavation and treatment). For each general response action, several possible remedial technologies may exist, and they can be further broken down into a number of process options. The technologies and process options are then screened based on several criteria. Those technologies and process options remaining after screening are assembled into alternatives in Section 4.

The following sections present general response actions for each media that may be applicable to the Site.

3.1 General Response Actions

The general response actions that may be applicable at the Site include the following:

- No further action
- Institutional controls
- Containment
- In situ treatment
- Collection/ex situ treatment/discharge (groundwater)
- Removal/ex situ treatment/disposal (soil)

For each response action (except no action), remedial technologies and associated process options considered to be potentially appropriate and effective for the contaminated groundwater of the Site were identified based on professional experience, published sources, computer databases, and other documentation and resources.

3.1.1 No Further Action

The no further action response includes no action for groundwater.

3.1.2 Institutional controls

Institutional controls consist of access and use restrictions or an alternative water supply and may be necessary in conjunction with other actions. At OECI, additional access and use restrictions are not warranted due to existing restrictions and permitting processes currently preventing new well installations onsite. Groundwater and surface water monitoring may be necessary to track the direction and rate of movement of the groundwater contaminant plume.

3.1.3 Containment

Containment is used to minimize contaminant migration as well as prevent direct contact exposures. Both vertical and horizontal barriers can be used for containment. However, there are no applicable technologies to the Site due to restoration of the groundwater aquifer as the primary RAO rather than containment of groundwater.

3.1.4 In Situ Treatment

In situ treatment methods can be used to reduce the contaminant concentrations in soil and groundwater and can be chemical, physical, or biological. Examples of in situ treatment technologies include chemical oxidation, chemical reduction, permeable reactive barriers, air sparging, resistive heating, thermal desorption, monitored natural attenuation (MNA), and enhanced reductive dechlorination, among others.

3.1.5 Collection / Ex Situ Treatment / Discharge (Groundwater)

In this response action, groundwater would be extracted from the aquifer hydraulically using pumping in wells. The contaminants would then be removed from the water by physical ex situ treatment using technologies such as liquid-phase air stripping and carbon adsorption. Discharge of groundwater can be accomplished by discharge to surface water using an existing perforated discharge pipe.

3.1.6 Removal / Ex Situ Treatment / Disposal (Soil)

Removal of source area soils can be conducted by excavation using ordinary construction equipment such as backhoes, bulldozers, and front-end loaders. Physical, chemical, biological, or thermal technologies can be used for ex situ treatment of soils offsite. Treatment processes available at landfills include land treatment, incineration, and thermal desorption as necessary to achieve land disposal requirements. Disposal includes transportation to an approved Subtitle D or RCRA Subtitle C landfill, based on waste characterization.

3.2 Identification and Screening of Technology Types and Process Options

In this section, the technology types and process options available for site remediation are presented and screened. An inventory of technology types and process options is presented based on professional experience, published sources, computer databases, and other available documentation for the general response actions identified in Section 3.1. Each technology type and process option is either a demonstrated, proven process, or a potential process that has undergone laboratory trials or bench-scale testing.

Each technology and process option is screened initially based on technical implementability with respect to waste and site characteristics and screened secondarily based on a qualitative comparison of effectiveness, implementability, and relative cost. This step may eliminate a general response action from the alternatives screening process if there are no feasible technologies identified. The objective, however, is to retain the best technology types and process options within each general response action and to use them for developing remedial alternatives. The evaluation and screening of technology types and process options are presented in Table 3. The technologies and process options that are screened out based on technical implementability based on waste and site characteristics, effectiveness, implementability, and/or cost, are highlighted in the table.

As mentioned above, technology types and process options are secondarily screened in an evaluation process based on effectiveness, implementability, and relative cost. Effectiveness is considered the ability of the process option to perform as part of a comprehensive remedial plan to meet RAOs under the conditions and limitations present at the site. Additionally, the NCP defines effectiveness as the "degree to which an alternative reduces TMV through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." This is a relative measure for comparison of process options that perform the same or similar functions. Implementability refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed by the site. At this point, the cost criterion is comparative only, and similar to the effectiveness criterion, it is used to preclude further evaluation of process options that are very costly if there are other choices that perform similar functions with similar effectiveness. The cost criterion includes costs of construction and any long-term costs to operate and maintain technologies that are part of an alternative.

The NCP preference is for solutions that use treatment technologies to permanently reduce the TMV of hazardous substances. Available treatment processes are typically divided into the following technology types: physical, chemical, biological, and thermal, which are applied in one or more general response actions with varying results.

Table 3 presents the results of a qualitative comparison of technology types and process options available for remediation. The screening is intended to highlight the most important aspects of the technology relative to the screening criteria. The rationale for selecting these process options is indicated in Table 3.

TABLE 3
Remedial Technology Screening
OECI Focused Feasibility Study Report

				Initial Screening	Secondary Screening			
General Response Actions	**Remedial Technology**	**Process Options**	**Descriptions**	**Technical Implementability Based on Waste and Site Characteristics**	**Effectiveness**	**Implementability**	**Relative Cost Range**	**Screening Comment**
No Action	None	None	No action.	Technically implementable.	None.	Implementable.	Zero.	Required for comparison.
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property, source area, and/or downgradient groundwater exceeding the cleanup goals to restrict groundwater and land use.	Existing restrictions prevent new well installation.				
		Permits	Regulations promulgated to require a permit for various activities (i.e., installation of wells, etc.).	Existing permitting process is adequate to prevent new well installation.				
	Alternative Water Supply		Replacement of existing water supply wells with new water supply wells completed in deeper uncontaminated aquifer and sealed from cross connection to overlying contaminated groundwater.	Technically implementable.	Good. Deeper uncontaminated groundwater is available and new wells easily installed.	Implementable.	Moderate capital cost.	Retained.
	Monitoring		Monitoring is implemented to evaluate site conditions, concentration levels, and natural attenuation parameters.	Technically implementable.	Effective for evaluation of contaminant migration and trends over time.	Implementable.	Low.	Retained. Critical to monitor effectiveness of any action.
Containment	Vertical Barriers	Slurry wall, sheet piling, vibrating beam wall, grout curtains, etc.	Create a subsurface barrier to horizontal groundwater flow. Slurry wall constructed by excavating a trench around the contaminated area and filling with a bentonite slurry. For sheet piles, interlocking steel piles are driven into subsurface along the boundaries of the impacted area. For vibrating beam walls, vibratory force is used to advance a steel beam into the ground. A relatively thin wall of cement or bentonite is injected as the beam is withdrawn. For grout curtains, grout pressure-injected along contamination boundaries in a regular overlapping pattern of drilled holes.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO rather than containment.				
		Permeability Reduction Agents	Cement grout or organic polymer injected into the soil matrix to reduce permeability.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				
		Ground Freezing (Cryocell process)	Ground freezing technology is used to form a flow-impervious, removable, and fully monitored ice barrier that circumscribes the contaminant source in situ.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				
	Horizontal Barriers	Block Displacement	Controlled injection of slurry in notched injection holes produces a horizontal barrier beneath contamination.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				

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General Response Actions	**Remedial Technology**	**Process Options**	**Descriptions**	**Technical Implementability Based on Waste and Site Characteristics**	**Effectiveness**	**Implementability**	**Relative Cost Range**	**Screening Comment**
		Grout Injection	Grout pressure injected at depth through closely spaced drilled holes.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				
		Ground Freezing	Similar to vertical barriers by ground freezing.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				
		Liners	Liners placed to restrict vertical flow can be constructed of the same materials considered for cap construction.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				
In Situ Treatment	Chemical	Chemical Oxidation (ISCO)	Aqueous injection of oxidizing agents (peroxide/iron, permanganate, persulfate, or ozone) to promote abiotic in situ oxidation of chlorinated organic compounds.	Technically implementable.	Effective. Requires good contact between target contaminant and reagent.	Commercially available. Moderate health and safety concerns depending on oxidant selected. High organic content in groundwater would reduce efficiency.	Moderate to high. More costly than reductive processes because anaerobic groundwater would require much higher oxidant dosage to overcome the reducing environment. Oxidation is also not cost effective for low-concentration dissolved VOC plumes.	Not retained. Anaerobic reductive dechlorination processes are more suitable to the present reducing environment in groundwater.
		Chemical Reduction (ISCR)	Shallow soil mixing of reducing agents (zero-valent iron, hydrogen) to promote abiotic in situ reduction of chlorinated organic compounds.	Technically implementable.	Effective in treating site COCs. Most suitable as a source area treatment for high concentration groundwater.	Well-developed technology with minimal equipment requirements.	Considered to have good potential for cost-effectiveness for source zones but is costly for low concentration plumes.	Retained for further evaluation for groundwater.
		Permeable Reactive Barriers (Passive Treatment Walls)	Permeable treatment walls are installed across the flow path of impacted groundwater. As groundwater moves through the treatment wall, COCs are passively removed in the treatment zones by physical, chemical, and/or biological processes. At this site zero valent iron (ZVI) would be the reactive media to promote in situ reductive dechlorination.	Not technically implementable. Groundwater is a useable aquifer and restoration to drinking water standards is the RAO, rather than containment.				

TABLE 3
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General Response Actions	Remedial Technology	Process Options	Descriptions	Initial Screening: Technical Implementability Based on Waste and Site Characteristics	Secondary Screening: Effectiveness	Secondary Screening: Implementability	Secondary Screening: Relative Cost Range	Secondary Screening: Screening Comment
	Physical	In-well Air Stripping (Circulating Wells)	Groundwater is aerated and lifted within a well bore, re-infiltrates through a different strata of the formation, and creates groundwater circulation.	Technically implementable.	Effectiveness is reduced by poor development of circulation zones due to heterogeneities in aquifer permeability. Typically, in-well air stripping systems are a cost-effective approach for remediating VOC-contaminated ground water at sites with deep water tables because the water does not need to be brought to the surface. Operate more efficiently with horizontal conductivities greater that 10 to 3 cm/sec. Potential poor effectiveness as a result of low-permeability zones within silty-sand aquifer.	Requires close well spacing. High iron concentrations may result in fouling.	Moderate to high. Extensive system capital investment required relative to alternatives.	Not retained due to poor effectiveness and the potential for well screen fouling.
		Air Sparging	Air is injected into saturated media to remove COCs through volatilization. May also be used at lower air flow rates to promote biodegradation of petroleum VOCs. Often coupled with SVE for collection/treatment of displaced VOCs.	Technically implementable.	Potential poor effectiveness as a result of low permeability zones within silty-sand aquifer.	Requires close well spacing. High iron concentrations may result in fouling.	Low to moderate. Generally considered cost effective where applicable.	Not retained due to poor effectiveness and potential for well screen clogging. Also the shallow groundwater table makes the technology impractical.
		Dual phase extraction (DPE)	DPE is a technology that uses a high vacuum system to remove liquid (i.e., NAPL, contaminated groundwater) and soil vapor. The main purpose of the system is to lower the water table using high vacuum or groundwater pumping to expose the aquifer matrix to more rapid remediation via soil vapor extraction. Once above ground, the extracted vapors, liquid-phase organics, and/or groundwater are separated and treated.	Not technically implementable. Aquifer is too permeable to dewater.				
		Bioslurping	Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils. Vacuum-enhanced free-product recovery extracts LNAPLs from the capillary fringe and the water table.	Not technically implementable. Bioslurping is not applicable at sites such as OECI without LNAPL or aerobically biodegradable COCs.				

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		Pneumatic fracturing	High-pressure injection of air to create self-propped subsurface fracture patterns that minimize COC travel time via diffusion. Complements vapor and fluid extraction technologies. The fracturing extends and enlarges existing fissures and introduces new fractures, primarily in the horizontal direction.	Not needed because unconsolidated formations are of sufficient permeability and do not require fracturing.				
		Hydraulic fracturing	High-pressure injection of fluids, followed by granular slurry, to create subsurface fracture patterns that minimize COC travel time via diffusion. Complements vapor or fluid extraction technologies.	Not needed because unconsolidated formations are of sufficient permeability and do not require fracturing.				
		Hot Water or Steam Flushing/Stripping (i.e., Hydrous Pyrolysis/ Oxidation [HPO])	Steam is forced into an aquifer through injection wells Vaporized components rise to the unsaturated zone, where they are removed by vacuum extraction and treated.	Technically implementable.	Increases the rate of VOC removal. The process is applicable to shallow and deep contaminated areas, and readily available mobile equipment can be used.	Implementable though energy intensive and typically intended for high concentration areas.	Very high due to heating equipment and power requirements.	Not retained due to extensive heating and power requirements and excessive costs. Other processes are retained that are more suitable for high concentration source areas.
		Electrical Resistance Heating (ERH)	ERH is an electrical resistance heating technology that delivers separate electric phases through electrodes placed in a circle around a soil vent that promotes in situ generation of steam to vaporize target compounds. Vapors recovered in a SVE system and treated as needed to remove VOCs from air discharge.	Technically implementable.	Effective for treatment of VOCs in shallow soils.	Implementable. Requires that soils remain moist to ensure effective transfer of electricity and heat to aquifer.	High, power consumption costs vary.	Not retained due to extensive heating and power requirements and excessive costs. Other processes are retained that are more suitable for high concentration source areas.

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				Initial Screening	Secondary Screening			
General Response Actions	**Remedial Technology**	**Process Options**	**Descriptions**	**Technical Implementability Based on Waste and Site Characteristics**	**Effectiveness**	**Implementability**	**Relative Cost Range**	**Screening Comment**
		In-Situ Thermal Desorption (ISTD)	The aquifer is heated in situ with heating elements. The heating results in vaporization of water and constituents for collection by a heated vapor extraction well.	Technically implementable.	Effective for treatment of VOCs and SVOCs in soils and groundwater with low gradients.	Implementable. Requires accurate conceptual model to ensure heating elements are installed below contamination. Vapor migration outside of collection area is a concern.	High capital and O&M costs for equipment and power. If NAPL is recovered disposal and treatment costs increase.	Not retained due to extensive heating and power requirements and excessive costs. Other processes are retained that are more suitable for high concentration source areas.
		Dynamic Underground Stripping (DUS)	A combination of in-situ steam injection, electrical resistance heating and fluid extraction to enhance contaminant removal from the subsurface. Similar to Enhanced Soil Vapor Extraction, except that it also treats groundwater contamination.	Technically implementable.		Implementable. Treated soils can remain at elevated temperatures for years after cleanup stimulating regrowth of biological community. Soil venting can accelerate the cooling process.	Very high costs due to relatively extensive capital system requirements, but becomes more cost-effective in larger applications.	Not retained due to extensive heating and power requirements and excessive costs. Other processes are retained that are more suitable for high concentration source areas.
	Biological	Enhanced Reductive Dechlorination	Subsurface delivery of electron donors such as hydrogen, lactate, food-grade oils, corn syrup, etc. within the target zone to stimulate anaerobic biodegradation of dissolved phase chlorinated compounds by reductive dechlorination.	Technically implementable.	Very effective when used to enhance existing anaerobic conditions for remediation of CVOCs. May result in increases in daughter products such as cis-1,2-DCE and vinyl chloride, which could potentially result in impacts on nearby residential wells or Davy Creek. Effective for dissolved phase COCs not source area removal.	Implementable. Site-specific bench and/or pilot-scale testing recommended, relies on advective transport of amendments.	Low to Moderate Will in many cases be more cost-effective than aerobic process since maintenance of aerobic conditions is not required.	Retained for further evaluation for groundwater.

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General Response Actions	Remedial Technology	Process Options	Descriptions	Initial Screening: Technical Implementability Based on Waste and Site Characteristics	Secondary Screening: Effectiveness	Secondary Screening: Implementability	Secondary Screening: Relative Cost Range	Secondary Screening: Screening Comment
		Natural Attenuation	Monitoring is implemented to evaluate site conditions, concentration levels, and natural attenuation parameters. Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce concentrations to acceptable levels.	Technically implementable.	Good. Demonstrated to be occurring at the OECI site. Less generation or transfer of remediation wastes; less intrusive as few surface structures are required; natural attenuation may be used in conjunction with, or as a followup to, other (active) remedial measures; and overall cost will likely be lower than active remediation. Longer time frames may be required to achieve remediation objectives, compared to active remediation.	Good regulatory agency acceptance.	Generally, the lowest cost alternative where applicable. The most significant costs associated with natural attenuation are most often due to monitoring requirements.	Retained for further evaluation for groundwater.
		Phytoremediation	Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in ground water, surface water, and leachate. These mechanisms include enhanced rhizosphere biodegradation, hydraulic control, phyto-degradation and phyto-volatilization.	Not technically implementable. Not effective for remediating groundwater to depths needed at OECI.				
Groundwater Collection	Hydraulic	Vertical Wells	Conventional groundwater extraction is pumping in vertical wells. Other extraction device include vacuum enhanced recovery, jet-pumping systems, etc.	Technically implementable.	Widely used and demonstrated effectiveness.	Implementable.	Low. Least cost groundwater extraction technology.	Retained for further evaluation for groundwater.
		Horizontal Wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Technically implementable.	Widely used and demonstrated effectiveness. Increasingly applied technology for increasing production rate from low permeability sites, or to access areas inaccessible with vertical well technology.	Implementable.	Moderate. Significantly higher than vertical wells.	Not retained. Vertical wells have previously demonstrated effectiveness and access is sufficient.
		Drains	Underground gravel-filled trenches generally equipped with tile or perforated pipe are installed to collect groundwater.	Technically implementable.	Although they may be effective, drains are not suited to high permeability formations where extraction wells are more effective.	Implementable.	Moderate to high. May require long piping runs to transfer collected groundwater to treatment system or discharge point.	Not retained. Groundwater is more effectively removed from the high permeability aquifer materials using vertical wells.

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Remedial Technology Screening
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General Response Actions	Remedial Technology	Process Options	Descriptions	Initial Screening: Technical Implementability Based on Waste and Site Characteristics	Secondary Screening: Effectiveness	Secondary Screening: Implementability	Secondary Screening: Relative Cost Range	Secondary Screening: Screening Comment
		One-pass trenching	Trenches backfilled with granular material provide preferred flow path for collection in pipe or sump. Groundwater collection technique to increase production rate from low permeability areas.	Not technically implementable. Limited to depths of 25 feet or less. Unconsolidated geologic unit extends to 55 feet below ground surface.				
Ex Situ Treatment of Groundwater	Chemical	Chemical Oxidation (e.g., UV Oxidation)	Oxidizing agents are used to destroy organic contaminants in an ex situ reactor. Potential oxidizing agents are UV radiation, ozone, and/or hydrogen peroxide/ferrous iron, or permanganate.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Solar Detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight. Contaminants are mixed with a semiconductor catalyst (e.g., titanium dioxide), and fed through a reactor which is illuminated by sunlight. Ultraviolet light activates the catalyst, which results in the formation of reactive chemicals known as radicals. These radicals are powerful oxidizers that break down the contaminants into non-toxic byproducts such as carbon dioxide and water.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Chemical Reduction	Reducing agents (ZVI) are used to destroy organic contaminants in an ex situ reactor. For example, CVOCs are reduced to carbon dioxide and water.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Precipitation	This process transforms dissolved compounds into an insoluble solid, facilitating the compound's subsequent removal from the liquid phase by sedimentation or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation. It is used as a pretreatment process with other technologies (such as chemical oxidation or air stripping), where the presence of metals would interfere with treatment.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Ion Exchange	Ion exchange removes ions from the aqueous phase by the exchange of cations or anions between the contaminants and the exchange medium. Ion exchange materials may consist of resins made from synthetic organic materials that contain ionic functional groups to which exchangeable ions are attached. They also may be inorganic and natural polymeric materials. After the resin capacity has been exhausted, resins can be regenerated for reuse.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Hydrolysis	Destruction of contaminant through hydrolytic breakage of chemical bonds at elevated pH and high temperatures to aid in the breakage of chemical bonds.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				

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Remedial Technology Screening
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				Initial Screening	Secondary Screening			
General Response Actions	**Remedial Technology**	**Process Options**	**Descriptions**	**Technical Implementability Based on Waste and Site Characteristics**	**Effectiveness**	**Implementability**	**Relative Cost Range**	**Screening Comment**
	Physical Treatment	Separation	Separation processes seek to detach contaminants from their medium (i.e., groundwater and/or binding material that contain them). Ex situ separation of waste stream can be performed by many processes: (1) distillation, (2) filtration/ultrafiltration/microfiltration, (3) freeze crystallization, (4) membrane evaporation, and (5) reverse osmosis.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Liquid-Phase Carbon Adsorption	Liquid phase carbon adsorption is a full-scale technology in which ground water is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb. When the concentration of contaminants in the effluent from the bed exceeds a certain level, the carbon can be regenerated in place; removed and regenerated at an off-site facility; or removed and disposed. The two most common reactor configurations for carbon adsorption systems are the fixed bed and the pulsed or moving bed.	Technically implementable.	Existing air stripping followed by carbon adsorption has been effective.	Proven technology, previously used for treatment of groundwater. O&M costs may be high depending on system loading and resulting rate of carbon use.	Moderate to high. There are costs to regenerate and replace GAC. Costs are also lower at higher flow rates.	Retained for further evaluation for groundwater.
		Air Stripping	Air stripping is a full-scale technology in which volatile organics are partitioned from ground water by greatly increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Treatment of air emissions may be necessary.	Technically implementable.	Existing air stripping followed by carbon adsorption has been effective.	Implementable. O&M on the unit due to precipitation on the components. Air strippers are commercially available and widely used.	Moderate to high.	Retained for further evaluation for groundwater.
	Biological Treatment	Aerobic Cometabolic Bioremediation	Organics in wastewater oxidized through the use of a mixed culture of organisms in aerobic conditions. Bioreactor combines contaminants, inducers and electron acceptor (oxygen) to enhance aerobic biodegradation. Inducers serve as carbon sources that activate aerobic enzyme systems known to degrade CVOCs.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
		Anaerobic Bioremediation	Organics in wastewater oxidized through the use of a mixed culture of organisms in anaerobic conditions. Bioreactor containing contaminants and electron donors to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.	Existing air stripping and carbon adsorption system is available onsite and has been proven effective.				
Discharge of Groundwater	Wastewater discharge	Land Application	Liquid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized.	Not technically implementable. Poor effectiveness for CVOCs because they are not readily degradable aerobically.				

TABLE 3
Remedial Technology Screening
OECI Focused Feasibility Study Report

General Response Actions	Remedial Technology	Process Options	Descriptions	Initial Screening: Technical Implementability Based on Waste and Site Characteristics	Secondary Screening: Effectiveness	Secondary Screening: Implementability	Secondary Screening: Relative Cost Range	Secondary Screening: Screening Comment
		POTW	Aqueous streams are discharged to a POTW for treatment.	Not technically implementable based on POTW infrastructure not available in the site vicinity.				
		Surface Water	Discharge of treated groundwater to nearby surface water body. Existing perforated discharge pipe would be used.	Technically implementable.	Effective reuse of treated groundwater.	Implementable.	Low.	Retained for further evaluation for treated groundwater.
		Reinjection	Reinjection of treated groundwater to the aquifer upgradient or side-gradient to the impacted area.	Technically implementable.	Reinjection does not increase effectiveness significantly in high permeability aquifers such as that present at site.	Implementable. Reinjected water would likely be required to meet drinking water MCLs.	Moderate.	Not retained because it does not offer advantages relative to existing surface water discharge infrastructure and is more costly.
		Evaporation Ponds	Surface impounds are used to contain treated or untreated wastewater or groundwater until it evaporates.	Technically implementable	Ponds would have to be very large to accommodate flow rate and allow time for sufficient volatilization. Air emissions of VOCs would not be controlled.	Not likely to be implementable due to air emissions and large land requirement.	Moderate.	Not retained due to air emissions and land requirements.
Soil Removal	Excavation	Excavation	Excavation of soils can use ordinary construction equipment backhoes, bulldozers, and front-end loaders.	Most soil is not likely to exceed land use restrictions. Treatment of soil exceeding land use restrictions would be performed at cost at the landfill.	Very effective because limits of contamination can be determined during excavation.	Excavation combined with off-site disposal of VOC contaminated soil is well proven and readily implementable technology.	High costs for deep excavation.	Retained for further evaluation.
Ex Situ Treatment of Soil	Onsite Physical, Chemical, Thermal, and Biological Treatment	Varied, see description	Onsite treatment processes could include physical treatments such as, SVE, solidification, and soil washing; chemical treatment such as, chemical oxidation or thermal treatment incineration; and biological treatment such as, anaerobic composting or land farming.	Onsite treatment is not considered technically implementable due to close proximity of residences, potential for short term construction impacts, and high treatment costs associated with relatively small treatment volumes compared to offsite treatment options.				

TABLE 3
Remedial Technology Screening
OECI Focused Feasibility Study Report

				Initial Screening	Secondary Screening			
General Response Actions	**Remedial Technology**	**Process Options**	**Descriptions**	**Technical Implementability Based on Waste and Site Characteristics**	**Effectiveness**	**Implementability**	**Relative Cost Range**	**Screening Comment**
	Offsite Physical, Chemical, Thermal, and Biological Treatment	Varied, see description	Treatment processes available at landfills include treatments such as land treatment, incineration, and thermal desorption. Soil would be treated as needed to meet the land disposal requirements. For TCE treatment to the higher of 90% reduction or 60 mg/kg is required.	Most soil is not likely to exceed land disposal restrictions. Treatment of soil exceeding land disposal restrictions would be performed at cost at the landfill.	Good.	There are suitable landfills within the upper midwest area capable of performing treatment processes.	Moderate to high.	Retained for further evaluation.
Disposal of Soil	Landfill	Onsite Landfill	Construction of a landfill cell in accordance with Subtitle C standards for placement of soil.	The OECI site is not well suited due to the high water table and close proximity to residences. Not cost effective for small volumes of soil.				
		Offsite Hazardous Waste Landfill	Transport and dispose of soil in approved RCRA Subtitle C landfill.	Technically implementable.	Good.	There are suitable landfills within the upper midwest area, though distance to Subtitle C is relatively greater than distance to Subtitle D.	Moderate to high.	Retained for further evaluation.
		Offsite Non-Hazardous Waste Landfill	Transport and dispose of soil in approved Subtitle D landfill.	Technically implementable.	Good.	There are suitable landfills within relative proximity of the site.	Moderate.	Retained for further evaluation.

Note:
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.
Effectiveness is the ability to perform as part of an overall alternative that can meet the objective under conditions and limitations that exist onsite
Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the physical, regulatory, technical, and schedule constraints.
- *Relative cost is for comparative purposes only and it is judged relative to the other processes and technologies that perform similar functions.*

The response action and process options remaining following screening are included in Table 4 and are subject to refinement/revision based on further investigation findings, results of treatability studies, or recent technological developments.

TABLE 4
Response Action And Process Options Remaining Following Screening
OECI Focused Feasibility Study Report

Response Action	Remedial Technology	Process Option
No Action	None	None
Institutional Controls	Alternative Water Supply	None
	Monitoring	None
In Situ Treatment	Chemical	Chemical Reduction
	Biological	Enhanced Reductive Dechlorination
		Natural Attenuation
Collection of Groundwater	Hydraulic	Vertical Wells
Ex Situ Treatment of Groundwater	Physical	Carbon Adsorption Air Stripping
Discharge of Groundwater	Wastewater Discharge	Surface Water
Soil Removal	Excavation	Excavation
Ex Situ Treatment of Soil	Offsite Physical, Chemical, Thermal, and Biological	Varied
Disposal of Soil	Landfill	Offsite Hazardous Waste Landfill
		Offsite Non-Hazardous Waste Landfill

SECTION 4

Development of Alternatives

4.1 Introduction

The remedial technologies and process options that remained after screening for the groundwater media were assembled into a range of alternatives.

The specific details of the remedial components discussed for each alternative are intended to serve as representative examples to allow order-of-magnitude cost estimates. Other viable options within the same remedial technology that achieve the same objectives may be evaluated. The following sections provide rationale for development and a detailed description of each alternative.

4.2 Alternative Development

The developed remedial alternatives are summarized in Table 5. Five alternatives were developed to provide a range of remedial actions for the remaining site contamination. Each remaining technology was incorporated into at least one alternative.

Two combinations of technologies that were not developed into alternatives include the following:

- Substrate Injection for Reductive Dechlorination and MNA
- Substrate Injection for Reductive Dechlorination, Groundwater Extraction and Treatment, and Long-Term Monitoring

These combinations were not developed due to their inability to adequately address the RAOs. Each of these includes substrate injection as the primary means of treating the remaining source area. The most likely conceptual model for the remaining source area is that high concentrations of TCE are present in a low-permeability clay soil in the upper 7 to 10 feet of soil. Under this conceptual model injection into the source zone area would likely not be as effective as other suitable options because adequate distribution of the substrate is difficult to achieve in low-permeability clay zones. The validity of this conceptual model would be evaluated in a source zone delineation investigation as the initial phase for alternatives including active remediation. Additionally, a potential exists to increase human health risks with respect to the water supply wells or adversely affect Davy Creek as a result of migration of an increased flux of TCE degradation products following injection. The addition of pump and treat may address some of the concerns with the ability to draw the groundwater into the treatment system; however, with a source area remaining as a contributing factor to dissolved-phase VOCs, the timeframe for treatment would be extensive.

TABLE 5
Remedial Alternative Development

General Response Actions	Remedial Technology/ Process Option	1—No Further Action	2—MNA	3—Source Zone Removal/In Situ Treatment and MNA	4—Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment and Long-Term Monitoring	5—Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
No Action	None	x				
Institutional Controls	Alternative Water Supply					X (contingent)
	Monitoring		x	x	x	x
In Situ Treatment	Chemical Reduction (in situ chemical reduction)			x	x	
	Enhanced Reductive Dechlorination					x
	Natural Attenuation		x	x	x	x
Groundwater Collection	Vertical Wells				x	
Ex Situ Treatment of Groundwater	Liquid-Phase Carbon Adsorption				x	
	Air Stripping				x	
Groundwater Discharge	Surface Water				x	
Soil Removal	Excavation			x	x	x
Ex Situ Treatment of Soil	Offsite Physical, Chemical, Thermal, and Biological Treatment			x	x	x
Disposal of Soil	RCRA Subtitle C Landfill			x	x	x
	Subtitle D Landfill			x	x	x

4.3 Alternative Descriptions

4.3.1 Alternative 1—No Further Action

The objective of Alternative 1, the No Further Action alternative, is to provide a baseline for comparison to other alternatives, as required by the NCP. Alternative 1 does not include any further remedial action for groundwater. It does not include monitoring or other institutional controls.

4.3.2 Alternative 2—Monitored Natural Attenuation

The objective of Alternative 2 is to rely on natural attenuation for remediation of the groundwater plume and conduct compliance monitoring. The MNA program includes the ongoing natural in situ treatment of the VOC groundwater plume along with collection of natural attenuation parameters and VOC analysis for compliance monitoring as an institutional control.

Natural attenuation is the process by which contaminant concentrations are reduced by one or more factors including volatilization, dispersion, adsorption, and biodegradation. Based on the site groundwater data, anaerobic conditions conducive to biological reductive dechlorination of the site CVOCs are present in the groundwater. Natural attenuation parameters collected would be used to assess the degree of natural attenuation and allow estimates of the time necessary to reach PRGs.

The lateral extents of groundwater CVOC concentrations are shown on Figures 7 and 8. If compliance monitoring data of these concentrations indicate further expansion of the plume above remedial goals along with a potential for adverse effects on receptors, active restoration with one of the remaining alternatives (3, 4, or 5) would be implemented.

The objective of the monitoring program would be to collect natural attenuation parameters to evaluate biodegradation of the VOCs, collect sufficient information to track the lateral and vertical extent of the VOC contaminant plume (including groundwater migration to surface water in Davy Creek), and monitor changes in concentrations.

The existing groundwater monitoring network for Alternative 2 (Figure 9) is assumed to include shallow and deep monitoring wells at 10 and 9 locations, respectively. Additionally, it will include bedrock monitoring wells and water supply wells at 7 and 11 locations, respectively. The monitoring wells will be sampled annually and analyzed for VOCs and the following natural attenuation parameters:

- Alkalinity
- Dissolved oxygen
- Oxidation reduction potential
- Chloride
- Ethane
- Ethene
- Iron, total
- Iron, dissolved
- Manganese, total

- Manganese, dissolved
- Methane
- Nitrogen, nitrate (as N)
- pH
- Specific conductance
- Sulfate and sulfide
- Temperature
- Total organic carbon

A total of three surface water sampling locations would be monitored. The surface water samples would be collected annually and analyzed for VOCs.

4.3.3 Alternative 3—Source Zone Removal / In Situ Treatment and MNA

The objective of Alternative 3 is to target the source zone by either removal by excavation or in situ treatment by chemical reduction. In conjunction with one of these alternatives an MNA program, similar to that of Alternative 2, which includes natural attenuation and compliance monitoring of the VOC groundwater plume would be implemented.

Due to limited historical data regarding the potential source areas, delineation of the source areas will be conducted to characterize the vertical and horizontal extent of contamination in the southeast area of the site. Delineation will be conducted using membrane interface probe systems with soil grab samples for TCE by direct push technology as confirmation. Subsurface profiling using the membrane interface probe system will provide lithologic information and allow for continuous rapid field screening to determine the presence of VOCs in the unsaturated and saturated zones. Following the delineation activities, the information will be used to select the most appropriate remedial alternative to address the source zone contamination. For this reason, both source zone removal as well as source zone in situ treatment options have been retained and carried through the remaining alternatives.

Source zone removal includes excavation with readily available construction equipment followed by offsite disposal and ex situ treatment (if necessary) of excavated material. Based on waste characterization, disposal may be to an offsite hazardous waste landfill and/or an offsite non-hazardous waste landfill. Ex situ treatment of soil (if necessary) may include physical, chemical, thermal or biological treatment offsite at the landfill. The estimated target area for excavation to support development of the cost estimate is based primarily on a soil gas survey conducted during the RI (Figure 9). The total estimated volume of soil to be excavated based on available historic data is approximately 1,600 yd^3. Source zone excavation and offsite disposal would likely be chosen if significant soil contamination was limited to clays in the upper 10 feet of soil, and a relatively small percentage failed the TCLP limit of 0.5 milligrams per liter for TCE. Excavation and offsite treatment costs increase significantly for deeper soils or soils that require significant offsite treatment to meet LDRs prior to disposal. In these cases, the most cost-effective treatment is in situ chemical reduction.

Source zone in situ treatment includes chemical reduction using zero valent iron to promote abiotic in situ reduction of CVOCs in the source areas. The amendment would be delivered as a slurry via shallow in situ soil mixing of the target area (Figure 9). The total estimated volume of soil to be mixed in situ based on available historic data is approximately 1,600 yd^3.

Following either source zone removal or source zone in situ treatment, the MNA program for Alternative 3 is as described for Alternative 2.

4.3.4 Alternative 4—Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring

The objective of Alternative 4 is to target the source zone by either removal by excavation or in situ treatment by chemical reduction. One of these technologies would be followed by ex situ treatment of the VOC groundwater plume using groundwater extraction and treatment. A long-term monitoring program that includes natural attenuation and compliance monitoring of the VOC groundwater plume would be implemented concurrently to the other components of the alternative.

Removal of the VOC source zone or in situ treatment of the source zone, including delineation, is as described for Alternative 3.

Ex situ treatment of the VOC groundwater plume will be conducted using the existing groundwater extraction system available onsite. The goal of this treatment is to target the high-concentration dissolved phase VOCs remaining in the groundwater following removal or treatment of the source zone.

As previously discussed, in 1996, USEPA constructed a treatment system to treat groundwater extracted by five wells (Figure 2). The extraction system operated successfully until it was shut down in July 2004 because groundwater concentrations from the extraction wells were no longer decreasing with continued operation, or were decreasing at a very low rate. The system used pumping of vertical extraction wells followed by ex situ treatment of VOCs in groundwater via air stripping and carbon adsorption. Surface water discharge was completed by a NPDES permit through a perforated pipe to Davy Creek. The EWs installed to support the treatment system have since been abandoned. New extraction wells will be installed in targeted locations and connected to the existing underground piping system. Three wells will be placed near the source zone (near former EW-03, EW-04 and EW-05) to focus on the higher concentration VOC dissolved phase plume near the southeast portion of the site (Figure 9). Locations may be adjusted to optimize extraction and treatment, such as moving the former location of EW-03 southwest to target higher concentrations near well nest MW-105. It is assumed that all other components of the existing treatment system are operational. Costs have been included for startup to evaluate the system and replace some components if needed.

The groundwater extraction and treatment component of this alternative would continue extraction and treatment of the contaminated groundwater for a period of 5 years. This period is based on historic data that indicated concentrations rapidly decreased and then leveled off at approximately 5 years following a source removal. Further reductions to PRGs would be by natural attenuation.

The long-term monitoring program for Alternative 4 is as described for Alternative 2 with the addition of monitoring of three extraction wells for natural attenuation and compliance parameters.

4.3.5 Alternative 5—Source Zone Removal / In Situ Treatment, Substrate Injection and MNA

The objective of Alternative 5 is to target the source zone by either removal by excavation or in situ treatment by chemical reduction. One of these technologies would be followed by biological in situ treatment of the VOC groundwater plume using enhanced reductive dechlorination. An MNA program that includes natural attenuation and compliance monitoring of the VOC groundwater plume would be implemented concurrently with the other components of the alternative. An alternative water supply via installation of new residential water supply wells is included as a contingency in the event of an increase in concentration of COCs or degradation products above drinking water standards as a result of substrate injection.

Removal of the VOC source zone or in situ treatment of the source zone, including delineation, is as described for Alternative 3.

Biological in situ treatment will be conducted by enhanced reductive dechlorination with the subsurface delivery of electron donors such as hydrogen, lactate, food-grade oils, corn syrup, etc. within the target zone. The goal of this treatment is to stimulate anaerobic biodegradation of high concentration dissolved phase chlorinated compounds within the VOC groundwater plume. In the absence of oxygen (anaerobic conditions), the VOCs would be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate would be converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, nitrogen gas would ultimately be produced.

Several different types of food-grade substrate can potentially be used at the Site including soluble substrate (such as sodium lactate or high fructose corn syrup) or a low solubility/slow-release substrate (such as emulsified vegetable oil). Soluble substrates degrade quickly and have relatively short half lives. Therefore, they typically must be injected more frequently to obtain results similar to one injection of a slow-release substrate (CH2M HILL 2008). A slow-release substrate is recommended at the site for longer-term supplementation effects and was included for cost estimating purposes.

Enhanced reductive dechlorination implementation is assumed to include the one-time injection of emulsified vegetable oil into the shallow and deep unconsolidated layers of the aquifer. An aqueous solution of an estimated 2 percent substrate by volume will be prepared onsite and injected into a series of closely spaced, 2-inch-diameter temporary injection points installed to a depth of approximately 20 feet below ground surface.

Temporary injection points will be installed in a barrier configuration to use natural advective transport as the mechanism to bring dissolved contaminants into contact with the amendments and to be reductively dechlorinated. The points will be placed in a line perpendicular to the groundwater flow for the target treatment zone (Figure 10). Based on previous studies in similar geology, the injection spacing was estimated to occur on a 15-foot spacing (estimating a 7.5-foot radius of influence) (CH2M HILL 2008).

It is expected that only a portion of the dissolved phase contaminant mass will be treated within the injection area and that treatment will continue as the contaminant mass and associated degradation products are transported beyond the injection area. For this reason, a contingency for an alternative water supply is included with this alternative. This would include replacement of existing residential water supply wells with new water supply wells completed in the deeper uncontaminated aquifer and sealed from cross connection to overlying contaminated groundwater. This would be implemented if drinking water standards are exceeded in the existing residential water supply wells.

The MNA program for Alternative 5 is as described for Alternative 2.

SECTION 5

Detailed Analysis of Alternatives

5.1 Introduction

The detailed analysis of alternatives presents the relevant information needed to compare the remedial alternatives. This analysis follows the development of alternatives, precedes the selection of a remedy, and consists of the following components:

- A detailed evaluation of each individual alternative against seven National Oil and Hazardous Substances Pollution Contingency Plan (NCP) evaluation criteria
- A comparative evaluation of alternatives to one another with respect to the seven NCP evaluation criteria.

The detailed evaluation is presented in table format. The comparative evaluation is presented in text and highlights the most important factors that distinguish alternatives from each other. A cost estimate is included for each alternative in Appendix B. The selection of the remedy is conducted following the focused FS in the United States Environmental Protection Agency (USEPA) Record of Decision.

5.2 Evaluation Criteria

In accordance with the NCP, remedial actions must include the following:

- Be protective of human health and the environment
- Attain applicable or relevant and appropriate requirements (ARARs) or provide grounds for invoking a waiver of ARARs that cannot be achieved
- Be cost effective
- Utilize permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces toxicity, mobility, and volume (TMV) as a principal element

In addition, the NCP emphasizes long-term effectiveness and related considerations including:

- The long-term uncertainties associated with land disposal
- The goals, objectives, and requirements of the Solid Waste Disposal Act
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate
- The short- and long-term potential for adverse health effects from human exposure

- Long-term maintenance costs
- The potential for future remedial action costs if the selected remedial action fails
- The potential threat to human health and the environment associated with excavation, transportation, disposal, or containment

Provisions of the NCP require that each alternative be evaluated against nine criteria listed in 40 Code of Federal Regulations (CFR) 300.430(e)(9). The criteria were published in the March 8, 1990, *Federal Register* (55 FR 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately compare the alternatives and to select the most appropriate alternative for implementation at the site as a remedial action. The evaluation criteria include the following:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability—technical and administrative
- Cost
- State acceptance
- Community acceptance

The criteria are divided into three groups: threshold, balancing, and modifying criteria. Threshold criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—either they are met by a particular alternative, or that alternative is not considered acceptable. The two threshold criteria are overall protection of human health and the environment and compliance with ARARs. If ARARs cannot be met, a waiver may be obtained in situations where one of the six exceptions listed in the NCP occur (see 40 CFR 300.430 (f)(1)(ii)(C)(1 to 6).

Unlike the threshold criteria, the five balancing criteria weigh the trade-offs between alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The five balancing criteria include the following:

- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability—technical and administrative
- Cost

The modifying criteria are community and state acceptance, which are evaluated following public comment on the proposed plan and are used to modify the selection of the recommended alternative. The remaining seven evaluation criteria, encompassing both threshold and balancing criteria, are briefly described below.

5.2.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify that a waiver is appropriate.

Overall Protection of Human Health and the Environment

Protectiveness is the primary requirement that remedial actions must meet under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A remedy is protective if it adequately eliminates, reduces, or controls current and potential risks posed by the site through each exposure pathway. The assessment with respect to this criterion describes how the alternative achieves and maintains protection of human health and the environment.

Compliance with ARARs

Compliance with ARARs is one of the statutory requirements of remedy selection. ARARs are cleanup standards, standards of control, and other substantive environmental statutes or regulations that are either "applicable" or "relevant and appropriate" to the CERCLA cleanup action (42 United States Code [USC] 9621(d)(2)). Applicable requirements address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site. Relevant and appropriate requirements are those that while not applicable, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to environmental or technical factors at a particular site. The assessment with respect to this criterion describes how the alternative complies with ARARs or presents the rationale for waiving an ARAR. ARARs can be grouped into the following three categories:

- **Chemical-specific:** Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge.
- **Action-specific:** Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials.
- **Location-specific:** Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs.

The identification and analysis of the potential ARARs relative to the remediation of the OECI site were summarized in Section 2.1 and are provided in Appendix A.

5.2.2 Balancing Criteria

The five criteria listed below are used to weigh the trade-offs between alternatives.

Long-term Effectiveness and Permanence

This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the long term as well as in the short term. The assessment of alternatives with respect to this criterion evaluates the residual risks at a site after completing a remedial action or enacting a no-action alternative and includes evaluation of the adequacy and reliability of controls.

Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element. The assessment with respect to this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ and is specific to evaluating how treatment reduces TMV.

Short-term Effectiveness

This criterion addresses short-term impacts of the alternatives. The assessment with respect to this criterion examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until the response objectives have been met.

Implementability

The assessment with respect to this criterion evaluates the technical and administrative feasibility of the alternative and the availability of the goods and services needed to implement it.

Cost

Cost encompasses all engineering, construction, and operation and maintenance (O&M) costs incurred over the life of the project. The assessment with respect to this criterion is based on the estimated present worth of the costs for each alternative. Present worth is a method of evaluating expenditures such as construction and O&M that occur over different lengths of time. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. The present worth of a project represents the amount of money, which if invested in the initial year of the remedy and disbursed as needed, would be sufficient to cover all costs associated with the remedial action. Appendix B provides a breakdown of the cost estimate for each alternative.

The level of detail required to analyze each alternative with respect to the cost criteria depends on the nature and complexity of the site, the types of technologies and alternatives being considered, and other project-specific considerations. The analysis is conducted in sufficient detail to understand the significant aspects of each alternative and to identify the uncertainties associated with the evaluation.

The cost estimates presented for each alternative have been developed strictly for comparing the alternatives. The final costs of the project and the resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, the firm selected for final engineering design, and other variables; therefore, final project costs will vary from the cost estimates. Because of these factors, project feasibility and funding needs must be reviewed carefully before specific financial decisions are made or project budgets are established to help ensure proper project evaluation and adequate funding.

The cost estimates are order-of-magnitude estimates having an intended accuracy range of plus 50 to minus 30 percent. The range applies only to the alternatives as they are described in Section 4 and does not account for changes in the scope of the alternatives. Selection of specific technologies or processes to configure remedial alternatives is intended not to limit flexibility during remedial design, but to provide a basis for preparing cost estimates. The specific details of remedial actions and cost estimates would be refined during final design.

5.3 Detailed Analysis of Alternatives

5.3.1 Detailed Evaluation

The following alternatives were evaluated in detail using the seven evaluation criteria:

- Alternative 1—No Further Action
- Alternative 2—Monitored Natural Attenuation (MNA)
- Alternative 4—Source Zone Removal/In Situ Treatment and MNA
- Alternative 5—Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring
- Alternative 6—Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA

The detailed evaluations for these alternatives are presented in Table 6.

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
1. Overall Protection of Human Health and the Environment	▪ CVOCs will continue to persist in groundwater at concentrations exceeding MCLs/ESs onsite for decades with a potential for increased concentrations in the residential wells. ▪ The potential for future human exposure to contaminated groundwater via installation of new residential or other production wells within the plume or surrounding areas is minimal because well installation permits would not be granted for the affected area.	▪ CVOCs will continue to persist in groundwater at concentrations exceeding MCLs/ESs onsite with a potential for increased concentrations in the residential wells. ▪ The potential for future human exposure to contaminated groundwater via installation of new residential or other production wells within the plume or surrounding areas is minimal because well installation permits would not be granted for the affected area. ▪ Under this alternative, the monitoring will be required to be in effect for decades.	▪ This alternative actively reduces the concentrations of CVOCs in groundwater in potential source areas, thus reducing the timeframe to meet the MCLs/ESs. ▪ Treats both dissolved and adsorbed phases of contamination. Relatively small hot spots of high adsorbed and dissolved phase CVOCs can be successfully treated. ▪ MNA will be utilized for the CVOC plume. ▪ The potential for future human exposure to contaminated groundwater will be minimized through source removal/in situ treatment and compliance and MNA monitoring. ▪ Under this alternative, the monitoring will be required to be in effect for an estimated 15 years to achieve MCLs/ESs.	▪ This alternative actively reduces the concentrations of CVOCs in groundwater in potential source areas, thus reducing the timeframe to meet the MCLs/ESs. ▪ Treats both dissolved and adsorbed phases of contamination. Relatively small hot spots of high adsorbed and dissolved phase CVOCs can be successfully treated. ▪ Groundwater extraction and treatment has demonstrated effectiveness in reduction of CVOC concentrations via extraction and ex situ groundwater treatment when implemented following source removal/treatment. Based on previous extraction and treatment, once the source has been removed/treated it is estimated that approximately 5 years will be needed to reduce VOCs to MCLs/ESs. ▪ Long-term monitoring will be used for the CVOC plume. ▪ The potential for future human exposure to contaminated groundwater will be minimized through source removal/in situ treatment, extraction and treatment of groundwater, and long-term monitoring. ▪ Under this alternative, the monitoring will be required to be in effect for an estimated 5 years to achieve MCLs/ESs.	▪ This alternative actively reduces the concentrations of CVOCs in groundwater in potential source areas, thus reducing the timeframe to meet the MCLs/ESs. ▪ Treats both dissolved and adsorbed phases of contamination. Relatively small hot spots of high adsorbed and dissolved phase CVOCs can be successfully treated. ▪ Substrate injection has demonstrated effectiveness in reduction of residual adsorbed and dissolved phase CVOC concentrations. ▪ An alternative water supply via installation of new residential water supply wells in a deeper uncontaminated aquifer sealed off from cross connection is included as a contingency in the event of an increase in concentration of COCs or degradation products above drinking water standards due to substrate injection. ▪ MNA will be used for the CVOC plume. ▪ The potential for future human exposure to contaminated groundwater will be minimized through source removal/in situ treatment, substrate injection, new well installation (if needed), and compliance and MNA monitoring. ▪ Substrate injection will increase the concentrations of daughter products such as cis-1,2-DCE and vinyl chloride. These, in turn, are expected to increase in concentration in Davy Creek under this alternative. Though they are not expected to exceed surface water standards; monitoring will be important to evaluate impacts on ecological receptors under this alternative. ▪ Under this alternative, the monitoring will be required to be in effect for an estimated 5 years to achieve MCLs/ESs.

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
2. Compliance with ARARs	▪ Would meet ARARs when CVOCs in groundwater do not result in concentrations that exceed groundwater MCLs/ESs. Under this alternative, this could take decades. ▪ Does not meet ARARs because the NCP requirement to achieve MCLs in a reasonable time frame cannot be determined due to the lack of monitoring.	▪ Would meet ARARs when CVOCs in groundwater do not result in concentrations that exceed groundwater MCLs/ESs. Under this alternative, this could take decades.	▪ Must meet substantive requirements for air pollution control during excavation or in situ treatment. ▪ Requires proper protection of streams, wetlands, and other water bodies during construction. ▪ Would meet ARARs when CVOCs in groundwater do not result in concentrations that exceed groundwater MCLs/ESs. ▪ RCRA regulations for non-hazardous disposal of solid waste or characteristically hazardous waste would be met for excavation and disposal of contaminated soil in the source zone, where applicable.	▪ Must meet substantive requirements for air pollution control during excavation or in situ treatment. ▪ Requires proper protection of streams, wetlands, and other water bodies during construction. ▪ Would meet ARARs when CVOCs in groundwater do not result in concentrations that exceed groundwater MCLs/ESs. ▪ RCRA regulations for non-hazardous disposal of solid waste or characteristically hazardous waste would be met for excavation and disposal of contaminated soil in the source zone, where applicable. ▪ Extraction is expected to continue for 5 years under this alternative with concurrent long-term monitoring. ▪ The substantive requirements for a permit for discharge of treated groundwater, where applicable, would be met prior to implementation of this alternative.	▪ Must meet substantive requirements for air pollution control during excavation or in situ treatment. ▪ Requires proper protection of streams, wetlands, and other water bodies during construction. ▪ Would meet ARARs when CVOCs in groundwater do not result in concentrations that exceed groundwater MCLs/ESs. ▪ RCRA regulations for non-hazardous disposal of solid waste or characteristically hazardous waste would be met for excavation and disposal of contaminated soil in the source zone, where applicable. ▪ Substrate injection is expected to be on a one-time basis for reduction of the residual adsorbed and dissolved phase VOCs. ▪ The substantive requirements for an injection permit would be met prior to implementation of this alternative.
3. Long-Term Effectiveness and Permanence					
(a) Magnitude of residual risks	▪ No significant change in risk because no action taken. Reduction in risk relating to CVOC contamination in groundwater exceeding groundwater MCLs/ESs would occur very slowly over decades.	▪ No significant change in risk because no action taken. Reduction in risk relating to CVOC contamination in groundwater exceeding groundwater MCLs/ESs would occur very slowly over decades.	▪ Excavation or in situ chemical reduction will treat the source zone area. Residual risks related to contaminated groundwater exceeding MCLs/ESs and potential future human exposure to contaminated groundwater will remain following removal/in situ treatment but the monitoring time frame will be reduced compared to Alternatives 1 and 2.	▪ Excavation or in situ chemical reduction will treat the source zone area. Residual risks related to contaminated groundwater exceeding MCLs/ESs and potential future human exposure to contaminated groundwater will remain following removal/in situ treatment but the monitoring time frame will be reduced compared to Alternatives 1, 2, and 3. ▪ Effectiveness is enhanced because the extraction and treatment of groundwater has demonstrated effectiveness in reduction of residual dissolved phase VOC concentrations. Additionally, extraction will draw groundwater away from potential human receptors.	▪ Excavation or in situ chemical reduction will treat the source zone area. Residual risks related to contaminated groundwater exceeding MCLs/ESs and potential future human exposure to contaminated groundwater will remain following removal/in situ treatment but the monitoring time frame will be reduced compared to Alternatives 1, 2, and 3. ▪ Effectiveness is enhanced because the biological substrate is soluble and can be transported by groundwater to downgradient areas requiring treatment. Adequate distribution of the substrate to all areas of the groundwater plume, especially in areas of lower permeability, though is difficult to achieve. ▪ Risks related to potential future human exposure to contaminated groundwater are significantly reduced because new residential water supply wells would be installed if drinking water standards are exceeded.

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
(b) Adequacy and reliability of controls	▪ Not applicable.	▪ Requires reliance on groundwater and surface water monitoring activities and maintenance of the monitoring system network. The reliability of the system network is expected to be good if properly maintained. Reliance on this monitoring will be necessary for decades under this alternative.	▪ Requires reliance on groundwater and surface water monitoring activities and maintenance of the monitoring system network. The reliability of the system network is expected to be good if properly maintained. Reliance on this monitoring may be needed for 15 years.	▪ Requires reliance on groundwater and surface water monitoring activities and maintenance of the monitoring system network. The reliability of the system network is expected to be good if properly maintained. Reliance on this monitoring may be needed for 5 years.	▪ Requires reliance on groundwater and surface water monitoring activities and maintenance of the monitoring system network. The reliability of the system network is expected to be good if properly maintained. Reliance on this monitoring may be needed for 5 years. ▪ Adequacy of controls is increased with installation of new residential water supply wells (if needed).
4. Reduction of Toxicity, Mobility, or Volume through Treatment					
(a) Treatment process used	▪ Not applicable.	▪ Natural attenuation only.	▪ Groundwater CVOC concentrations in the potential source area and contributions to the dissolved phase plume are reduced via source zone removal or in situ treatment. Excavated soils exceeding TCLP would likely be treated prior to land filling to meet LDRs. In situ treatment would be by reductive dechlorination through shallow soil mixing of zero valent iron (ZVI). ▪ Remaining residual dissolved phase VOC concentrations are reduced via natural attenuation.	▪ Groundwater CVOC concentrations in the potential source area and contributions to the dissolved phase plume are reduced via source zone removal or in situ treatment. Excavated soils exceeding TCLP would likely be treated prior to land filling to meet LDRs. In situ treatment would be by reductive dechlorination through shallow soil mixing of zero valent iron (ZVI). ▪ This alternative will extract groundwater in the highest concentration areas of the dissolved phase plume and pump the water to the onsite treatment system. The onsite treatment system will remove CVOCs using air stripping and carbon adsorption. ▪ Remaining residual dissolved phase VOC concentrations are reduced via extraction and treatment and natural attenuation.	▪ Groundwater CVOC concentrations in the potential source area and contributions to the dissolved phase plume are reduced via source zone removal or in situ treatment. Excavated soils exceeding TCLP would likely be treated prior to land filling to meet LDRs. In situ treatment would be by reductive dechlorination through shallow soil mixing of zero valent iron (ZVI). ▪ CVOC concentrations in the groundwater plume are reduced as the native biomass is enhanced. Reductions in CVOC concentrations take place through biologically accelerated reductive dechlorination. ▪ Remaining residual dissolved phase VOC concentrations are reduced via natural attenuation.
(b) Degree and quantity of TMV reduction through Treatment	▪ Not applicable.	▪ Reduction of an unknown source zone CVOC mass and an estimated 80 pounds of CVOCs in the groundwater plume to MCLs/ESs using natural attenuation alone would take decades.	▪ Essentially all of an estimated 80 pounds of CVOCs in the groundwater plume will be removed through natural attenuation following source zone removal/in situ treatment.	▪ Essentially all of an estimated 80 pounds of CVOCs in the groundwater plume will be removed through collection and treatment along with natural attenuation following source zone removal/in situ treatment. ▪ Contaminated groundwater near the source zone and highest concentrated areas will be collected and treated. Approximately 99% of CVOCs extracted will be destroyed.	▪ Essentially all of an estimated 80 pounds of CVOCs in the groundwater plume will be removed through natural attenuation and substrate injection following source zone removal/in situ treatment. ▪ Contaminated groundwater near the source zone and highest concentrated areas would be partially to completely dechlorinated as groundwater came into contact with the treatment zones and is transported downgradient. In situ treatment via substrate injection may remove the majority of the dissolved and adsorbed mass in the groundwater plume while the remainder will naturally attenuate.

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
(c) Irreversibility of TMV reduction	• Not applicable.	▪ Natural degradation of CVOCs is irreversible.	▪ Chemical reduction and accelerated biodegradation of the CVOCs are irreversible. ▪ Natural degradation of CVOCs is irreversible.	▪ Chemical reduction and accelerated biodegradation of the CVOCs are irreversible. ▪ Activated carbon removes the VOCs from the extracted groundwater by adsorption, which is reversible. However activated carbon will be re-generated through incineration which destroys the CVOCs and is irreversible. ▪ Natural degradation of CVOCs is irreversible.	▪ Chemical reduction and accelerated biodegradation of the CVOCs are irreversible. ▪ Biological enhancement of reductive dechlorination is irreversible. ▪ Natural degradation of CVOCs is irreversible.
(d) Type and quantity of treatment residuals	▪ None, because no treatment included.	▪ None.	▪ None.	▪ About 4,000 pounds per year of granular activated carbon is generated as a result of treatment.	▪ Substrate injection results in increased mobilization of naturally occurring iron. ▪ Substrate injection will increase the concentrations of daughter products such as cis-1,2-DCE and vinyl chloride. These may discharge to Davy Creek prior to complete degradation.
(e) Statutory preference for treatment as a principal element	▪ Preference not met for groundwater because no treatment included.	▪ Preference not met for groundwater because no treatment beyond natural attenuation included.	▪ Preference met under either excavation and treatment of hazardous waste soil at the landfill or in situ treatment onsite.	▪ Preference met under either excavation and treatment of hazardous waste soil at the landfill or in situ treatment onsite. ▪ Preference met for groundwater because treatment occurs at the onsite treatment plant.	▪ Preference met under either excavation and treatment of hazardous waste soil at the landfill or in situ treatment onsite. ▪ Preference met for groundwater because treatment occurs in situ.
5. Short-Term Effectiveness					

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
(a) Protection of workers during remedial action	▪ No remedial construction, so no risks to workers.	▪ No risks to workers during MNA monitoring.	▪ Excavation of soil could result in potential exposure of workers via inhalation. ▪ Though excavation is preferred, if contamination extends too deep for cost effective excavation, in situ treatment may be performed. If so, risks to workers during in situ treatment (soil mixing) are present as a result of the potential generation and accumulation of hydrogen gas. Accumulation of hydrogen will be monitored to prevent explosive conditions in and near the mix areas. ▪ Proper health and safety procedures such as air monitoring and additional measures such as use of non-sparking tools near the mix areas would be included in the Health and Safety Plan for construction. ▪ No risks to workers during MNA monitoring.	▪ Excavation of soil could result in potential exposure of workers via inhalation. ▪ Though excavation is preferred, if contamination extends too deep for cost effective excavation, in situ treatment may be performed. If so, risks to workers during in situ treatment (soil mixing) are present as a result of the potential generation and accumulation of hydrogen gas. Accumulation of hydrogen will be monitored to prevent explosive conditions in and near the mix areas. ▪ Proper health and safety procedures such as air monitoring and additional measures such as use of non-sparking tools near the mix areas would be included in the Health and Safety Plan for construction. ▪ Minimal risks to workers during extraction well installation or operation of the treatment system. Proper health and safety procedures must be followed during construction and operation. ▪ No risks to workers during long-term monitoring.	▪ Excavation of soil could result in potential exposure of workers via inhalation. ▪ Though excavation is preferred, if contamination extends too deep for cost effective excavation, in situ treatment may be performed. If so, risks to workers during in situ treatment (soil mixing) are present as a result of the potential generation and accumulation of hydrogen gas. Accumulation of hydrogen will be monitored to prevent explosive conditions in and near the mix areas. ▪ Proper health and safety procedures such as air monitoring and additional measures such as use of non-sparking tools near the mix areas would be included in the Health and Safety Plan for construction. ▪ Minimal risks to workers related to general construction safety during injection and new water supply well installation activities (if needed). ▪ No risks to workers during MNA monitoring.
(b) Protection of community during remedial action	▪ No remedial construction, so no short-term risks to community.	▪ No remedial construction, so no short-term risks to community. ▪ Periodic groundwater and surface water sampling do not pose risk to the community.	▪ Minimal risks to the community during excavation or in situ treatment activities. The primary area of construction is the southeast portion of the site, opposite of the residential area. Access for trucks hauling equipment and soil during construction is primarily independent of the residential area. ▪ Dust emissions are expected during excavation activities. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ Periodic groundwater and surface water sampling do not pose risk to the community.	▪ Minimal risks to the community during excavation, in situ treatment, or extraction well installation activities. The primary area of construction is the southeast portion of the site, opposite of the residential area. Access for trucks hauling equipment and soil during construction is primarily independent of the residential area. ▪ Dust emissions are expected during excavation activities. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ No risks to the community during operation of the groundwater extraction and treatment system since it is installed primarily inside the building. • Periodic groundwater and surface water sampling does not pose risk to the community.	▪ Minimal risks to the community during excavation or in situ treatment activities. The primary area of construction is the southeast portion of the site, opposite of the residential area. Access for trucks hauling equipment and soil during construction is primarily independent of the residential area. ▪ Dust emissions are expected during excavation activities. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ No risks to community during injection activities. ▪ Minimal risks to the community during new water supply well installation activities (if needed). • Periodic groundwater and surface water sampling does not pose risk to the community.

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts.	▪ No remedial construction, so no environmental impacts.	▪ Excavation related environmental impacts may include dust and erosion. Impacts may be controlled through use of dust suppressants and implementation of an erosion control plan. ▪ Soil mixing of ZVI results in reducing conditions in the groundwater and elevated levels of iron and manganese. The addition of bentonite to the soil mix though decreases permeability significantly and limits the effect on the more permeable aquifer. ▪ Minimal areas of the ground surface will be disturbed. The facility is currently not operating and all areas will be restored following construction activities.	▪ Excavation related environmental impacts may include dust and erosion. Impacts may be controlled through use of dust suppressants and implementation of an erosion control plan. ▪ Soil mixing of ZVI results in reducing conditions in the groundwater and elevated levels of iron and manganese. The addition of bentonite to the soil mix though decreases permeability significantly and limits the effect on the more permeable aquifer. ▪ Minimal areas of the ground surface will be disturbed. The facility is currently not operating and all areas will be restored following construction activities. ▪ Ecological damage from installation of temporary roadway and extraction well near the wetlands area will be mitigated by planting to re-establish the native flora. ▪ No environmental impacts during operations of the groundwater extraction and treatment system. Onsite discharge to Davy Creek would meet all discharge limits to prevent risks to human health and aquatic life.	▪ Excavation related environmental impacts may include dust and erosion. Impacts may be controlled through use of dust suppressants and implementation of an erosion control plan. ▪ Soil mixing of ZVI results in reducing conditions in the groundwater and elevated levels of iron and manganese. The addition of bentonite to the soil mix though decreases permeability significantly and limits the effect on the more permeable aquifer. ▪ Minimal areas of the ground surface will be disturbed. The facility is currently not operating and all areas will be restored following construction activities. ▪ Injection of biological substrates into the permeable aquifer results in reducing conditions in the groundwater and elevated levels of iron and manganese. The increased dissolved iron may produce an orange-brown iron precipitate as it discharges to Davy Creek. ▪ Substrate injection will increase the concentrations of daughter products such as cis-1,2-DCE and vinyl chloride. These in turn are expected to increase in concentration in Davy Creek under this alternative. Though they are not expected to exceed surface water standards, monitoring will be important to evaluate impacts on ecological receptors under this alternative.
(d) Time until RAOs are achieved	▪ Long-term attainment of groundwater and surface water RAOs will take decades to meet under this alternative. Estimated to require 50 years.	▪ Long-term attainment of groundwater and surface water RAOs will take decades to meet under this alternative. Estimated to require 50 years.	▪ Attainment of groundwater and surface water RAOs will require an estimated 15 years.	▪ Attainment of groundwater and surface water RAOs will require an estimated 5 years.	▪ Attainment of groundwater and surface water RAOs will require an estimated 5 years.
6. Implementability					
(a) Technical feasibility	▪ No impediments.	▪ No impediments.	▪ No impediments are expected.	▪ No impediments are expected.	▪ Pilot testing to establish effectiveness and dosage of amendment may be necessary.
(b) Administrative feasibility	▪ No impediments.	▪ No impediments.	▪ No impediments are expected.	▪ No impediments are expected. ▪ The substantive requirements for a discharge to Davy Creek will be met, where applicable. No impediments are expected based on previous operation and discharge of the onsite groundwater treatment system.	▪ No impediments are expected.

TABLE 6
Detailed Evaluation of Alternatives

Detailed Evaluation Criterion	Alternative 1 No Further Action	Alternative 2 MNA	Alternative 3 Source Zone Removal/In Situ Treatment and MNA	Alternative 4 Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long-Term Monitoring	Alternative 5 Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
(c) Availability of services and materials	▪ None needed.	▪ None needed.	▪ Necessary engineering services and materials readily available for source zone removal or in situ treatment.	▪ Necessary engineering services and materials readily available for source zone removal or in situ treatment and installation and operation of pump and treat system.	▪ Necessary engineering services and materials readily available for source zone removal or in situ treatment, installation of substrate injection, and installation of new residential water supply wells (if needed).
7. Total Cost	Total Capital Cost $0 Annual O&M Cost $0 Total Periodic Cost $150,000 Total Present Worth Cost $77,000	Total Capital Cost $0 Annual O&M Cost $45,000 Total Periodic Cost $150,000 Total Present Worth Cost $1,300,000	Total Capital Cost $620,000 Annual O&M Cost $45,000 Total Periodic Cost $45,000 Total Present Worth Cost $1,200,000	Total Capital Cost $870,000 Annual O&M Cost $280,000 Total Periodic Cost $15,000 Total Present Worth Cost $2,200,000	Total Capital Cost $760,000 Annual O&M Cost $45,000 Total Periodic Cost $15,000 Total Present Worth Cost $980,000

5.3.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The RAOs for remediation of groundwater at the OECI site include the following:

- Prevention of future residential exposure to groundwater that exceeds federal maximum contaminant levels (MCLs) or Wisconsin State Enforcement Standards (ESs).
- Restoration of groundwater exceeding federal MCLs and Wisconsin State ESs in a reasonable timeframe given the site-specific circumstances.

The RAO for potential future affects on surface water includes the prevention of future adverse affects to ecological receptors as a result of groundwater discharge to surface water of Davy Creek.

The No Further Action Alternative is not considered protective of human health and the environment because it does not include groundwater or surface water monitoring.
A potential for future risk above federal MCLs or Wisconsin State ESs from residential exposure to groundwater onsite exists as a result of potential increasing concentrations in water supply wells.

The remaining alternatives are considered protective of public health and the environment because they all include, at a minimum, groundwater monitoring for compliance and to verify natural attenuation is occurring. The differences between alternatives in how they achieve protectiveness are discussed under the balancing criteria.

A summary of the overall protectiveness of the alternatives is in the table below.

Overall Protection of Human Health and the Environment

Does Not Meet Criteria	Meets Criteria
1	2, 3,4, 5

Compliance with ARARs

Appendix A presents a compilation of all the state and federal chemical-specific, action-specific, and location-specific ARARs considered for the OECI site. With the exception of the No Further Action Alternative, all remedial alternatives would meet ARARs. None of the alternatives are expected to reach the MCLs/ESs during the active phase of the treatment process because of the adsorbed and dissolved phase chlorinated volatile organic compounds (CVOCs) in the residual plume. As a result, all rely on MNA to eventually reach the MCLs/ESs. The active treatment alternatives that include source zone removal/in situ treatment (Alternatives 3, 4, and 5) are expected to reduce the mass of CVOCs in the aquifer much more rapidly than MNA of Alternative 2.

Additionally, the alternatives must meet the substantive requirements for air pollution control during excavation or in situ treatment and Resource Conservation and Recovery Act of 1976 regulations for non-hazardous disposal of solid waste or characteristically hazardous waste, where applicable. For Alternatives 4 and 5, respectively, the substantive requirements for obtaining a discharge of treated groundwater permit or an injection permit would be met. A summary of the compliance with ARARs is in the table below.

Compliance with ARARs

Does Not Meet Criteria	Meets Criteria
1	2, 3, 4, 5

Long-term Effectiveness and Permanence

The long-term effectiveness and permanence of the active treatment alternatives that include source zone removal/in situ treatment (Alternatives 3, 4, and 5) exceed the effectiveness and permanence of Alternatives 1 and 2 because they include active treatment of source zone CVOCs contributing to the groundwater plume. Active treatment contributes to achieving the RAOs by reducing a continuing source of dissolved-phase CVOCs to the groundwater in the southeast portion of the site.

Alternative 3 has a somewhat lower long-term effectiveness compared to Alternatives 4 and 5 because it relies on MNA only after source zone removal/in situ treatment for further reduction of CVOCs in the dissolved-phase groundwater plume. Under this alternative, the monitoring will be required to be in effect for an estimated 15 years to reach MCLs/ESs.

Alternatives 4 and 5 have similar long-term effectiveness, each requiring about 5 years to reduce CVOC concentrations in the groundwater to MCLs/ESs. Alternative 4 includes extraction of contaminated groundwater in the vicinity of the highest concentrations of CVOCs and treatment using an existing onsite system containing air stripping and carbon adsorption. Groundwater extraction and treatment has demonstrated effectiveness in reduction of CVOC concentrations following source removal/treatment and is estimated to operate for approximately 5 years to reach MCLs/ESs.

Alternative 5 includes injection of biological amendments resulting in enhancement of the natural reductive dechlorination process of the adsorbed and dissolved phases CVOCs. The biological amendment is soluble and can be transported by groundwater to downgradient areas requiring treatment, though adequate distribution within areas of lower permeability is difficult to achieve resulting in diminished effectiveness in those areas. Substrate injection will also increase concentrations of daughter products such as cis-1,2-DCE and vinyl chloride, which may increase in concentration in Davy Creek. They are not expected to exceed standards, and monitoring of surface water is included in the MNA program. This alternative also includes, as a contingency, the installation of new residential water supply wells in a deeper, uncontaminated aquifer in the event of an increase in concentration of COCs or degradation products above drinking water standards due to substrate injection.

No Further Action (Alternative 1) and MNA (Alternative 2) are similar in their long-term effectiveness and permanence; however, the adequacy of controls is higher for MNA. Both alternatives are significantly less effective and permanent than Alternatives 3, 4, and 5 since natural processes are the only technology relied on to reduce the concentrations of CVOCs and these processes will take many decades to return groundwater to MCLs/ESs.

A summary of the relative ranking of alternatives is in the table below.

Long-term Effectiveness and Permanence
Relative Ranking from Lowest to Highest

Lowest 0	1	2	3	Highest 4
1	2		3	4, 5

Reduction of TMV through Treatment

Alternatives 3, 4, and 5provide the greatest and most immediate reduction of CVOC source zone TMV. The excavation of the source area and subsequent treatment to meet land disposal restrictions is the preferred method of source zone removal if contamination is relatively shallow. If excavation costs are particularly high because of the presence of deeper contamination, in situ treatment using zero-valent iron will be performed. In either case these alternatives are estimated to essentially eliminate the source zone contributing to the groundwater plume based on review of historic site information. The mass of CVOCs in the source zone is unknown at this time, but would be determined during a predesign investigation.

There is an estimated 80 pounds of CVOCs in the groundwater plume downgradient of the source area. Alternatives 4 and 5 reduce the volume and mass of CVOCs in the groundwater plume more immediately than Alternative 3 and are anticipated to require the least amount of time to achieve a measurable reduction in TMV. However, all three alternatives remove essentially all estimated 80 pounds of CVOC mass in the plume following source zone removal/in situ treatment over time.

Alternative 2 relies on MNA only and the reduction of an unknown source-zone CVOC mass in addition to the estimated 80 pounds of CVOCs in the groundwater plume. MNA of the source zone and groundwater will take decades longer than Alternatives 3, 4, and 5.

Alternative 1 does not include treatment of the CVOC source zone or groundwater plume and does not meet the statutory preference for treatment.

A summary of the relative ranking of alternatives is in the table below.

Reduction of Toxicity, Mobility, and Volume through Treatment
Relative Ranking from Lowest to Highest

Lowest 0	1	2	3	Highest 4
1	2		3	4, 5

Short-term Effectiveness

There are no additional risks to the workers, the community, or the environment during the remedial action of Alternative 1 (No Further Action) and Alternative 2 (MNA) because no remedial construction is undertaken.

Alternatives 3, 4, and 5 have relatively minor risks to workers that can be mitigated through proper health and safety procedures. The risks are related to the potential contaminant exposure by inhalation during excavation or potential generation and accumulation of hydrogen gas during in situ soil mixing. To mitigate the risks, proper health and safety procedures such as air monitoring and use of non-sparking tools near the mix areas will be included in the Health and Safety Plan for construction.

Alternatives 3, 4, and 5 have minimal risks to the community related to general construction activities and dust emissions expected during excavation. Based on the location of the primary area for construction, to the southeast of the site away from the residential area, sufficient access to minimize risk should be available for general construction activities. For all alternatives, air monitoring and control measures would be implemented to control emissions and protect the community.

Alternatives 3, 4, and 5 have similar environmental impacts related to source zone removal/in situ treatment such as dust and erosion and elevated levels of iron and manganese in the groundwater as a result of reducing conditions from soil mixing. Impacts may be mitigated using dust suppressants and implementation of an erosion control plan. The addition of bentonite to the soil mix area would reduce permeability and limit the effect of elevated iron and manganese on the more permeable aquifer. Additional environmental impacts associated with Alternative 4 are due to the construction required for a temporary roadway and extraction well near the wetland area. For Alternative 5, injection of substrate into the aquifer results in reducing conditions that may elevate levels of iron and manganese and increase concentrations of daughter products such as cis-1,2-Dichloroethene and vinyl chloride. However, the discharge of iron and daughter products is not expected to adversely impact aquatic life in Davy Creek.

The short-term effectiveness with respect to the time until the RAOs are achieved is shortest for the Alternatives 4 and 5 because these alternatives actively reduce the mass of CVOCs in the groundwater plume following source zone removal/in situ treatment. For Alternatives 4 and 5, it is estimated that attainment of groundwater and surface water RAOs will require 5 years.

Alternative 3 relies on MNA only following source-zone removal/in situ treatment and is estimated to take 15 years to achieve groundwater and surface water RAOs.

Alternatives 1 and 2 are estimated to require 50 years to attain groundwater and surface water RAOs.

A summary of the relative ranking of alternatives is in the table below.

Short-term Effectiveness
Relative Ranking from Lowest to Highest

Lowest **0**	**1**	**2**	**3**	**Highest** **4**
1, 2		3, 5		4

Implementability

All alternatives can be implemented at the site, and no technical or administrative implementability problems are expected. For Alternatives 3, 4, and 5, the stabilized in situ soil mixed area (if applicable) should remain undisturbed until sampling results indicate the CVOCs have been fully degraded.

Cost

A summary of the estimated costs for each of the groundwater media alternatives is presented in Table 6 and in more detail in Appendix B. The table breaks down the estimated capital, O&M, and present net worth cost.

The No Further Action Alternative has the least present worth cost, as the only task associated with this alternative is the 5-year review (assumed for 50 years). Alternative 2 (MNA), Alternative 3 (Source Zone Removal and MNA), and Alternative 5 have similar present values. The costs for Alternative 2 include monitoring and the 5-year review (assumed for 50 years). The costs for Alternative 3 include the capital cost for implementation of the source zone removal and MNA for an estimated 15 years. The costs for Alternative 5 include the capital cost for implementation of the source removal and substrate injection. The estimated capital costs for the alternative water supply are shown but are not included in the total costs because implementation is included as a contingency. The overall duration for Alternative 5 is less when compared to Alternatives 2 and 3, so the cost for monitoring and the 5-year review is less (assumed to be 5 years). The highest present value is for Alternative 4 (Source Zone Removal, Groundwater Extraction and Treatment, and Long-Term Monitoring) because of the higher capital cost of refurbishing the extraction and treatment system and the operations and maintenance of the system (assumed to be 5 years).

SECTION 6

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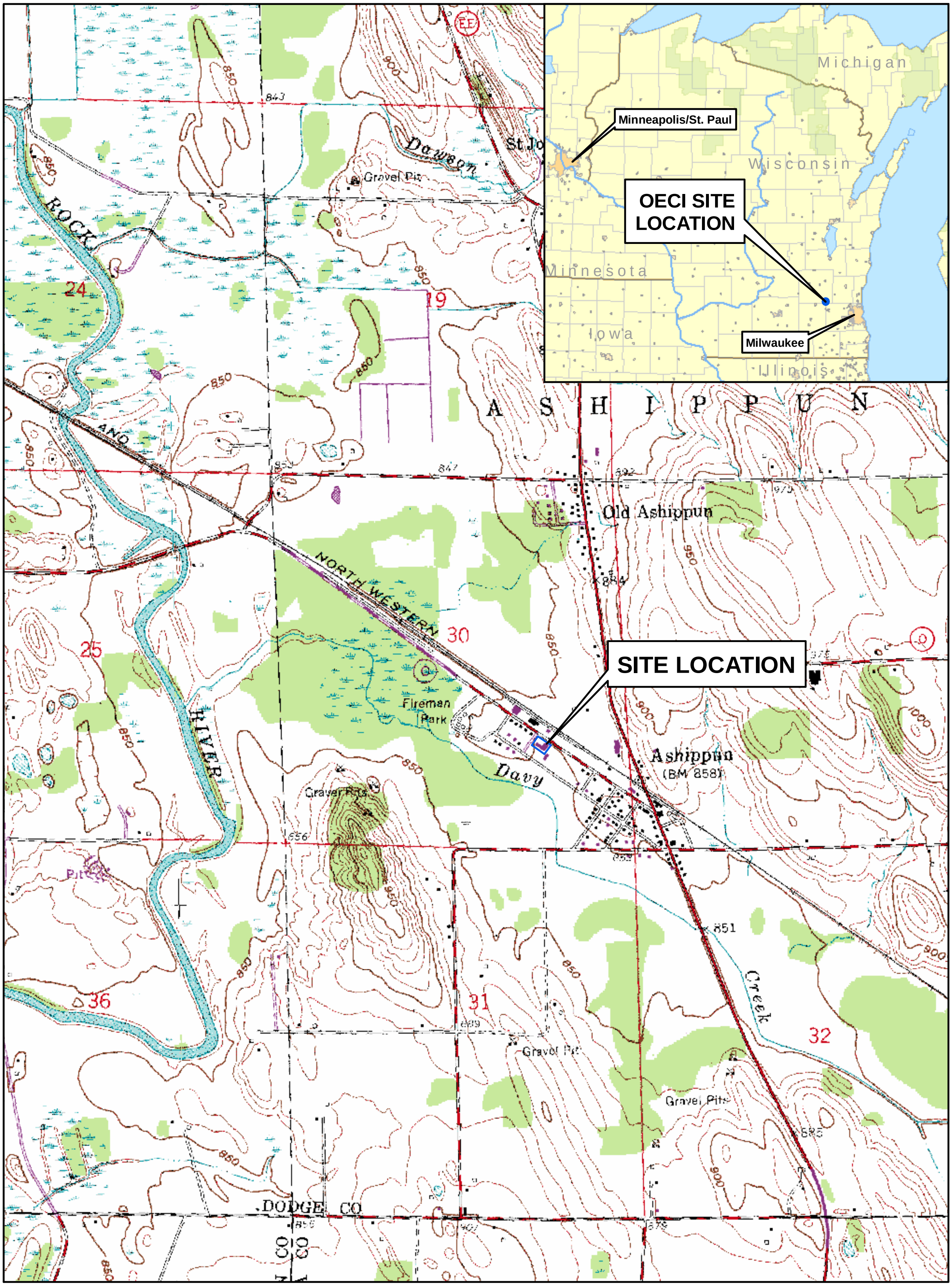
Figures



N

0 1,000 2,000

Feet

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FIGURE 1
Site Location
Focused Feasibility Study Report - July 2010
OECI Site

\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE01_SITE_LOCATION_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:01:58

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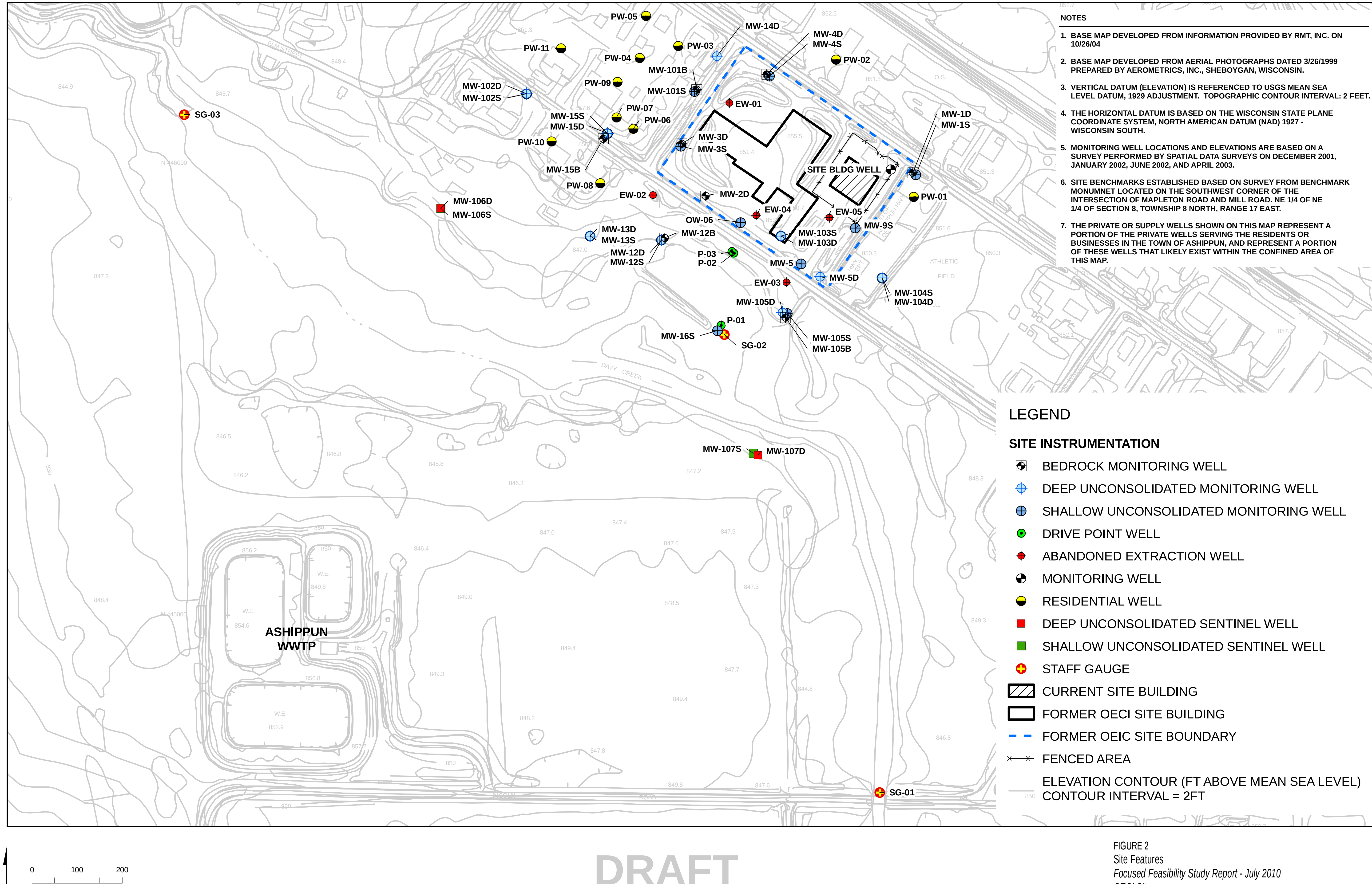

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FIGURE 2
Site Features
Focused Feasibility Study Report - July 2010
OECI Site

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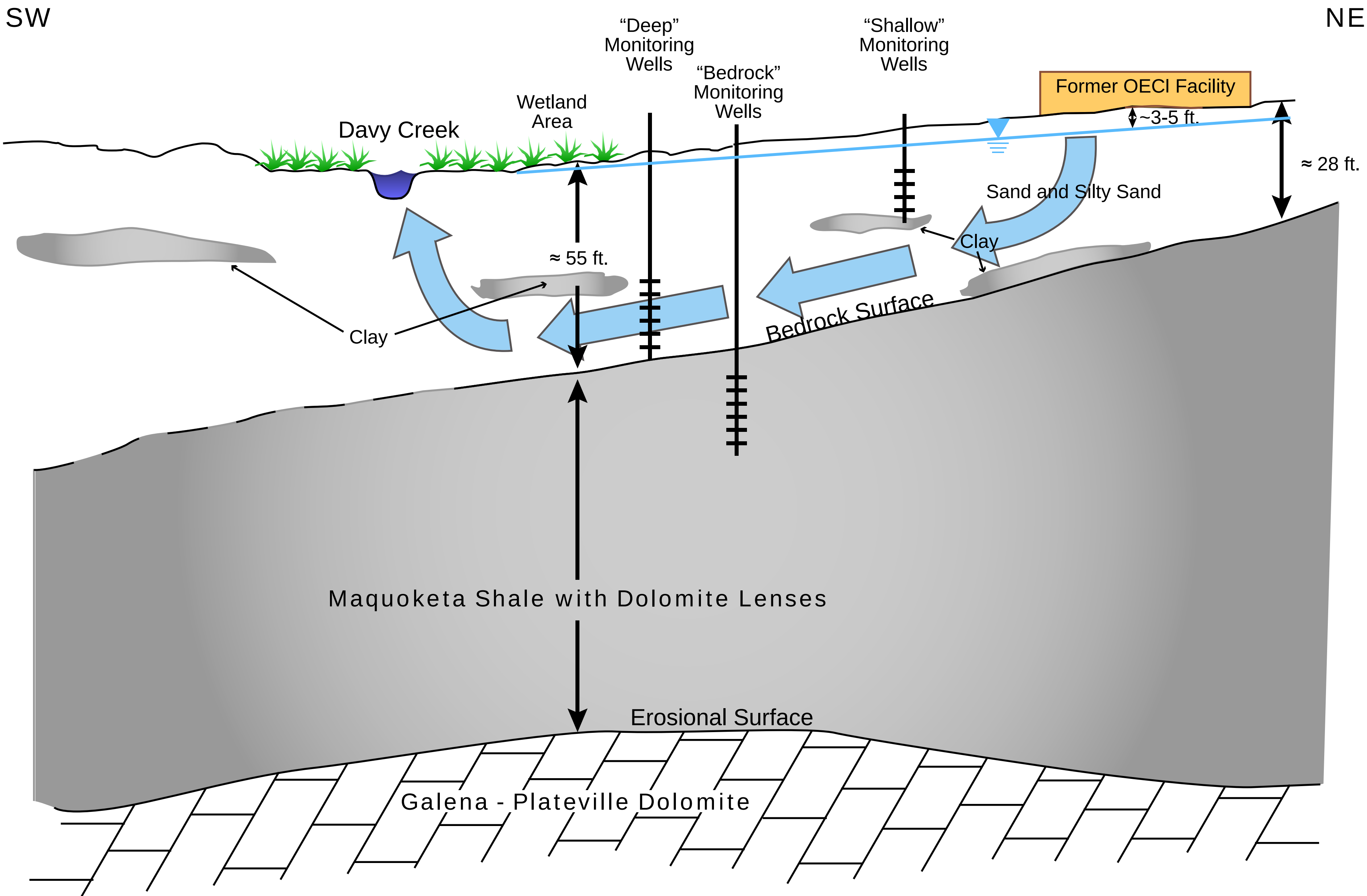
\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE02_SITE_MONITORING_LOCATIONS_FFSR_JULY2010.MXD MPETERSH 7/7/2010 13:49:13



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- NOT TO SCALE -

FIGURE 3
Conceptual Depiction of Site Aquifer Units and Well Placement
Focused Feasibility Study Report – July 2010
OECI Site

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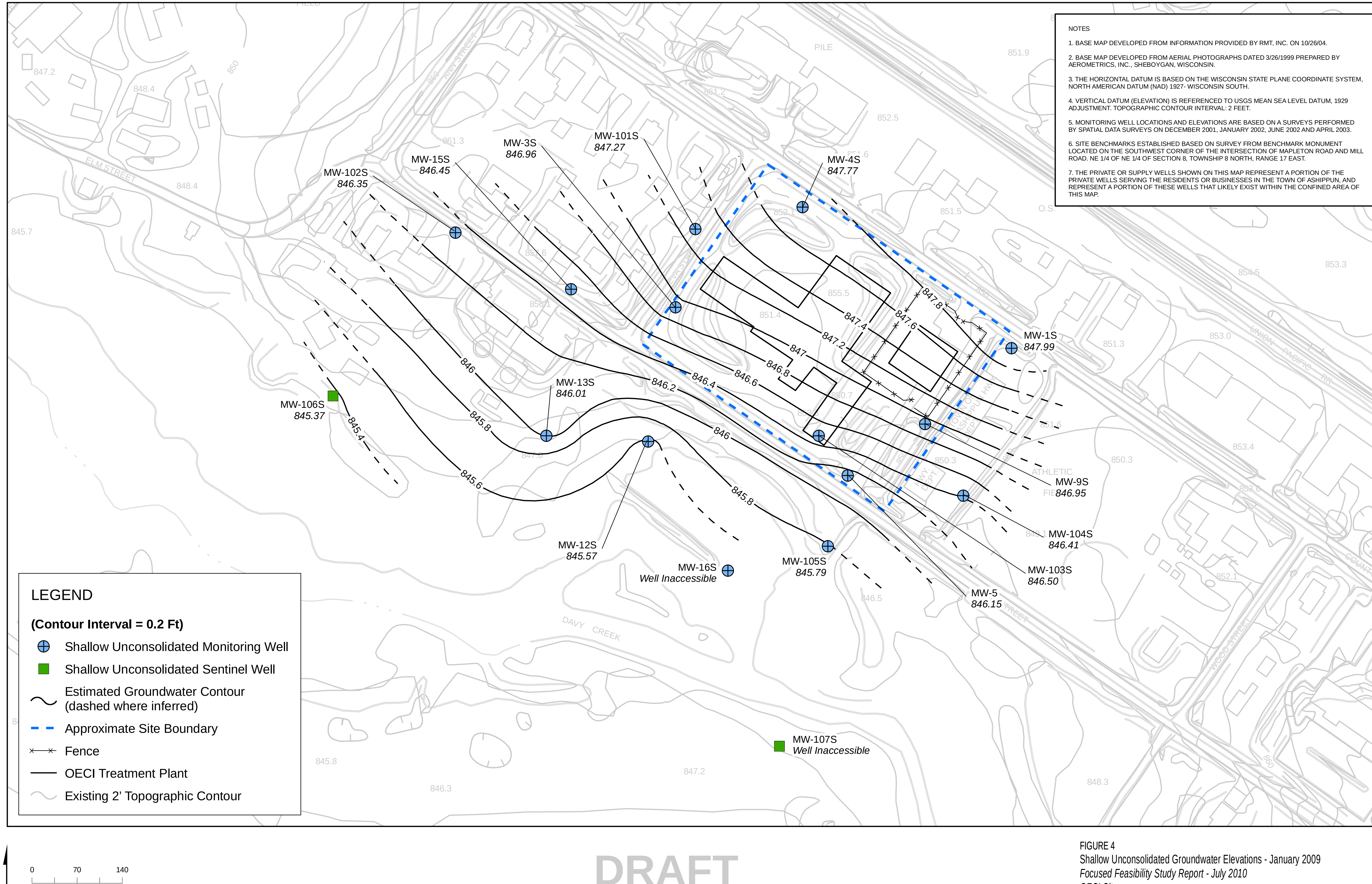

FIGURE 4
Shallow Unconsolidated Groundwater Elevations - January 2009
Focused Feasibility Study Report - July 2010
OECI Site

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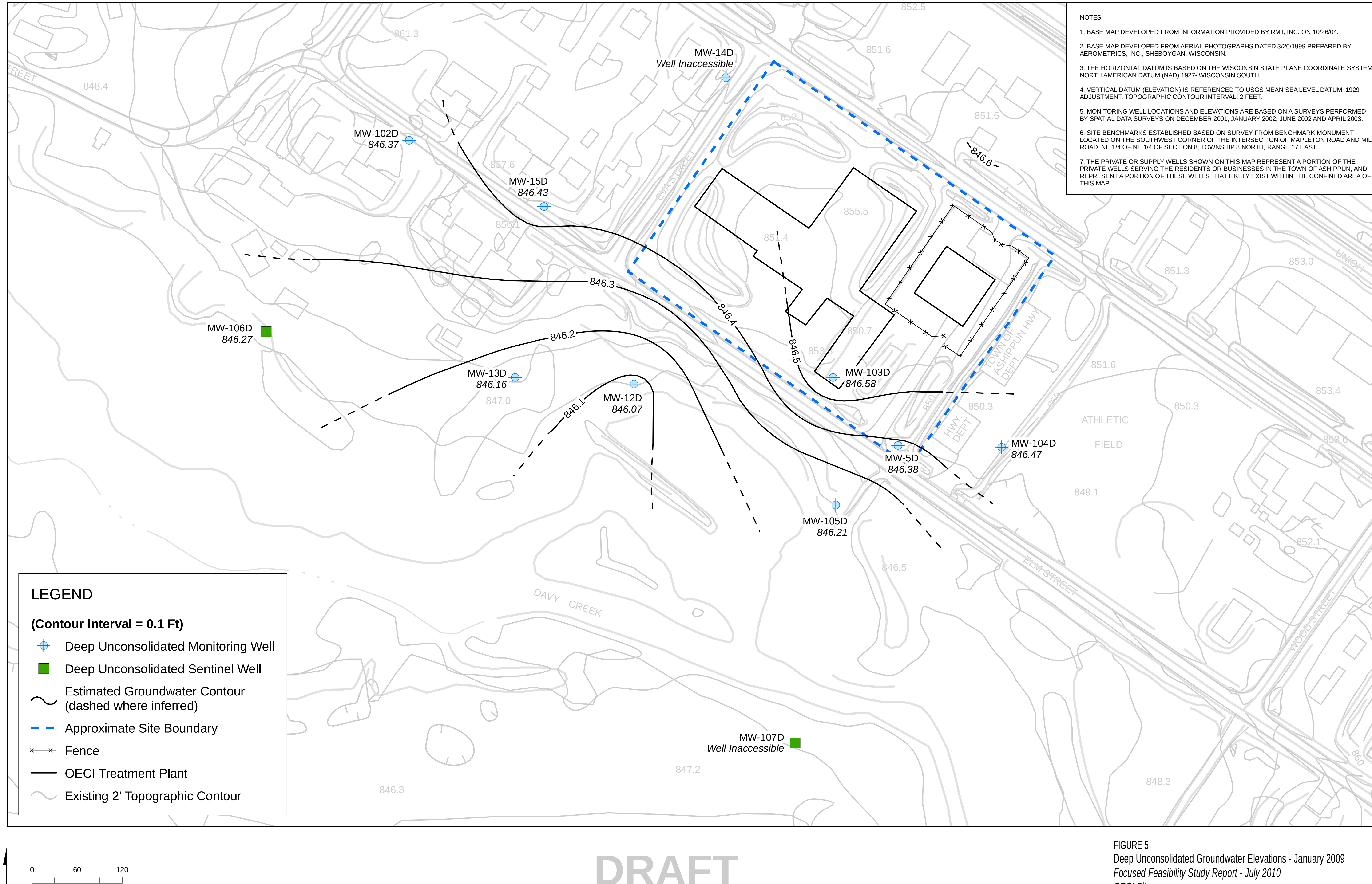
\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE04_SHALLOW_UNCONSOLIDATED_AQUIFER_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:01:21



NOTES

1. BASE MAP DEVELOPED FROM INFORMATION PROVIDED BY RMT, INC. ON 10/26/04.

2. BASE MAP DEVELOPED FROM AERIAL PHOTOGRAPHS DATED 3/26/1999 PREPARED BY AEROMETRICS, INC., SHEBOYGAN, WISCONSIN.

3. THE HORIZONTAL DATUM IS BASED ON THE WISCONSIN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM (NAD) 1927- WISCONSIN SOUTH.

4. VERTICAL DATUM (ELEVATION) IS REFERENCED TO USGS MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT. TOPOGRAPHIC CONTOUR INTERVAL: 2 FEET.

5. MONITORING WELL LOCATIONS AND ELEVATIONS ARE BASED ON A SURVEYS PERFORMED BY SPATIAL DATA SURVEYS ON DECEMBER 2001, JANUARY 2002, JUNE 2002 AND APRIL 2003.

6. SITE BENCHMARKS ESTABLISHED BASED ON SURVEY FROM BENCHMARK MONUMENT LOCATED ON THE SOUTHWEST CORNER OF THE INTERSECTION OF MAPLETON ROAD AND MILL ROAD. NE 1/4 OF NE 1/4 OF SECTION 8, TOWNSHIP 8 NORTH, RANGE 17 EAST.

7. THE PRIVATE OR SUPPLY WELLS SHOWN ON THIS MAP REPRESENT A PORTION OF THE PRIVATE WELLS SERVING THE RESIDENTS OR BUSINESSES IN THE TOWN OF ASHIPPUN, AND REPRESENT A PORTION OF THESE WELLS THAT LIKELY EXIST WITHIN THE CONFINED AREA OF THIS MAP.

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FIGURE 5
Deep Unconsolidated Groundwater Elevations - January 2009
Focused Feasibility Study Report - July 2010
OECI Site

CH2MHILL

\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE05_DEEP_UNCONSOLIDATED_AQUIFER_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:03:05

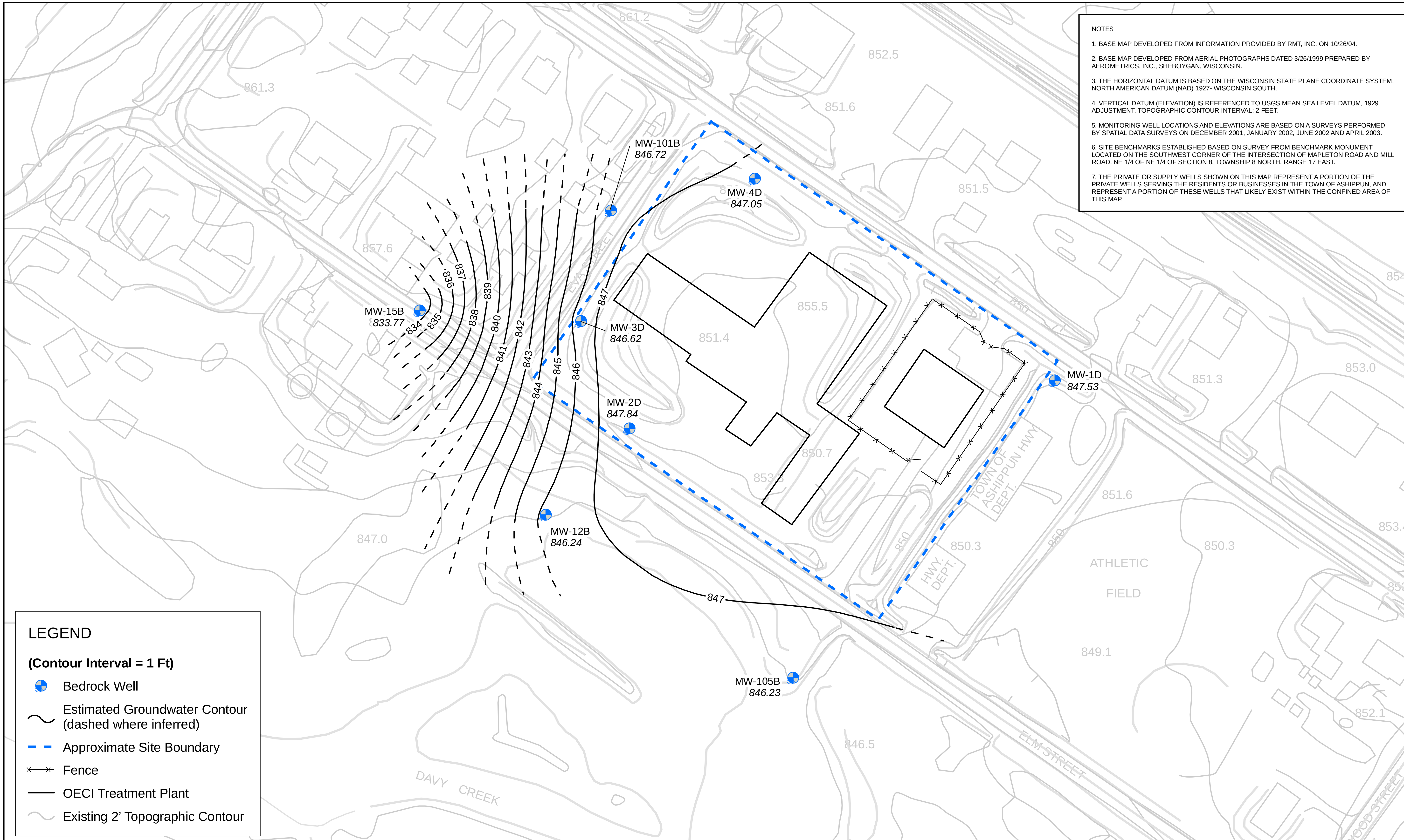

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FIGURE 6
Bedrock Groundwater Elevations - January 2009
Focused Feasibility Study Report - July 2010
OECI Site

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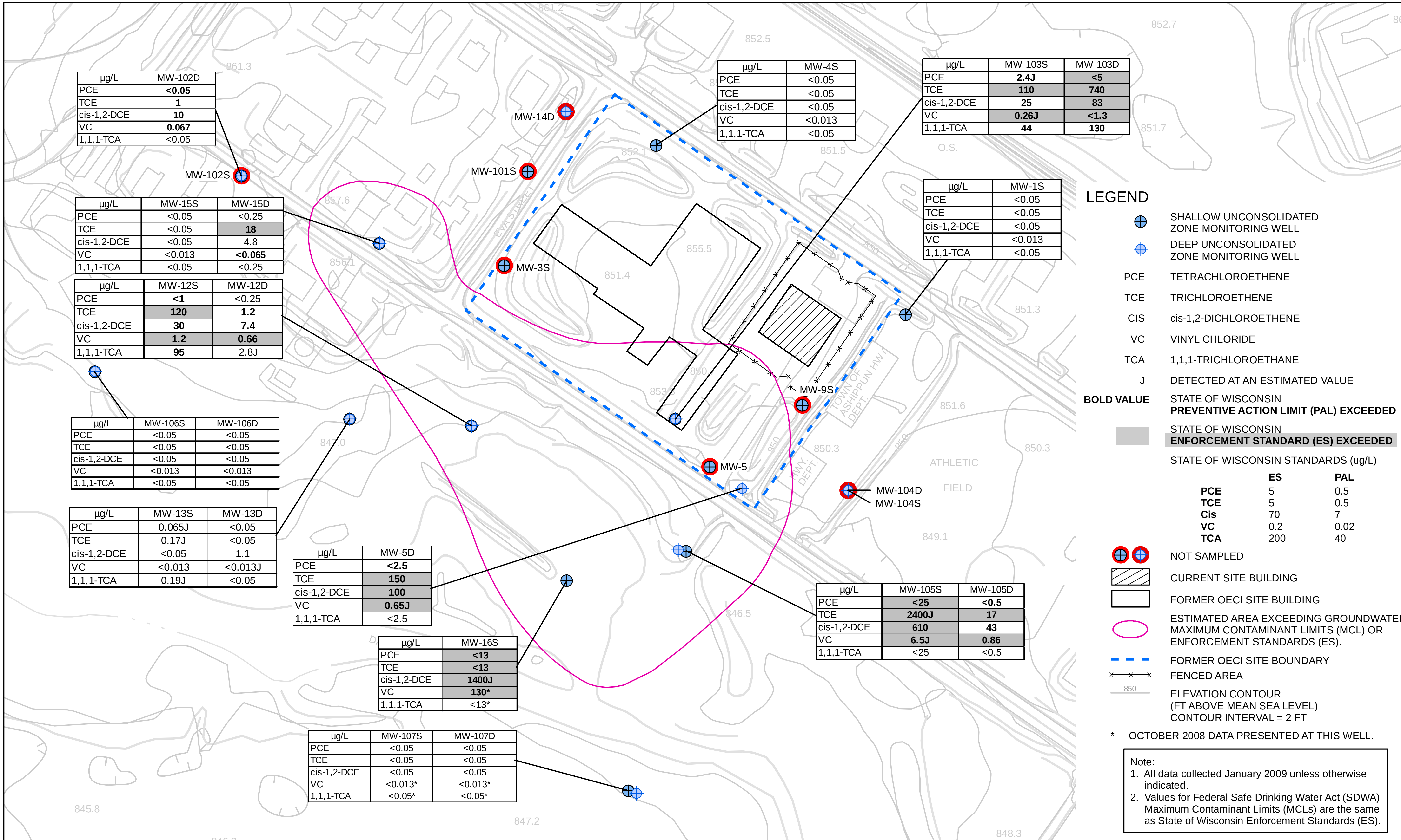
\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE06_BEDROCK_CONTOUR_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:03:44



µg/L	MW-102D
PCE	**<0.05**
TCE	**1**
cis-1,2-DCE	**10**
VC	**0.067**
1,1,1-TCA	<0.05

µg/L	MW-4S
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	<0.05
VC	<0.013
1,1,1-TCA	<0.05

µg/L	MW-103S	MW-103D
PCE	**2.4J**	**<5**
TCE	**110**	**740**
cis-1,2-DCE	**25**	**83**
VC	**0.26J**	**<1.3**
1,1,1-TCA	**44**	**130**

µg/L	MW-15S	MW-15D
PCE	<0.05	<0.25
TCE	<0.05	**18**
cis-1,2-DCE	<0.05	4.8
VC	<0.013	**<0.065**
1,1,1-TCA	<0.05	<0.25

µg/L	MW-1S
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	<0.05
VC	<0.013
1,1,1-TCA	<0.05

µg/L	MW-12S	MW-12D
PCE	**<1**	<0.25
TCE	**120**	**1.2**
cis-1,2-DCE	**30**	**7.4**
VC	**1.2**	**0.66**
1,1,1-TCA	**95**	2.8J

µg/L	MW-106S	MW-106D
PCE	<0.05	<0.05
TCE	<0.05	<0.05
cis-1,2-DCE	<0.05	<0.05
VC	<0.013	<0.013
1,1,1-TCA	<0.05	<0.05

µg/L	MW-13S	MW-13D
PCE	0.065J	<0.05
TCE	0.17J	<0.05
cis-1,2-DCE	<0.05	1.1
VC	<0.013	<0.013J
1,1,1-TCA	0.19J	<0.05

µg/L	MW-5D
PCE	**<2.5**
TCE	**150**
cis-1,2-DCE	**100**
VC	**0.65J**
1,1,1-TCA	<2.5

µg/L	MW-16S
PCE	**<13**
TCE	**<13**
cis-1,2-DCE	**1400J**
VC	**130***
1,1,1-TCA	<13*

µg/L	MW-105S	MW-105D
PCE	**<25**	**<0.5**
TCE	**2400J**	**17**
cis-1,2-DCE	**610**	**43**
VC	**6.5J**	**0.86**
1,1,1-TCA	<25	<0.5

µg/L	MW-107S	MW-107D
PCE	<0.05	<0.05
TCE	<0.05	<0.05
cis-1,2-DCE	<0.05	<0.05
VC	<0.013*	<0.013*
1,1,1-TCA	<0.05*	<0.05*

LEGEND

- SHALLOW UNCONSOLIDATED ZONE MONITORING WELL
- DEEP UNCONSOLIDATED ZONE MONITORING WELL
- PCE TETRACHLOROETHENE
- TCE TRICHLOROETHENE
- CIS cis-1,2-DICHLOROETHENE
- VC VINYL CHLORIDE
- TCA 1,1,1-TRICHLOROETHANE
- J DETECTED AT AN ESTIMATED VALUE
- **BOLD VALUE** STATE OF WISCONSIN **PREVENTIVE ACTION LIMIT (PAL) EXCEEDED**
- STATE OF WISCONSIN **ENFORCEMENT STANDARD (ES) EXCEEDED**

STATE OF WISCONSIN STANDARDS (ug/L)

	ES	PAL
PCE	5	0.5
TCE	5	0.5
Cis	70	7
VC	0.2	0.02
TCA	200	40

- NOT SAMPLED
- CURRENT SITE BUILDING
- FORMER OECI SITE BUILDING
- ESTIMATED AREA EXCEEDING GROUNDWATER MAXIMUM CONTAMINANT LIMITS (MCL) OR ENFORCEMENT STANDARDS (ES).
- FORMER OECI SITE BOUNDARY
- FENCED AREA
- 850 ELEVATION CONTOUR (FT ABOVE MEAN SEA LEVEL) CONTOUR INTERVAL = 2 FT

* OCTOBER 2008 DATA PRESENTED AT THIS WELL.

Note:
1. All data collected January 2009 unless otherwise indicated.
2. Values for Federal Safe Drinking Water Act (SDWA) Maximum Contaminant Limits (MCLs) are the same as State of Wisconsin Enforcement Standards (ES).

N 0 60 120 Feet

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FIGURE 7
Groundwater Concentrations in Shallow and Deep Unconsolidated Wells
Focused Feasibility Study Report - July 2010
OECI Site

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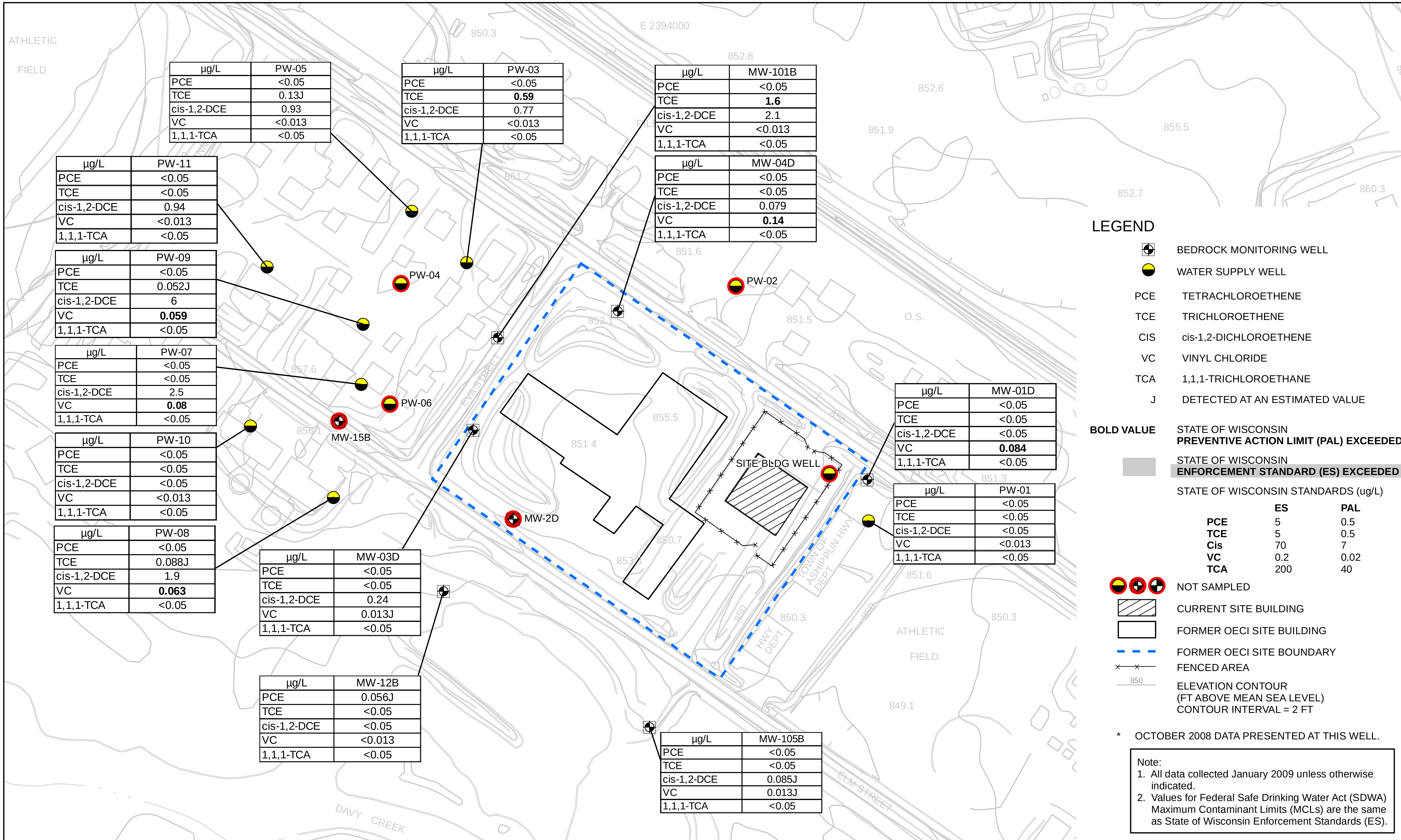
\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE07_SHALLOW_UNCON_AQ_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:04:41



µg/L	PW-05
PCE	<0.05
TCE	0.13J
cis-1,2-DCE	0.93
VC	<0.013
1,1,1-TCA	<0.05

µg/L	PW-03
PCE	<0.05
TCE	**0.59**
cis-1,2-DCE	0.77
VC	<0.013
1,1,1-TCA	<0.05

µg/L	MW-101B
PCE	<0.05
TCE	**1.6**
cis-1,2-DCE	2.1
VC	<0.013
1,1,1-TCA	<0.05

µg/L	MW-04D
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	0.079
VC	**0.14**
1,1,1-TCA	<0.05

µg/L	PW-11
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	0.94
VC	<0.013
1,1,1-TCA	<0.05

µg/L	PW-09
PCE	<0.05
TCE	0.052J
cis-1,2-DCE	6
VC	**0.059**
1,1,1-TCA	<0.05

µg/L	PW-07
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	2.5
VC	**0.08**
1,1,1-TCA	<0.05

µg/L	PW-10
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	<0.05
VC	<0.013
1,1,1-TCA	<0.05

µg/L	PW-08
PCE	<0.05
TCE	0.088J
cis-1,2-DCE	1.9
VC	**0.063**
1,1,1-TCA	<0.05

µg/L	MW-03D
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	0.24
VC	0.013J
1,1,1-TCA	<0.05

µg/L	MW-12B
PCE	0.056J
TCE	<0.05
cis-1,2-DCE	<0.05
VC	<0.013
1,1,1-TCA	<0.05

µg/L	MW-105B
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	0.085J
VC	0.013J
1,1,1-TCA	<0.05

µg/L	MW-01D
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	<0.05
VC	**0.084**
1,1,1-TCA	<0.05

µg/L	PW-01
PCE	<0.05
TCE	<0.05
cis-1,2-DCE	<0.05
VC	<0.013
1,1,1-TCA	<0.05

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FIGURE 8
Groundwater Concentrations in Bedrock Wells
Focused Feasibility Study Report - July 2010
OECI Site

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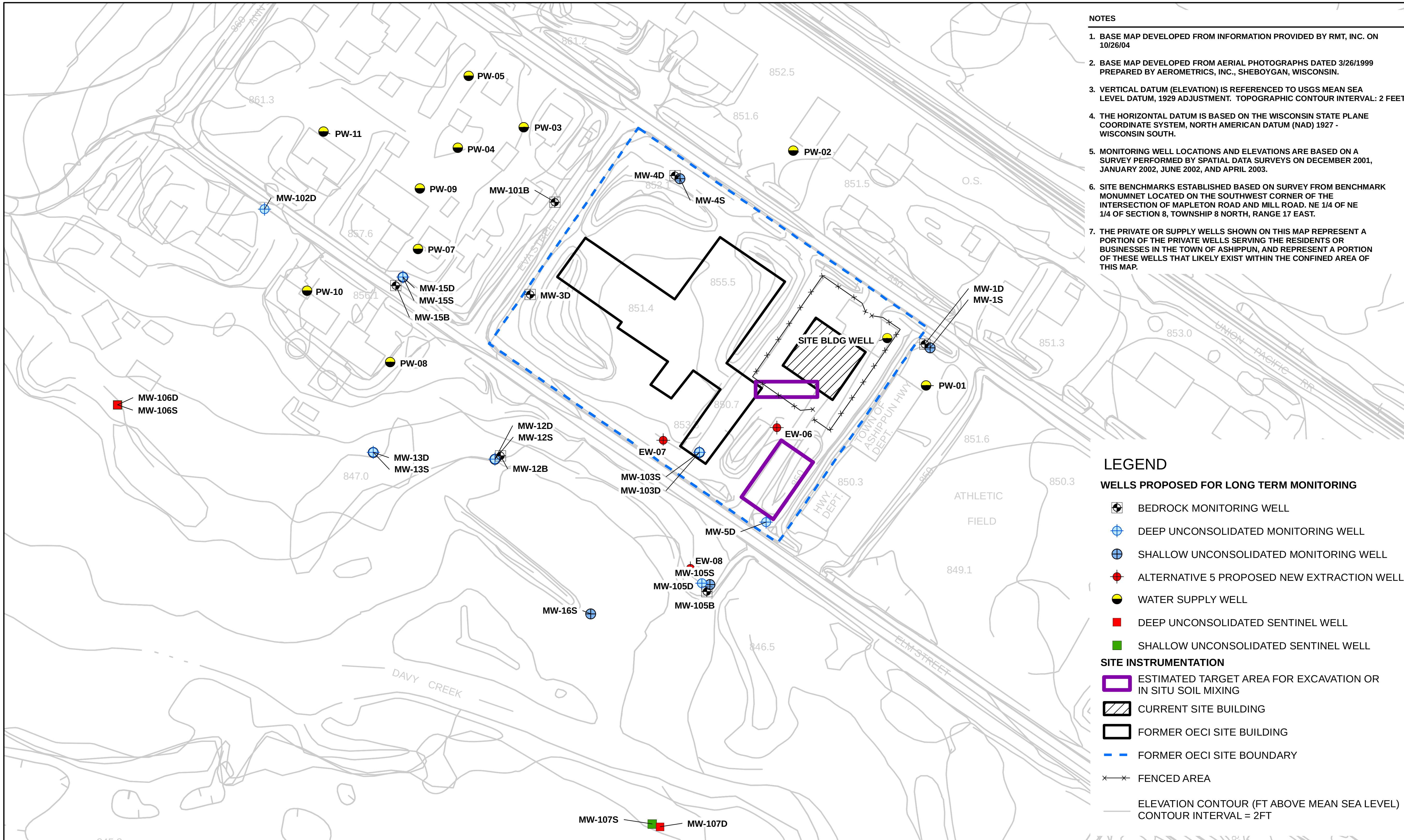
\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE08_BEDROCK_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:05:35



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N

0 60 120
Feet

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FIGURE 9
Alternatives 2, 3, and 4
Focused Feasibility Study Report - July 2010
OECI Site

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\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE09_ALTERNATIVES_2_3_4_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:07:04

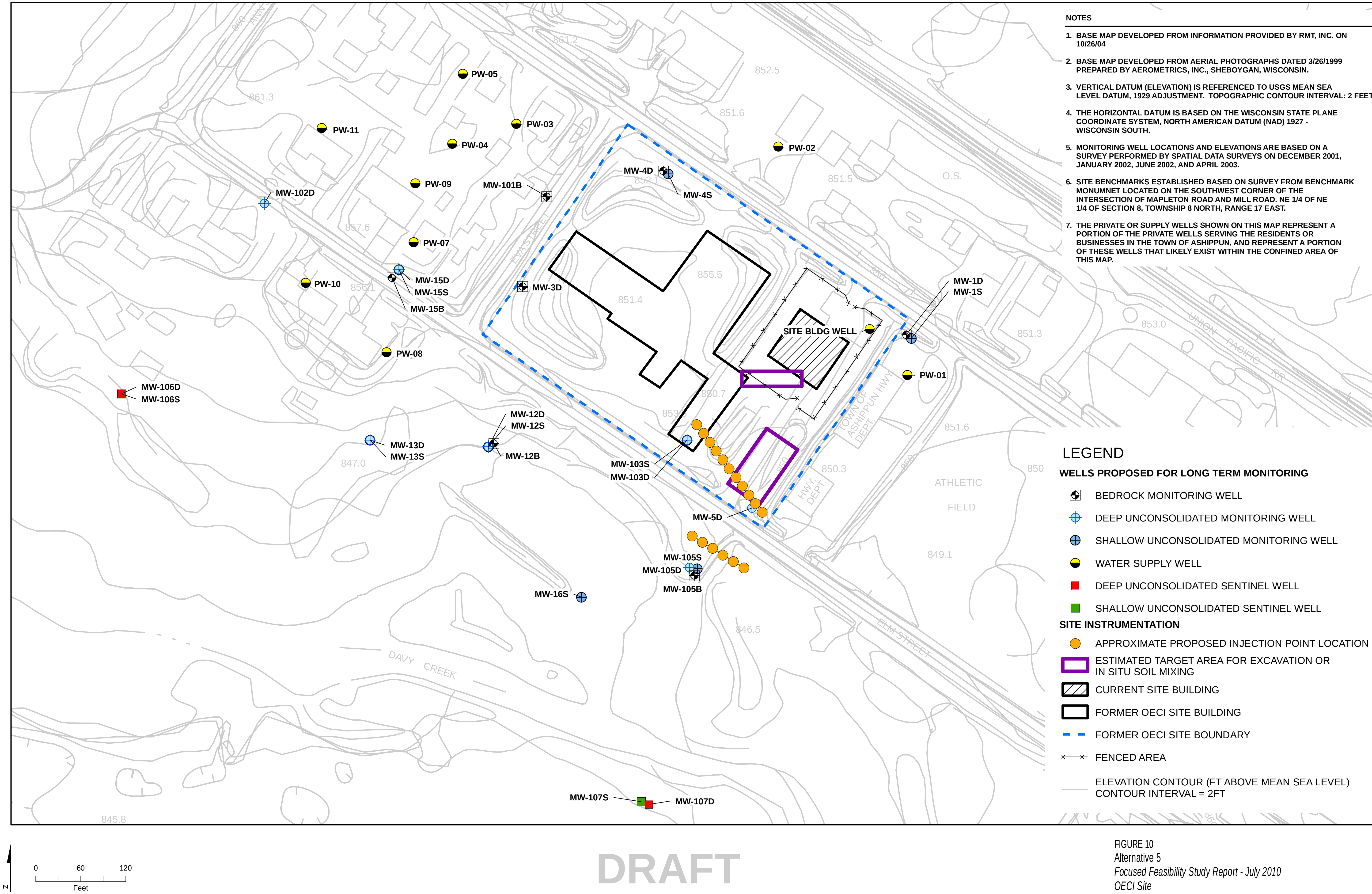

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FIGURE 10
Alternative 5
Focused Feasibility Study Report - July 2010
OECI Site

\\LAKEFRONT\PROJ\GIS\OECI\MAPFILES\OEIC_2010_FS\FIGURE10_ALTERNATIVE_5_FFSR_JULY2010.MXD MPETERSH 7/8/2010 08:10:29

Appendix A
Evaluation of ARARs

TABLE A-1
Evaluation of Applicable or Relevant and Appropriate Requirements
OECI Focused Feasibility Study Report

Regulation	Requirement	ARAR Status	Analysis
Chemical-Specific ARARs			
CERCLA Guidance on Land Use in the CERCLA Remedy Selection Process	Establishes appropriate considerations in defining future land use.	TBC	Provides guidance to USEPA in selecting land use for remedy selection purposes.
40 CFR 260 through 264, Subtitle C	Regulates the generation, transport, storage, treatment, and disposal of hazardous wastes generated in the course of a remedial action. Regulates the construction, design, monitoring, operation, and closure of hazardous waste facilities.	ARAR	Requirements under these regulations may be relevant and appropriate to storage of certain non-hazardous wastes or treatment system residuals if the risk they present are similar to those associated with hazardous wastes. The criteria and limitations used to identify wastes as being hazardous or non-hazardous are applicable to groundwater treatment residuals.
40 CFR 261–Identification and Listing of Hazardous Waste	Identifies those wastes subject to regulation as hazardous wastes.	ARAR	The criteria and limitations used to identify wastes as being hazardous or nonhazardous in 40 CFR 261 are relevant and appropriate to all proposed cleanup actions at the Oconomowoc site. Determining whether wastes qualify as hazardous will often establish the applicability of other regulations.
40 CFR 264, Subpart G–Closure and Post-Closure	Provides technical and procedural closure requirements for hazardous waste facilities. Requires the facility be closed in a manner that controls, minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface water or to the atmosphere.	Not an ARAR	No remedial alternative includes consolidation.
40 CFR 268 Subpart D–Treatment Standards	Materials containing RCRA hazardous waste subject to land disposal restrictions. Some hazardous wastes restricted from land disposal in Subpart C may be land-disposed providing they attain levels achievable by best demonstrated available technologies (BDAT) for each hazardous constituent for each listed waste.	ARAR	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed. No alternatives propose moving soil within the area of contamination.
NR 720–Soil Cleanup Standards	Establishes the soil cleanup standards (residual contaminant levels, RCLs) for the remediation of soil contamination.	Not an ARAR	Applies to determining the effectiveness of soil remedial alternatives. Do not apply to remediation of groundwater.
Groundwater			
Federal Water Pollution Control Act as amended by the Clean Water Act of 1977, Section 208(b)	The proposed action must be consistent with regional water quality management plans as developed under Section 208 of Clean Water Act.	ARAR	Substantive requirements adopted by the state pursuant to Section 208 of the Clean Water Act would be applicable to direct discharge of treatment system effluent or other discharges to surface water.
Federal Water Pollution Control Act as amended by the Clean Water Act of 1977, Section 304	Establishes water quality criteria for specific pollutants for the protection of human health and for the protection of aquatic life. These federal water quality criteria are non-enforceable guidelines used by the state to set water quality standards for surface water.	TBC	Water quality criteria may be relevant and appropriate to groundwater or treatment system effluent or other discharges to surface water.
40 CFR 122.44(a)–Technology-Based Effluent Limitations and Standards	Requires the use of the Best Available Technology (BAT) for toxic and nonconventional wastewaters or the Best Conventional Technology (BCT) for conventional pollutants. The nature of the wastewater and the technology-based limitations will be determined by the state on a case-by-case basis.	ARAR	Substantive requirement is used by WDNR in setting discharge limits for onsite groundwater treatment.
40 CFR 122.44(e)–Technology-Based Controls for Toxic Pollutants	Discharge limits must be established at concentrations exceeding levels achievable by the technology-based (BAT/BCT) standards. The discharge limitations would be evaluated on a case-by-case basis depending on the proposed treatment system and the receiving water.	ARAR	Substantive requirement is used by WDNR in setting discharge limits for onsite groundwater treatment.
40 CFR 131–Water Quality Standards	States are granted enforcement jurisdiction over direct discharges and may adopt reasonable standards to protect or enhance the uses and qualities of surface water bodies in the state.	ARAR	Applicable to direct discharge of treatment system effluent or other process waters. Such a discharge would activate the administrative requirements of this rule because it would affect offsite surface waters.
40 CFR 141–National Primary Drinking Water Regulations	Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) for specific chemicals to protect drinking water quality.	ARAR	MCLs and nonzero MCLGs are relevant and appropriate because groundwater is used as drinking water supply.
Safe Drinking Water Act (SDWA)— Maximum Contaminant Levels (MCLs) 40 CFR 141.61 (organic chemicals) 40 CFR 141.62 (inorganic chemicals)	CERCLA 121(d) states that a remedial action will attain a level under the SDWA. MCLs are enforceable maximum permissible level of a contaminant which is delivered to any user of a public water system.	ARAR	MCLs are relevant and appropriate for potential drinking water sources per the NCP. Remedies may not have to demonstrate compliance with an ARAR that is technically impracticable (see NCP), such as areas of DNAPL.
SDWA—Maximum Contaminant Level Goals (MCLGs) 40 CFR 141.50 (organic chemicals) 40 CFR 141.51 (inorganic chemicals)	CERCLA 121(d)(2)(A) states that a remedial action attain MCLGs where relevant and appropriate. MCLGs are non-enforceable health goals under the SDWA.	ARAR	Non-zero MCLGs may be relevant and appropriate. MCLGs equal to zero are not appropriate for cleanup of groundwater or surface water at CERCLA sites by USEPA policy (see NCP).
40 CFR 143-SDWA—Secondary MCLs (SMCLs)	Non-enforceable limits intended as guidelines for use by states in regulating water supplies. Secondary MCLs are related to aesthetic concerns (e.g. taste and odor) and are not health-related.	Not an ARAR	Chemicals with SMCLs have not been identified as chemicals of concern at this site.
Office of Drinking Water. Drinking water health advisories.	Guidance levels for drinking water issued by Office of Drinking Water.	TBC	May be used for chemicals without MCLs if groundwater is to meet drinking water quality.
NR 140–Groundwater Quality (Enforcement Standards)	Establishes the remediation goals for groundwater which are to achieve the Enforcement Standards (ESs) at the site. Also specifies actions required should a groundwater standard be exceeded at the point of standards application.	ARAR	Relevant to determine effectiveness of remedial alternatives considered.
NR 140–Groundwater Quality (Preventative Action Limits)	Establishes the Preventive Action Limits (PALs) at the site. Also specifies actions required should a groundwater standard be exceeded at the point of standards application.	ARAR	Relevant to determine effectiveness of remedial alternatives considered.
NR 809–Safe Drinking Water	Establishes drinking water standards for water supplies, including federal MCLs. Also specifies sampling and analysis requirements.	ARAR	MCLs are relevant and appropriate for potential drinking water sources per the NCP. Remedies may not have to demonstrate compliance with an ARAR that is technically impracticable (see NCP), such as areas of DNAPL.
Surface Water			
Federal Water Pollution Control Act as amended by the Clean Water Act of 1977, Section 208(b)	Establishes water quality criteria for specific pollutants for the protection of human health and aquatic life. These federal water quality criteria are non-enforceable guidelines used by the state to set water quality standards for surface water.	TBC	Water quality criteria are TBCs used in setting standards for discharges to surface water from a treatment system.
NR 102–Water Quality Standards for Wisconsin Surface Water	Describes the designated use categories and water quality criteria to support uses.	ARAR	Surface water standards are applicable to Davy Creek. Also treated groundwater must meet water quality standards.
NR 103–Water Quality Standards for Wetlands	Establishes water quality standards for wetlands and implementation procedures for application of the wetland water quality standards.	ARAR	Relevant to treated discharge from groundwater source control. Also relevant for soil excavation and groundwater withdrawal activities that have the potential to impact wetlands.
NR 104–Uses and Designated Standards and Secondary Values	Establishes surface water classifications and specifies effluent limitations for intrastate waters.	ARAR	Actions involving treated discharge must meet water quality standards.
NR 105–Surface Water Quality Criteria for Toxic Substances	Establishes water quality criteria and methods for developing criteria and secondary values for toxic and organoleptic substances for the protection of human health and welfare, and propagation of fish, aquatic life and wildlife. Also requires that contaminated sediment be remediated to meet sediment quality criteria that are protective of surface water quality standards.	ARAR	Water quality criteria are used by WDNR in setting WPDES discharge limit for toxics and developing sediment quality criteria.
NR 106–Procedures for Calculating Water Quality Based Effluent Limitations for Toxic and Organoleptic Substances Discharged to Surface Waters	Specifies the procedures to calculate effluent limits for toxic and organoleptic substances and if and how these limits will be included in WPDES permits.	ARAR	Water quality criteria are used by WDNR in setting WPDES discharge limit for toxics and developing sediment quality criteria. Surface water standards are applicable to Davy Creek.
Air			
Clean Air Act	Calls for development and implementation of regional air pollution control programs.	ARAR	Section 101 of the Clean Air Act delegates primary responsibility for regional air quality management to the states. The rules for implementation of regional air quality plans are contained in 40 CFR 52. Regulations promulgated under the Clean Air Act may apply to possible actions at the site that generate air emissions, but are most applicable to stationary sources.
40 CFR 50–National Primary and Secondary Ambient Air Quality Standards	Establishes Ambient Air Quality Standards.	ARAR	Applicable to discharges of toxic substances to the atmosphere during waste handling or treatment. The existing groundwater treatment system did not require air emission controls so it is unlikely re-starting the treatment system with lower VOC concentrations will require air emission controls. The substantive requirements of an air permit will need to be re-evaluated.
40 CFR 61–National Emission Standards for Hazardous Waste Pollutants	Requires limits on the discharges of toxic substances to the atmosphere.	ARAR	Applicable to discharges of toxic substances to the atmosphere during waste handling or treatment. The existing groundwater treatment system did not require air emission controls so it is unlikely re-starting the treatment system with lower VOC concentrations will require air emission controls. The substantive requirements of an air permit will need to be re-evaluated.
40 CFR 264.AA–Air Emission Standards for Process Vents	Requires total organic emissions from air strippers or steam strippers to be reduced below 1.4 kg/hr and 2.8 Mg/yr or that total organic emissions be reduced by 95 percent by weight.	ARAR	Applicable to discharges of toxic substances to the atmosphere during waste handling or treatment. The existing groundwater treatment system did not require air emission controls so it is unlikely re-starting the treatment system with lower VOC concentrations will require air emission controls. The substantive requirements of an air permit will need to be re-evaluated.
NR 404–Ambient Air Quality	Establishes ambient air quality standards for particulate matter and specifies measurement methods.	ARAR	Relevant to excavation of soil for remediation.
NR 405 - Protection of Significant Deterioration	Establishes the requirements and procedures for reviewing and issuing air pollution control construction permits to any new major stationary source.	ARAR	Relevant to air emissions associated with restarting the existing groundwater treatment system.
NR 407 - Operation Permits	Required for all direct stationary sources requiring a permit.	ARAR	Relevant if the size of the pump and treat air emission system falls within the size and type limits requiring an operation permit.
NR 415–Control of Particulate Emissions	Establishes standards for fugitive dust emissions and specifies that precautions should be taken to prevent particulate matter from becoming air borne.	ARAR	Relevant to excavation of soil for remediation.

TABLE A-1
Evaluation of Applicable or Relevant and Appropriate Requirements
OECI Focused Feasibility Study Report

Regulation	Requirement	ARAR Status	Analysis
NR 419–Control of Organic Compound Emissions	Describes the notification and approval requirements and emission limitations for remediation of soil or water contaminated organic compounds.	ARAR	Applicable to discharges of toxic substances to the atmosphere during waste handling or treatment. The existing groundwater treatment system did not require air emission controls so it is unlikely re-starting the treatment system with lower VOC concentrations will require air emission controls. The substantive requirements of an air permit will need to be re-evaluated.
NR 431 - Control of Visible Emissions	This applies to all air contaminant sources and is used to categorize air contaminant sources and to establish visible emission limitations for these sources to protect air quality.	ARAR	No owner or operator of a direct or portable source may cause or allow emissions of shade or density great than number 2 of the Ringlemann chart or 40% opacity. This can affect operation of the groundwater treatment system emissions.
NR 439 - Reporting of Record Keeping, Testing, Inspection, and Determination of Compliance	This establishes general reporting, recordkeeping, testing, inspection and determination of compliance requirements for all air emission sources.	ARAR	Substantive requirements apply to the groundwater pump and treat system air emission unit.
NR 440 - Standards of Performance for New Stationary Sources	This enables WDNR to implement and enforce standards of performance for new stationary sources promulgated by the USEPA under the Clean Air Act.	ARAR	Applies to the groundwater treatment system emissions.
NR 445–Control of Hazardous Pollutants	Specifies emission limits and control requirements for air contaminant sources emitting hazardous pollutants.	ARAR	Emissions for actions that may emit air pollutants must meet NR 445 requirements.
NR 445.04–Emission Limits for New or Modified Sources	Specifies air concentrations not to be exceeded in terms of 24-hour and 1-hour averages. Requires lowest achievable emission rates and best available technology for air contaminants without acceptable ambient concentrations.	ARAR	Emissions for actions that may emit air pollutants must meet NR 445 requirements.
NR 449 - Control of Vinyl Chloride Emissions	Establishes emission limitations and sampling and testing procedures for vinyl chloride air contaminant sources.	ARAR	Applies to the groundwater treatment system emissions.
Location-Specific ARARs			
50 CFR 402 - Interagency Cooperation - Endangered Species Act of 1973 16 USC §1531 et seq. 50 CFR 200	Requires that Federal agencies ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	ARAR	Potential risks to threatened and endangered species were not identified previously at site.
50 CFR 402–Interagency Cooperation—Endangered Species Act of 1973, as amended	Requires remedial agency to consult with Fish and Wildlife Service if action may affect endangered species or critical habitat.	Not likely ARAR	Potential risks to endangered species or critical habitat were not identified previously at site.
National Historical Preservation Act 16 USC §661 et seq. 36 CFR Part 65	Establishes procedures to provide for preser-vation of scientific, historical, and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. If scientific, historical, or archaeological artifacts are discovered at the site, work in the area of the site affected by such discovery will be halted pending the completion of any data recovery and preservation activities required pursuant to the act and its implementing regulations.	Not likely ARAR	May be ARAR during the remedial activities if scientific, historic, or archaeological artifacts are identified during implementation of the remedy.
Fish and Wildlife Coordination Act (16 USC 661 et seq.)	The Act provides protection and consultation with the U.S. Fish and Wildlife Service and state counterpart for actions that would affect streams, wetlands, other water bodies, or protected habitats. Action taken should protect fish or wildlife, and measures should be developed to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	ARAR	The Act is considered an ARAR for construction activities performed during the implementation of remedies that may affect the wetlands and Davy Creek.
Protection of Wetlands—Executive Order 11990 40 CFR 6, Subpart A 50 CFR Part 6, Appendix A	Requires actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Appendix A requires that no remedial alternatives adversely affect a wetland if another practicable alternative is available. If none is available, effects from implementing the chosen alternative must be mitigated. Public notice and review of activities involving wetlands is required.	ARAR	Wetlands are present onsite.
Executive Order 11988 50 CFR Part 6, Appendix A	Requires actions to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains.	TBC	Site is within a floodplain.
Rivers and Harbors Act. 33 CFR Part 332, Section 10.	A permit is required for work in or affecting navigable waters of the U.S. This includes dredging, disposal of fill material, filling or modification of said waters below the ordinary high water level (OHWL).	Not likely ARAR	Remedial actions are not likely to affect Davy Creek.
Action-Specific ARARs/TBC			
Executive Orders 11988 and 11990 40 CFR 6, Subpart A	Requires federal agencies to avoid whenever possible, adversely affecting flood plains or wetlands and to evaluate potential effects of actions in these designated areas.	TBC	Applicable to wetlands and Davy Creek.
Occupational Safety and Health Act (29 U.S.C. 61 et seq.)	The Occupational Safety and Health Act was passed in 1970 to ensure worker safety on the job. The U.S. Department of Labor oversees the Act. Worker safety at hazardous waste sites is specifically addressed under 29 CFR 1910.120: Hazardous Waste Operations and Emergency Response; general worker safety is covered elsewhere within the law.	ARAR	The Act is considered an ARAR for construction activities performed during the implementation of remedies.
40 CFR 50-99	The Clean Air Act amendments of 1990 greatly expanded the role of National Emission Standards for Hazardous Air Pollutants by designating 179 new hazardous air pollutants and directed USEPA to attain maximum achievable control technology standards for emission sources. Such emission standards are potential ARARs if remedial technologies (such as incinerators or air strippers) produce air emissions of regulated hazardous air pollutants. Specifies requirements for air emissions such as particulates, sulfur dioxide, VOCs, hazardous air pollutants, and asbestos.	ARAR	The existing groundwater treatment system did not require air emission controls so it is unlikely re-starting the treatment system with lower VOC concentrations will require air emission controls. The substantive requirements of an air permit will need to be re-evaluated.
40 CFR 122.21–Application for Permit	Permit application must include a detailed description of the proposed action, including a listing of all required environmental permits.	Not an ARAR	Administrative requirement applicable only for discharges to offsite surface water.
40 CFR 122.44–Establishing Limitations, Standards, and Other Permit Conditions	Federally approved state water quality standards. These may be in addition to or more stringent than federal water quality standards under the CWA.	Not an ARAR	All substantive requirements under the cited sections of 40 CFR 122 would be applicable to the direct discharge of effluent to an onsite or offsite surface water body.
40 CFR 122.44(i)–Monitoring Requirements	Requires monitoring of discharges to ensure compliance. Monitoring programs shall include data on the mass, volume, and frequency of all discharge events.	ARAR	Substantive requirement is used by WDNR in setting discharge limits for onsite groundwater treatment.
40 CFR 125–USEPA Regulations on Criteria and Standards for the NPDES	The site operator shall develop a best management practice (BMP) program and shall incorporate it into the operations plan or the NPDES permit application if required.	ARAR	Substantive and administrative requirements of 40 CFR 125 would be applicable to the direct discharge of treatment system effluent to offsite surface water body.
40 CFR 136–Guidelines Establishing Test Procedures for the Analysis of [Water] Pollutants	These sections require adherence to sample preservation procedures including container materials and sample holding times.	ARAR	Applicable to direct discharge of treatment system effluent.
40 CFR 144– Underground Injection Control Program	Establishes the requirements for underground injection wells and for discharge of wastewaters and hazardous wastes. Reinjection is prohibited except for reinjection of contaminated groundwater into the same formation from which it was withdrawn pursuant to CERCLA activities.	ARAR	Applicable to injection activities for remediation of the groundwater or soil.
40 CFR 146–Underground Injection Control Program: Criteria and Standards	Establishes the technical criteria for the UIC program, including the construction, operating, monitoring and reporting requirements.	ARAR	Applicable to injection activities for remediation of the groundwater or soil.
40 CFR 147–Regulations on State UIC Programs (Subpart YY)	The proposed action is required to be in compliance with State underground injection requirements.	ARAR	Applicable to injection activities for remediation of the groundwater or soil.
Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 321 et seq.)	RCRA was passed in 1976. It amended the Solid Waste Disposal Act by including provisions for hazardous waste management.	Possible ARAR	There is no documented evidence of disposal of listed hazardous waste at the site. Soil excavated for offsite ex situ treatment or offsite disposal may however be characteristic hazardous waste.
40 CFR 268 Subpart C–Prohibitions on Land Disposal	The land disposal restriction under this subpart prohibits land-based disposal of certain solvent-containing wastes, dioxin-containing wastes, and listed wastes.	ARAR	The rules in 40 CFR 268 restrict land disposal of several types of hazardous wastes and as such, may affect the implementation of several potential actions, including actions involving disposal of contaminated soils. The land disposal ban may be applicable or relevant and appropriate to the proposed cleanup because qualifying hazardous wastes might be present in onsite soils. The LDRs delegate primary responsibility to the states except to the extent that promulgated federal regulations are not yet incorporated.
40 CFR 268 Land Disposal Restrictions	The land disposal restrictions require treatment before land disposal for a wide range of hazardous wastes.	Possible ARAR	ARAR for disposal of hazardous waste. Applicable to soils that are a characteristic hazardous waste or that contain a listed waste. Contaminated soils must meet the higher of 10 x the universal treatment standard or a 90% reduction of the contaminant concentration.
Hazardous Materials Transportation Act; 49 CFR 100-109 Transportation of hazardous materials.	Specific DOT requirements for labeling, packaging, shipping papers, and transport by rail, aircraft, vessel, and highway.	Possible ARAR	Off-site shipment of hazardous waste may occur.
40 CFR 262 and 263	Establishes responsibilities for transporters of hazardous waste in handling, transportation, and management of the waste. Sets requirements for manifesting, recordkeeping, and emergency response action in case of a spill.	Possible ARAR	Applicability depends on waste classification of groundwater treatment residuals and excavated soil.
NR 140.28(5)–Criteria for Granting a Temporary Exemption Where Infiltration or Injection is Utilized for a Remedial Action	Describes the criteria for requesting an exemption from WDNR to exceed the PALs or ES at a point of standard application for a remedial action including the infiltration or injection of contaminated groundwater.	Possible ARAR	Contaminant concentrations in the effluent may require variance to discharge the treated groundwater and this standard may be applied to remedial fluid injection.
NR 141–Groundwater Monitoring Well Requirements	Establishes minimum standards for the installation, construction and abandonment of monitoring wells.	ARAR	Construction and abandonment of monitoring wells must conform to standards specified.
NR 200–Application for Discharge Permit	Specifies requirements for applying for permit for discharges to surface water and to land areas where water may percolate or seep to groundwater.	ARAR	WPDES permit may be required for discharge to Davy Creek but not required for onsite discharges. All the substantive requirements, however, must be met.
NR 207–Water Quality Antidegradation Policy	Establishes implementation procedures for the antidegradation policy in NR 102.	ARAR	Applicable for discharges to Davy Creek. Establishes procedure to follow when proposing new or increased discharges to a surface water body.
NR 214–Land Treatment of Industrial Liquid Wastes, By-Product Solids and Sludges	Establishes the design for all land treatment systems that receive wastewater and require approval of plans and specifications by WDNR. Effluent limits, discharge permits and groundwater monitoring requirements are also specified. Use of injection wells of any sort is prohibited unless approved by WDNR.	Not ARAR	Land treatment is not included in remedial alternatives.

TABLE A-1
Evaluation of Applicable or Relevant and Appropriate Requirements
OECI Focused Feasibility Study Report

Regulation	Requirement	ARAR Status	Analysis
NR 217 - Effluent Standards and Limitations	Establishes effluent standards and limitations for pollutants in effluent discharged to surface waters.	ARAR	Applicable for groundwater treatment system discharge to Davy Creek.
NR 219–Analytical Test Methods and Procedures	Establishes analytical test methods, preservation procedures, requirements for laboratories, and procedures applicable to effluent limits for discharges to surface waters.	ARAR	Procedures applicable to effluent limitations for discharges from point sources under 144 and 147 stats.
NR 220–Categories and Classes of Point Sources and Effluent Limits	Required WDNR to establish effluent limits for uncategorized point sources (i.e., not included in NR 221 to 299 inclusive) and to base those limits on best practicable control technology currently available or best available control technology economically achievable.	ARAR	The substantive requirements of obtaining a WPDES permit would be necessary.
NR 600 to NR 685–Hazardous Waste Management Requirements	Specifies minimum requirements for storage or treatment of hazardous wastes.	ARAR	Applies to actions involving excavation and disposal of contaminated soil exceeding TCLP limits.
NR 605–Hazardous Waste Classification	Establishes criteria for the classification of hazardous waste.	ARAR	Contaminated soil may exceed TCLP toxicity characteristic levels and be considered a hazardous waste if recovered from ground.
NR 610 to NR 615–Small and Large Quantity Generator Standards	Specifies transportation standards for hazardous waste based on RCRA standards.	ARAR	Relevant and appropriate for offsite management of hazardous substances. Would also apply to any treatment residuals from water treatment units, including spent activated carbon.
NR 670–Miscellaneous Unit Standards	Establishes standards for environmental performance of miscellaneous treatment units.	ARAR	Placement of treated or untreated soil that is classified as hazardous waste may make NR 660 applicable, unless exemption under NR 680.04 is granted.
NR 675–Land Disposal Restrictions	Identifies hazardous wastes that are restricted from land disposal and defines exceptions.	ARAR	Soils and debris exceeding TCLP level or considered to contain listed waste-type contamination may not be disposed in a landfill without treatment. After treatment, characteristic waste-type soils and debris may be disposed of in a Subtitle D landfill. Soils and debris with listed waste-type contamination after treatment must be disposed of in a Subtitle C landfill.
NR 718–Management of Solid Wastes Excavated During Response Actions	Describes requirements for temporary storage, treatment, transportation, and disposal of contaminated soil and other non-hazardous solid wastes resulting from cleanup activities.	ARAR	Applicable if excavated soil are not hazardous and relevant and appropriate for hazardous wastes (as defined by NR 600.03).
NR 722–Standards for Selecting Remedial Actions	Describes requirements for identifying and evaluating remedial action options and selecting remedial actions.	ARAR	Requirements specified are consist with remedy selection in FS process.
NR 724–Remedial and Interim Action Design, Implementation, Operation, Maintenance, and Monitoring Requirements	Specifies the requirements for the design, implementation, operation, maintenance and monitoring of remedial actions.	ARAR	Design and implementation will conform to requirements specified.
NR 812–Well Construction and Pump Installation	Establishes the standards and methods for construction of new extraction wells and requirements for new pump installations.	ARAR	Construction of extraction wells will conform to standards specified.
NR 812.05–Disposal of Pollutants; Injection Prohibition	Specifies that injection of any waste to surface or subsurface water is allowed if approved by WDNR.	ARAR	Injection of treated groundwater will require approval from WDNR.
NR 812.37–Water Treatment	Describes the requirements for installation of point of use or in-house water treatment systems and establishes the need for WDNR approval.	Not ARAR	Point-of-use or in-house water treatment devices are not included in remedial alternatives.
Chapter 147 Statutes–Pollution Discharge Elimination	Requires point source discharges to obtain a permit from WDNR.	ARAR	Substantive requirements in obtaining a permit would have to be met for discharges to Davy Creek.

Note: Federal ARARs are included above however where the State of Wisconsin has authorization for the program the State of Wisconsin ARARs apply.

Appendix B

Detailed Cost Estimates

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: Oconomowoc Electroplating Company, Inc., Ashippun, WI
Media: Groundwater
Phase: Focused Feasibility Study

Base Year: 2010
Date: 7/8/2010 15:25

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	No Further Action	MNA	Source Zone Removal/In Situ Treatment and MNA	Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long Term Monitoring	Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA
Total Project Duration (Years)	50	50	15	5	5
Capital Cost	$0	$0	$620,000	$870,000	$760,000
Annual O&M Cost	$0	$45,000	$45,000	$280,000	$45,000
Total Periodic Cost	$150,000	$150,000	$45,000	$15,000	$15,000
Total Present Value of Alternative	$77,000	$1,300,000	$1,200,000	$2,200,000	$980,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.

Alternative: **Alternative 1** **COST ESTIMATE SUMMARY**
Name: **No Further Action**

Site: Oconomowoc Electroplating Company, Inc., Ashippun, \
Media: Groundwater
Phase: Focused Feasibility Study
Base Year: 2010
Date: 7/8/2010 15:25

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$0	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 2.7%

http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (2.7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	27.26	$0	
PERIODIC COST	5	$15,000	$15,000	0.88	$13,129	
PERIODIC COST	10	$15,000	$15,000	0.77	$11,492	
PERIODIC COST	15	$15,000	$15,000	0.67	$10,059	
PERIODIC COST	20	$15,000	$15,000	0.59	$8,804	
PERIODIC COST	25	$15,000	$15,000	0.51	$7,706	
PERIODIC COST	30	$15,000	$15,000	0.45	$6,745	
PERIODIC COST	35	$15,000	$15,000	0.39	$5,904	
PERIODIC COST	40	$15,000	$15,000	0.34	$5,167	
PERIODIC COST	45	$15,000	$15,000	0.30	$4,523	
PERIODIC COST	50	$15,000	$15,000	0.26	$3,959	
		$150,000			$77,487	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$77,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative 2** — **COST ESTIMATE SUMMARY**
Name: **MNA**

Site: Oconomowoc Electroplating Company, Inc., Ashippun, WI
Media: Groundwater
Phase: Focused Feasibility Study
Base Year: 2010
Date: 7/8/2010 15:25

Description: Compliance and MNA groundwater and surface water sampling would be conducted annually using existing monitoring network.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Groundwater and Surface Water Sampling						Assumed Level D
Groundwater Compliance Samples		37	EA	$65	$2,405	Contractor Estimate
Groundwater MNA Samples		22	EA	$175	$3,850	Contractor Estimate
Groundwater Compliance QC Samples		8	EA	$65	$520	Contractor Estimate
Groundwater MNA QC Samples		7	EA	$175	$1,225	Contractor Estimate
Surface Water Compliance Samples		3	EA	$65	$195	Contractor Estimate
Surface Water Compliance QC Samples		3	EA	$65	$195	Contractor Estimate
Labor		225	HRS	$80	$18,000	CH2M Est. - 4 persons
Equipment - meters		1	LS	$2,000	$2,000	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		20	HRS	$90	$1,800	CH2M Est.
Reporting		40	HRS	$90	$3,600	CH2M Est.
SUBTOTAL					$34,290	
Contingency		30%			$10,287	10% Scope + 20% Bid
SUBTOTAL					$44,577	
TOTAL ANNUAL O&M COST Year 1 to 50					**$45,000**	Yearly

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 2.7%

http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (2.7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST - Annual Sampling	1 to 50	$2,250,000	$45,000	27.26	$1,226,794	
PERIODIC COST	5	$15,000	$15,000	0.88	$13,129	
PERIODIC COST	10	$15,000	$15,000	0.77	$11,492	
PERIODIC COST	15	$15,000	$15,000	0.67	$10,059	
PERIODIC COST	20	$15,000	$15,000	0.59	$8,804	
PERIODIC COST	25	$15,000	$15,000	0.51	$7,706	
PERIODIC COST	30	$15,000	$15,000	0.45	$6,745	
PERIODIC COST	35	$15,000	$15,000	0.39	$5,904	
PERIODIC COST	40	$15,000	$15,000	0.34	$5,167	
PERIODIC COST	45	$15,000	$15,000	0.30	$4,523	
PERIODIC COST	50	$15,000	$15,000	0.26	$3,959	
		$2,400,000			$1,304,282	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$1,300,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative 3**
Name: **Source Zone Removal/In Situ Treatment and MNA**

COST ESTIMATE SUMMARY

Site: Oconomowoc Electroplating Company, Inc., Ashippun, WI
Media: Groundwater
Phase: Focused Feasibility Study
Base Year: 2010
Date: 7/8/2010 15:25

Description: Source zone dissolved phase VOCs would be delineated then either removed via excavation and shipped offsite to non-hazardous/hazardous waste facility or treated in situ using shallow soil mixing. For delineation, assume ~area of 40,000 square feet, w/25' spacing using membrane interface probe (MIP) technology followed by soil confirmation sampling. Source zone removal/in situ treatment assumed to be 1,600 cubic yards (CY) based on historical data, but will be refined following delineation activities. For excavation, 900 CY removal required for benching, to be reused in backfill (total excavation volume = 2,500 CY).

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Source Zone Delineation - Pre-Design Investigation					Assume ~150 feet/day
Mobilization/Demobilization	1	LS	$1,000	$1,000	Contractor Estimate
Per Diem - requires extra DY beyond length of proj.	10	CREW DY	$310	$3,100	Contractor Estimate
Consumable	9	DAY	$150	$1,350	Contractor Estimate
Membrane Interface Probing	9	DAY	$2,100	$18,900	Contractor Estimate
Data Uploads (Real Time)	9	DAY	$150	$1,350	Contractor Estimate
Data Report	1	LS	$500	$500	Contractor Estimate
Contracts/Submissions	1	LS	$150	$150	Contractor Estimate
3D Data Report	1	LS	$1,600	$1,600	Contractor Estimate
Direct Push Drilling Services	10	DAY	$1,600	$16,000	Contractor Estimate
Oversight Labor	100	HR	$80	$8,000	CH2M HILL; 1 person
Confirmation Soil Sampling	9	EA	$80	$720	Assume 10% of locations for VOC analysis
Data Evaluation and Report Preparation	40	HR	$100	$4,000	CH2M HILL; 1 person
SUBTOTAL				$56,670	
Source Zone Removal/In Situ Treatment					
Mobilization/Demobilization					
Mobilization/Demobilization	1	LS	$20,000	$20,000	Assume equip. for excavation/ISSM similar
Site Security	5	DAY	$420	$2,100	Overnight Security Guard @14 hr/day
Surveying	1	DAY	$2,000	$2,000	Post excavation/in situ treatment survey
Perimeter fencing (Temp. chain link)	800	LF	$16	$12,800	Around treatment areas. Assume 200'x200'
Erosion, sediment, and flood controls	1	LS	$5,000	$5,000	Silt fence, const. entry/exit, inlet protect, etc.
Air Monitoring	2	WK	$400	$800	Assume PID and Dust
Submittals/Project Closeout	1	LS	$5,000	$5,000	
SUBTOTAL				$47,700	
Soil Removal					
Excavation of soil, med. excavator + operator	5	DY	$1,500	$7,500	~600 CY/DY, 3 CY bucket, direct load
Laborers	5	DY	$1,200	$6,000	2 laborers at $60/HR EA for 10 HR/DY
Transportation of material to staging pad	900	CY	$5	$4,500	Material excavated for benching for reuse
Waste characterization	6	EA	$1,500	$9,000	Collect/analyze for RCRA disposal charact.
Transport excavated soil to Subtitle D landfill	2,016	TON	$10	$20,160	1.4 TN/CY; Contractor Estimate
Dispose of excavated soil at Subtitle D landfill	2,016	TON	$50	$100,800	1.4 TN/CY; Contractor Estimate
Transport excavated soil to Subtitle C landfill	224	TON	$75	$16,800	1.4 TN/CY; Contractor Estimate
Dispose of excavated soil at Subtitle C landfill	224	TON	$125	$28,000	1.4 TN/CY; Contractor Estimate
Confirmation sampling on backfill material	5	EA	$750	$3,750	per 1000 CY imported, VOCs, SVOCs, herbicides, pesticides, PCBs, metals
Backfill material procurement, transport, dump	1,850	CY	$16	$29,600	CH2M HILL Est.; exc. vol. +10% minus reuse
Backfill excavation, 12" lifts, spread and compact	2,750	CY	$9	$24,750	CH2M HILL Est.
Oversight Labor	50	HR	$80	$4,000	CH2M HILL 1 person, 5 DY, 10 HR/DY
SUBTOTAL				$254,860	
In Situ Soil Mixing (ISSM - For reference only)					
Soil Mixing	1,600	CY	$100	$160,000	Project Exper.
ZVI Amendment	45	TN	$750	$33,600	1.4 TN/CY of soil, 2% iron dry weight
Clay Amendment	22	TN	$160	$3,584	1.4TN/CY of soil, 1% clay by dry weight
Confirmation sampling on containment/backfill material	2	EA	$750	$1,500	per 1000 CY imported, VOCs, SVOCs, herbicides, pesticides, PCBs, metals
Containment berm construction	1,280	CY	$25	$32,000	Around each mix area, 6' high at 2:1 slope
Geotextile, 5' beyond perimeter of each mix area	944	SY	$4	$3,324	CH2M HILL Est., includes installation
Oversight Labor	50	HR	$80	$4,000	CH2M HILL 1 person, 5 DY, 10 HR/DY
				$11,520	
Backfill over geotextile	1,280	CY	$9		Project Exper; Assume ~3' thick - reuse of berm material
ISSM Patent Fee	1,600	CY	$7	$11,200	
SUBTOTAL				$260,728	
Site Restoration					
Seeding of Removal/In Situ Treatment Area	8,500	SF	$0.12	$1,020	CH2M HILL est.
Mulching and netting in place	8,500	SF	$0.76	$6,460	CH2M HILL est.
SUBTOTAL				$7,480	
RCRA Small Quantity Generator Permit					
Permit Application	40	HR	$90	$3,600	CH2M HILL 1 person
SUBTOTAL				$3,600	
SUBTOTAL				$370,310	
Contingency	25%			$92,578	10% Scope + 15% Bid
SUBTOTAL				$462,888	
Project Management	8%			$37,031	USEPA 2000, p. 5-13, $100K-$500K
Remedial Design	15%			$69,433	USEPA 2000, p. 5-13, $100K-$500K
Construction Management	10%			$46,289	USEPA 2000, p. 5-13, $100K-$500K
SUBTOTAL				$152,753	
TOTAL CAPITAL COST (Delineation and Soil Removal)				**$620,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater and Surface Water Sampling						Assumed Level D
Groundwater Compliance Samples		37	EA	$65	$2,405	Contractor Estimate
Groundwater MNA Samples		22	EA	$175	$3,850	Contractor Estimate
Groundwater Compliance QC Samples		8	EA	$65	$520	Contractor Estimate
Groundwater MNA QC Samples		7	EA	$175	$1,225	Contractor Estimate
Surface Water Compliance Samples		3	EA	$65	$195	Contractor Estimate
Surface Water Compliance QC Samples		3	EA	$65	$195	Contractor Estimate
Labor		225	HRS	$80	$18,000	CH2M Est. - 4 persons
Equipment - meters		1	LS	$2,000	$2,000	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		20	HRS	$90	$1,800	CH2M Est.
Reporting		40	HRS	$90	$3,600	CH2M Est.
SUBTOTAL					$34,290	
Contingency		30%			$10,287	10% Scope + 20% Bid
SUBTOTAL					$44,577	
TOTAL ANNUAL O&M COST Year 1 to 15					**$45,000**	Yearly

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
TOTAL ANNUAL PERIODIC COST					**$45,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 2.7%   http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (2.7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$620,000	$620,000	1.000	$620,000	
ANNUAL O&M COST	1 to 15	$675,000	$45,000	12.20	$549,052	
PERIODIC COST	5	$15,000	$15,000	0.88	$13,129	
PERIODIC COST	10	$15,000	$15,000	0.77	$11,492	
PERIODIC COST	15	$15,000	$15,000	0.67	$10,059	
		$1,340,000			$1,203,732	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$1,200,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative 4** — **COST ESTIMATE SUMMARY**

Name: **Source Zone Removal/In Situ Treatment, Groundwater Extraction and Treatment, and Long Term Monitoring**

Site: Oconomowoc Electroplating Company, Inc., Ashippun, WI
Media: Groundwater
Phase: Focused Feasibility Study
Base Year: 2010
Date: 7/8/2010 15:34

Description: Source zones would be removed or treated in situ followed by installation and connection of three extraction wells to existing onsite water treatment system. Groundwater would be treated using air stripping and carbon adsorption and discharged to Davy Creek.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Source Zone Delineation - Pre-Design Investigation					Assume ~150 feet/day
Mobilization/Demobilization	1	LS	$1,000	$1,000	Contractor Estimate
Per Diem - requires extra DY beyond length of proj.	10	CREW DY	$310	$3,100	Contractor Estimate
Consumable	9	DAY	$150	$1,350	Contractor Estimate
Membrane Interface Probing	9	DAY	$2,100	$18,900	Contractor Estimate
Data Uploads (Real Time)	9	DAY	$150	$1,350	Contractor Estimate
Data Report	1	LS	$500	$500	Contractor Estimate
Contracts/Submissions	1	LS	$150	$150	Contractor Estimate
3D Data Report	1	LS	$1,600	$1,600	Contractor Estimate
Direct Push Drilling Services	10	DAY	$1,600	$16,000	Contractor Estimate
Oversight Labor	100	HR	$80	$8,000	CH2M HILL; 1 person
Confirmation Soil Sampling	9	EA	$80	$720	Assume 10% of locations for VOC analysis
Data Evaluation and Report Preparation	40	HR	$100	$4,000	CH2M HILL; 1 person
SUBTOTAL				$56,670	
Source Zone Removal/In Situ Treatment					
Mobilization/Demobilization					
Mobilization/Demobilization	1	LS	$20,000	$20,000	Assume equip. for excavation/ISSM similar
Site Security	5	DAY	$420	$2,100	Overnight Security Guard @14 hr/day
Surveying	1	DAY	$2,000	$2,000	Post excavation/in situ treatment survey
Perimeter fencing (Temp. chain link)	800	LF	$16	$12,800	Around treatment areas. Assume 200'x200'
Erosion, sediment, and flood controls	1	LS	$5,000	$5,000	Silt fence, const. entry/exit, inlet protect, etc.
Air Monitoring	2	WK	$400	$800	Assume PID and Dust
Submittals/Project Closeout	1	LS	$5,000	$5,000	
SUBTOTAL				$47,700	
Soil Removal					
Excavation of soil, med. excavator + operator	5	DY	$1,500	$7,500	~600 CY/DY, 3 CY bucket, direct load
Laborers	5	DY	$1,200	$6,000	2 laborers at $60/HR EA for 10 HR/DY
Transportation of material to staging pad	900	CY	$5	$4,500	Material excavated for benching for reuse
Waste characterization	6	EA	$1,500	$9,000	Collect/analyze for RCRA disposal charact.
Transport excavated soil to Subtitle D landfill	2,016	TON	$10	$20,160	1.4 TN/CY; Contractor Estimate
Dispose of excavated soil at Subtitle D landfill	2,016	TON	$50	$100,800	1.4 TN/CY; Contractor Estimate
Transport excavated soil to Subtitle C landfill	224	TON	$75	$16,800	1.4 TN/CY; Contractor Estimate
Dispose of excavated soil at Subtitle C landfill	224	TON	$125	$28,000	1.4 TN/CY; Contractor Estimate
Confirmation sampling on backfill material	5	EA	$750	$3,750	per 1000 CY imported, VOCs, SVOCs, herbicides, pesticides, PCBs, metals
Backfill material procurement, transport, dump	1,850	CY	$16	$29,600	CH2M HILL Est.; exc. vol. +10% minus reuse
Backfill excavation, 12" lifts, spread and compac	2,750	CY	$9	$24,750	CH2M HILL Est.
Oversight Labor	50	HR	$80	$4,000	CH2M HILL 1 person, 5 DY, 10 HR/DY
SUBTOTAL				$254,860	
In Situ Soil Mixing (ISSM - For reference only)					
Soil Mixing	1,600	CY	$100	$160,000	Project Exper.
ZVI Amendment	45	TN	$750	$33,600	1.4 TN/CY of soil, 2% iron dry weight
Clay Amendment	22	TN	$160	$3,584	1.4TN/CY of soil, 1% clay by dry weight
Confirmation sampling on containment/backfill material	2	EA	$750	$1,500	per 1000 CY imported, VOCs, SVOCs, herbicides, pesticides, PCBs, metals
Containment berm construction	1,280	CY	$25	$32,000	Around each mix area, 6' high at 2:1 slope
Geotextile, 5' beyond perimeter of each mix area	944	SY	$4	$3,324	CH2M HILL Est., includes installation
Oversight Labor	50	HR	$80	$4,000	CH2M HILL 1 person, 5 DY, 10 HR/DY
Backfill over geotextile	1,280	CY	$9	$11,520	Project Exper; Assume ~3' thick - reuse of berm material
ISSM Patent Fee	1,600	CY	$7	$11,200	
SUBTOTAL				$260,728	
Site Restoration					
Seeding of Removal/In Situ Treatment Area	8,500	SF	$0.12	$1,020	CH2M HILL est.
Mulching and netting in place	8,500	SF	$0.76	$6,460	CH2M HILL est.
SUBTOTAL				$7,480	
RCRA Small Quantity Generator Permit					
Permit Application	40	HR	$90	$3,600	CH2M HILL 1 person
SUBTOTAL				$3,600	
SUBTOTAL (Dealineation and Soil Removal)				$370,310	
Contingency	25%			$92,578	10% Scope + 15% Bid
SUBTOTAL				$462,888	
Project Management	6%			$27,773	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$55,547	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$37,031	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$120,351	
TOTAL CAPITAL COST (Dealineation and Soil Removal)				**$590,000**	
Extraction Well Installation					
Mobilization/Demobilization	1	LS	$5,000	$5,000	Includes submittals, decon, etc.
Construction of access road	200	LF	$27	$5,400	Assumes gravel road (20-ft wide and 6-in thick)
Private Utility Locate	1	LS	$2,000	$2,000	Project Exper
Hollow-Stem Auger Drilling (8.25" ID)	135	LF	$95	$12,825	CH2M HILL est.
6-inch Carbon Steel Well Casing	45	LF	$65	$2,925	Contractor Estimate
6-inch Stainless Steel Well Screen (10')	90	LF	$198	$17,820	Contractor Estimate
Well Construction Materials (bentonite, sand, etc.)	135	LF	$30	$4,050	Contractor Estimate
Well Vault and Installation	3	EA	$1,900	$5,700	Contractor Estimate
Well flow meter	3	EA	$2,500	$7,500	Project Exper
Well VFD	3	EA	$2,500	$7,500	Project Exper
Well Development	3	EA	$250	$750	CH2M HILL est.
Trenching	450	LF	$25	$11,250	Contractor Estimate
1.5-inch HDPE Conveyance Piping	450	LF	$0.28	$126	CH2M HILL est.
4-inch HDPE Conveyance Piping	450	LF	$2.95	$1,328	CH2M HILL est.
Conveyance Piping/Misc Fittings	450	LF	$50	$22,500	Installation cost
Electrical Installation/Connection	450	LF	$20	$9,000	Assume parallel to conveyance
Groundwater Extraction Pumps	3	EA	$1,300	$3,900	CH2M HILL est.; Grundfos submersible or similar
Surveying	1	DAY	$2,000	$2,000	Project Exper
Frac Tank	1	EA	$1,500	$1,500	Assume 1 mo. Rental, treat water after particle settling
Frac Tank Cleaning and Disposal	1	LS	$2,000	$2,000	Project Exper
Roll-Off Box	1	EA	$2,000	$2,000	Lined, to manage soil cuttings - approx. 20 ton capacity
Transport soil cuttings to Subtitle D landfill	8	TON	$10	$77	1.5 T/CY, 30% swell; Contractor Estimate
Dispose of soil cuttings at Subtitle D landfill	8	TON	$50	$383	1.5 T/CY, 30% swell; Contractor Estimate
Oversight Labor	100	HR	$80	$8,000	CH2M HILL 1 person, 10 DY, 10 HR/DY
Drilling Crew Per Diem, assume 2 persons	10	DAY	$250	$2,500	Project Exper.
SUBTOTAL				$138,033	
Groundwater Treatment System Start-Up					
GAC Conduit/Control Box Relocation	1	LS	$5,000	$5,000	Move conduits overhead/relocate control boxes; CH2M Est.
GAC - Initial Replacement	2000	LB	$1.50	$3,000	Contractor Estimate
Extraction Well I&C Analog	6	EA	$400	$2,400	1 for each flow meter/VFD per well; Project Exper
Extraction Well I&C Discrete	6	EA	$250	$1,500	1 on, 1 off for each pump; Project Exper
Equipment replacement	1	LS	$15,000	$15,000	CH2M Est.
General Cleaning/Maintenance Prior to Start-Up	200	HR	$80	$16,000	2 people for 5 days @ 10 HR/DY; CH2M Est.
CH2M Hill Start-Up Labor	100	HR	$100	$10,000	2 people for 5 days @ 10 HR/DY; CH2M Est.
SUBTOTAL				$42,900	
SUBTOTAL (EW Installation and Treatment Start-Up)				$180,933	
Contingency	25%			$45,233	10% Scope + 15% Bid
SUBTOTAL				$226,166	
Project Management	6%			$13,570	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$27,140	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$18,093	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$58,803	
TOTAL CAPITAL COST (EW Installation and Treatment Start-Up)				**$280,000**	
TOTAL CAPITAL COST				**$870,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater Treatment System O&M						
Routine Operations and Monitoring		1,040	HR	$90	$93,600	1 Personnel part time, approx. 20 HR/week
Pump and Well Maintenance/Cleaning		4	EA	$8,975	$35,900	Contractor Estimate
GAC change-out		4,000	LB	$1.21	$4,850	Contractor Estimate; One 1,000 lb unit quarterly, incl. material/labor/T&D non-hazardous
pH Adjustment - Acid		400	GAL	$1	$400	Assume sulfuric acid, 100 GAL/quarter
Utilities (Gas, Electricity, Water, etc.)		12	MO	$2,000	$24,000	Avg. gas=$510/mo, electrical=$1,100/mo during operation
Snow Removal/Landscaping		1	YR	$5,000	$5,000	CH2M Est.
Reporting		40	HRS	$80	$3,200	CH2M Est.
Project Management		5%			$8,188	
SUBTOTAL					$175,138	
Contingency		30%			$52,541	10% Scope + 20% Bid
SUBTOTAL					$230,000	
Groundwater and Surface Water Sampling						Assumed Level D
Groundwater Compliance Samples		40	EA	$65	$2,600	Contractor Estimate
Groundwater MNA Samples		25	EA	$175	$4,375	Contractor Estimate
Groundwater Compliance QC Samples		8	EA	$65	$520	Contractor Estimate
Groundwater MNA QC Samples		7	EA	$175	$1,225	Contractor Estimate
Surface Water Compliance Samples		3	EA	$65	$195	Contractor Estimate
Surface Water Compliance QC Samples		3	EA	$65	$195	Contractor Estimate
Labor		225	HRS	$80	$18,000	CH2M Est. - 4 persons
Equipment - meters		1	LS	$2,000	$2,000	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		20	HRS	$90	$1,800	CH2M Est.
Reporting		40	HRS	$90	$3,600	CH2M Est.
SUBTOTAL					$35,010	
Contingency		30%			$10,503	10% Scope + 20% Bid
SUBTOTAL					$46,000	
TOTAL ANNUAL O&M COST Year 1 to 5					**$280,000**	Yearly

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
SUBTOTAL					$15,000	
TOTAL ANNUAL PERIODIC COST					**$15,000**	

Discount Rate = 2.7% http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (2.7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$870,000	$870,000	1.000	$870,000	
ANNUAL O&M COST (system operation)	1 to 5	$1,150,000	$230,000	4.62	$1,062,416	
ANNUAL O&M COST (LTM only)	1 to 5	$230,000	$46,000	4.62	$212,483	
PERIODIC COST	5	$15,000	$15,000	0.88	$13,129	
		$2,265,000			$2,158,029	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$2,200,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative 5**

Name: **Source Zone Removal/In Situ Treatment, Substrate Injection, and MNA**

COST ESTIMATE SUMMARY

Site: Oconomowoc Electroplating Company, Inc., Ashippun, WI
Media: Groundwater
Phase: Focused Feasibility Study
Base Year: 2010
Date: 7/8/2010 16:10

Description: Source zones would be removed or treated in situ followed by one time substrate injection to enhance bioremediation of CVOCs in groundwater. Assumed substrate material is emulsified oil for costing purposes. Replacement of residential water supply wells is included as a contingency in the event of an increase in concentration of COCs or degradation products above drinking water standards due to substrate injection, but is not included in the total cost for this alternative.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Source Zone Delineation - Pre-Design Investigation					Assume ~150 feet/day
Mobilization/Demobilization	1	LS	$1,000	$1,000	Contractor Estimate
Per Diem - requires extra DY beyond length of proj.	10	CREW DY	$310	$3,100	Contractor Estimate
Consumable	9	DAY	$150	$1,350	Contractor Estimate
Membrane Interface Probing	9	DAY	$2,100	$18,900	Contractor Estimate
Data Uploads (Real Time)	9	DAY	$150	$1,350	Contractor Estimate
Data Report	1	LS	$500	$500	Contractor Estimate
Contracts/Submissions	1	LS	$150	$150	Contractor Estimate
3D Data Report	1	LS	$1,600	$1,600	Contractor Estimate
Direct Push Drilling Services	10	DAY	$1,600	$16,000	Contractor Estimate
Oversight Labor	100	HR	$80	$8,000	CH2M HILL; 1 person
Confirmation Soil Sampling	9	EA	$80	$720	Assume 10% of locations for VOC analysis
Data Evaluation and Report Preparation	40	HR	$100	$4,000	CH2M HILL; 1 person
SUBTOTAL				$56,670	
Source Zone Removal/In Situ Treatment					
Mobilization/Demobilization					
Mobilization/Demobilization	1	LS	$20,000	$20,000	Assume equip. for excavation/ISSM similar
Site Security	5	DAY	$420	$2,100	Overnight Security Guard @14 hr/day
Surveying	1	DAY	$2,000	$2,000	Post excavation/in situ treatment survey
Perimeter fencing (Temp. chain link)	800	LF	$16	$12,800	Around treatment areas. Assume 200'x200'
Erosion, sediment, and flood controls	1	LS	$5,000	$5,000	Silt fence, const. entry/exit, inlet protect, etc.
Air Monitoring	2	WK	$400	$800	Assume PID and Dust
Submittals/Project Closeout	1	LS	$5,000	$5,000	
SUBTOTAL				$47,700	
Soil Removal					
Excavation of soil, med. excavator + operator	5	DY	$1,500	$7,500	~600 CY/DY, 3 CY bucket, direct load
Laborers	5	DY	$1,200	$6,000	2 laborers at $60/HR EA for 10 HR/DY
Transportation of material to staging pad	900	CY	$5	$4,500	Material excavated for benching for reuse
Waste characterization	6	EA	$1,500	$9,000	Collect/analyze for RCRA disposal charact.
Transport excavated soil to Subtitle D landfill	2,016	TON	$10	$20,160	1.4 TN/CY; Contractor Estimate
Dispose of excavated soil at Subtitle D landfill	2,016	TON	$50	$100,800	1.4 TN/CY; Contractor Estimate
Transport excavated soil to Subtitle C landfill	224	TON	$75	$16,800	1.4 TN/CY; Contractor Estimate
Dispose of excavated soil at Subtitle C landfill	224	TON	$125	$28,000	1.4 TN/CY; Contractor Estimate
Confirmation sampling on backfill material	5	EA	$750	$3,750	per 1000 CY imported, VOCs, SVOCs, herbicides, pesticides, PCBs, metal
Backfill material procurement, transport, dum	1,850	CY	$16	$29,600	CH2M HILL Est.; exc. vol. +10% minus reuse
Backfill excavation, 12" lifts, spread and compa	2,750	CY	$9	$24,750	CH2M HILL Est.
Oversight Labor	50	HR	$80	$4,000	CH2M HILL 1 person, 5 DY, 10 HR/DY
SUBTOTAL				$254,860	
In Situ Soil Mixing (ISSM - For reference only)					
Soil Mixing	1,600	CY	$100	$160,000	Project Exper.
ZVI Amendment	45	TN	$750	$33,600	1.4 TN/CY of soil, 2% iron dry weight
Clay Amendment	22	TN	$160	$3,584	1.4TN/CY of soil, 1% clay by dry weight
Confirmation sampling on containment/backfill material	2	EA	$750	$1,500	per 1000 CY imported, VOCs, SVOCs, herbicides, pesticides, PCBs, metals
Containment berm construction	1,280	CY	$25	$32,000	Around each mix area, 6' high at 2:1 slope
Geotextile, 5' beyond perimeter of each mix area	944	SY	$4	$3,324	CH2M HILL Est., includes installation
Oversight Labor	50	HR	$80	$4,000	CH2M HILL 1 person, 5 DY, 10 HR/DY
Backfill over geotextile	1,280	CY	$9	$11,520	Project Exper; Assume ~3' thick - reuse of berm material
ISSM Patent Fee	1,600	CY	$7	$11,200	
SUBTOTAL				$260,728	
Site Restoration					
Seeding of Removal/In Situ Treatment Area	8,500	SF	$0.12	$1,020	CH2M HILL est.
Mulching and netting in place	8,500	SF	$0.76	$6,460	CH2M HILL est.
SUBTOTAL				$7,480	
RCRA Small Quantity Generator Permit					
Permit Application	40	HR	$90	$3,600	CH2M HILL 1 person
SUBTOTAL				$3,600	
SUBTOTAL				$370,310	
Contingency	25%			$92,578	10% Scope + 15% Bid
SUBTOTAL				$462,888	
Project Management	6%			$27,773	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$55,547	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$37,031	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$120,351	
TOTAL CAPITAL COST (Delineation and Soil Removal)				**$580,000**	
One Time Substrate Injection					
Mobilization/Demobilization	1	LS	$2,000	$2,000	Contractor Estimate
Substrate Material	23100	LBS	$2	$46,200	$4/lb soil in a cylinder 10 feet high, 20 fee diameter; 23,100 lbs material
Potable Water	76,500	GAL	$0.05	$3,825	Contractor Estimate. 5-18,000 gal tanks for 1 mo. For estimated 76,500 gal of water
Frac Tank Rental	5	EA	$1,500	$7,500	Contractor Estimate; 1 mo. Rental
Geoprobe daily rate (Track Rig)	9	DAY	$2,000	$18,000	Contractor Estimate
Pump at 5 gpm @1850 psi	9	DAY	$500	$4,500	Contractor Estimate
Inoculant mixing unit	9	DAY	$300	$2,700	Contractor Estimate
100 feet of HP injection line	1	LS	$350	$350	Contractor Estimate
Skid steer/fork lift	9	DAY	$400	$3,600	Contractor Estimate
Drum pump	9	DAY	$50	$450	Contractor Estimate
Second Tech	9	DAY	$450	$4,050	Contractor Estimate
Consumables	9	DAY	$100	$900	Contractor Estimate
Subcontractor per diem, 2 men, 9 nights	18	DAY	$135	$2,430	Contractor Estimate
Oversight Labor	90	HR	$80	$7,200	CH2M Hill Est.; 1 person for 9 days, 10 hr/day
Oversight Per Diem	9	DAY	$50	$450	CH2M Hill Est.; 1 person for 9 days, 10 hr/day
Summary Report of Injection	80	HR	$100	$8,000	CH2M Hill Est.; Brief Report
SUBTOTAL				$112,155	
Residential Water Supply Well Replacement (For reference only)					
Well Abandonment	11	EA	$1,009	$11,094	Contractor Estimate
New Well Installation	11	EA	$6,210	$68,310	Contractor Estimate
New Well Pump Installation	11	EA	$3,000	$33,000	Contractor Estimate; Assumes existing connections used
Oversight Labor	350	HR	$80	$28,000	CH2M HILL 1 person, 20 DY, 10 HR/DY
SUBTOTAL				$140,404	
SUBTOTAL (Substrate Injection Only)				$112,155	
Contingency	25%			$28,039	10% Scope + 15% Bid
SUBTOTAL				$140,194	
Project Management	6%			$8,412	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$16,823	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$11,216	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$36,450	
TOTAL CAPITAL COST (Substrate Injection Only)				**$180,000**	
TOTAL CAPITAL COST				**$760,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater and Surface Water Sampling						Assumed Level D
Groundwater Compliance Samples		37	EA	$65	$2,405	Contractor Estimate
Groundwater MNA Samples		22	EA	$175	$3,850	Contractor Estimate
Groundwater Compliance QC Samples		8	EA	$65	$520	Contractor Estimate
Groundwater MNA QC Samples		7	EA	$175	$1,225	Contractor Estimate
Surface Water Compliance Samples		3	EA	$65	$195	Contractor Estimate
Surface Water Compliance QC Samples		3	EA	$65	$195	Contractor Estimate
Labor		225	HRS	$80	$18,000	CH2M Est. - 4 persons
Equipment - meters		1	LS	$2,000	$2,000	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		20	HRS	$90	$1,800	CH2M Est.
Reporting		40	HRS	$90	$3,600	CH2M Est.
SUBTOTAL					$34,290	
Contingency		30%			$10,287	10% Scope + 20% Bid
SUBTOTAL					$44,577	
TOTAL ANNUAL O&M COST Year 1 to 5					**$45,000**	Yearly

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
SUBTOTAL					$15,000	
TOTAL ANNUAL PERIODIC COST					**$15,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 2.7%

http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.htm

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (2.7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$760,000	$760,000	1.000	$760,000	
ANNUAL O&M COST	1 to 5	$225,000	$45,000	4.62	$207,864	
PERIODIC COST	5	$15,000	$15,000	0.88	$13,129	
		$1,000,000			$980,993	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$980,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000)