State of Oregon
Department of
Environmental
Quality

# RECORD OF DECISION

## SELECTED REMEDIAL ACTION

## For

# MILWAUKIE INTERNATIONAL WAY SITE
## MILWAUKIE, OREGON

**ECSI No. 2079**

**Prepared By**

**OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY**
**Northwest Region Office**

**January 2007**

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ACRONYMS

bgs: below ground surface
BTEX: Benzene, toluene, ethene, xylene
COC: Chemicals of Concern
COI: Chemicals of Interest
COPC: Chemicals of Potential Concern
CU: Confining Unit
CVOCs: Chlorinated Volatile Organic Compounds
CW: City Well
cy: cubic yards
DCE: dichloroethene
DEQ: Department of Environmental Quality
DNAPL: Dense Non-Aqueous Phase Liquid
EPA: United States Environmental Protection Agency
EES: Equitable Easement and Servitude
ELCR: Excess Lifetime Cancer Risk
EPC: Exposure Point Concentration
ERA: Ecological Risk Assessment
EXT: Extraction Well
FS: Feasibility Study
GCWs: Groundwater Circulation Wells
GRAs: General Response Actions
gpm: Gallons per minute
HHRA: Human Health Risk Assessment
HI: Hazard Index
HQ: Hazard Quotient
IRM: Interim Remedial Measure
LOF: Locality of the facility
MCL: Maximum Contaminant Level
µg/L: micrograms per liter
mg/kg: milligrams per kilogram
MFA: Maul Foster and Alongi
MIW: Milwaukie International Way
msl: mean sea level
MW: Monitoring Well
ND: Not Detected
OAR: Oregon Administrative Rule
ORS: Oregon Revised Statute
OSB: Off-Site Boring
PCE: Perchloroethene or tetrachloroethene
PRGs: Preliminary Remediation Goals
RA: Risk Assessment
RAOs: Remedial Action Objectives
RBCs: Risk Based Concentrations
RBCLs: Risk Based Cleanup Levels
RfD: Reference Dose
RI: Remedial Investigation

SVOCs: SemiVolatile Organic Compounds
TCE: Trichloroethene
TPH: Total Petroleum Hydrocarbons
UST: Underground Storage Tank
VOCs: Volatile Organic Compounds
VC: Vinyl Chloride
WRD: Water Resources Department

# 1. INTRODUCTION

## 1.1 INTRODUCTION

This document presents the selected remedial action for the Milwaukie International Way (MIW) site at 4288 SE International Way ("Revtek Property") and 4252 SE International Way ("Watumull Property") in Milwaukie Oregon, which was developed in accordance with Oregon Revised Statutes (ORS) 465.200 et. seq. and Oregon Administrative Rules (OAR) Chapter 340, Division 122, Sections 0010 through 0115.

The selected remedial action is based on the administrative record for this site. A copy of the Administrative Record Index is attached as Appendix A. This report summarizes the more detailed information contained in the following reports: Remedial Investigation and Risk Assessment (URS 2005a), and Draft Feasibility Study Report (URS 2006a). DEQ did not require a revision to the Draft Feasibility Study (FS) because the draft report satisfied the requirements of OAR 340-122-0085.

## 1.2 SCOPE AND ROLE OF THE SELECTED REMEDIAL ACTION

The selected remedial action addresses the presence of chlorinated volatile organic compounds (CVOCs) in contaminated groundwater, soil, and, air at the MIW site. The selected remedial action consists of the following elements:

- Continue groundwater extraction in the source area with the extraction well and extraction trench installed for the interim remedial measure;
- Continue to treat extracted groundwater through air stripping and carbon adsorption;
- Extract contaminated groundwater using additional extraction well(s) to prevent further downgradient migration of site contaminants in groundwater;
- Treat the source area with an in-situ bioremediation technology;
- Monitor groundwater in the source area and downgradient to confirm contaminant reduction and mass removal;
- Implement institutional controls;
- Perform periodic remedy review; and,
- Implement contingency measures as necessary.

# 2. SITE DESCRIPTION AND HISTORY

## 2.1 SITE DESCRIPTION AND LAND USE

The MIW site is located on SE International Way in Milwaukie, Clackamas County Oregon (Figure 2-1). The site consists of two adjoining properties located at 4288 SE International Way ("Revtek Property") and 4252 SE International Way ("Watumull Property") (Figure 2-2) and properties to the east, west, north and south where site contaminants have migrated in groundwater. The Revtek Property is designated as lot 7, block 2 of the Freeman Industrial Park and is being used currently for commercial property. The Watumull property is designated as lots 8 and 9 of the Freeman Industrial Park and is being used currently for commercial property. Walter and Alice Freeman (the Freemans) previously owned and operated the site as a single undivided parcel. Approximately one half of the Revtek property is either paved, or contains buildings, with the remaining half consisting of unpaved soil. The Watumull property is either paved or contains buildings with some landscaped areas.

## 2.2 PHYSICAL SETTING

### 2.2.1 Climate

Milwaukie receives approximately 38 inches of precipitation annually. Most of the precipitation falls between October and March. Monthly precipitation averages range from almost 6 inches in January, November and December to less than 1 inch in July and August. Summer daytime high temperatures typically range in the mid to upper 70s, with nighttime summer lows in the 50s. Historical winter daytime temperatures are typically between 40 and 50, while nighttime temperatures are in the mid to upper 30s.

### 2.2.2 Topography and Geology

The site it located at the southern end of the Portland Basin, a structural depression bounded on the west by the West Hills, the south by Oatfield Ridge, and the east by a cluster of small volcanic centers of the Boring Basalts. The floor of the basin, composed of flows of the Columbia River Basalt Group, lies between 1500 and 1700 feet below corresponding units in the surrounding hills.

The basin is filled with a series of formations comprising, for the most part, sediments from the Columbia and Willamette Rivers. Lowermost is the Sandy River Mudstone, a thick sequence of fine-grained lacustrine deposits laid down in a lake which formed at the confluence of the two rivers between approximately 5 and 8 million years ago.

The Sandy River Mudstone is overlain by the 2 to 5 million-year-old Troutdale Formation, a coarse-grained sequence deposited as a prograding delta of the Columbia River into the Portland Basin. It is characterized by intrusive and metamorphic rock lithologies from the headwaters of the Columbia River, specifically yellow quartzite.

Surficial material in the basin is fine- to coarse-grained fluvial sediments resulting from the Missoula Floods between 13,000 and 15,000 years ago. During the Frasier Glaciation the Clark Fork of the Columbia River in northern Idaho was blocked by an alpine glacier, backing up a large lake into western Montana. Failure of the ice dam produced a flood which spread over much of eastern Washington and was funneled through the Cascade Range along the Columbia River.

The traction load of coarse sediment at the base of these floods formed a series of foreset beds deposited from north to south as the floods slowed while moving up the Willamette Valley and lost carrying capacity. When the floods waters reached a hydrostatic level and stopped flowing altogether, forming a lake with a surface elevation near 400 feet, much of the suspended sediment load dropped out and formed fine-grained units on top of the coarse-grained traction load deposits. Reversed direction flow during draining of the ponded flood waters eroded some of the fine material.

These floods occurred numerous times, perhaps as many as 40, leading to sets of fine- and coarse-grained units. Later floods eroded channels into deposits from the earlier ones, creating discontinuous units disrupted by cut and fill features. The site is situated in one such channel where flood waters ran into Oatfield Ridge and turned to the southeast. The Clackamas River later occupied a portion of this channel but never reached the vicinity of the site, instead turning south about a mile east of the site and followed the course of modern Kellogg Creek.

The site itself sits on a slightly elevated ridge within the channel, an erosional remnant from scouring by one of the very last floods. The ridge is flanked by elongate trench-like features most probably the result of erosion by climbing nick points[1] during the waning stages of the flood. Directly under the ridge are three gravel units separated by very fine-grained beds referred to as confining units. In the erosional trench to the south of the ridge the fine-grained beds have not been definitely identified in well logs having evidently been removed during the formation of the nick point (Figure 2-3).

### 2.2.3 Hydrogeology

#### 2.2.3.1 Stratigraphy

The stratigraphy of the MIW investigation area includes the following zones described for the investigation: shallow, deep (upper, central, and lower), confining unit #1, sand and gravel, and confining unit #2. Figure 2-4 provides the plan view for the cross sections presented in Figures 2-5 and 2-6 describing the stratigraphy.

Shallow Zone –The Shallow Zone comprises fine grained deposits in approximately the first 20 feet below ground surface. They were deposited during the ebbing flow of the Missoula floods as part of the "channel facies" and are composed of interbedded combinations of sands and silts. In low lying areas, especially in the northeast portion of the study area on the Watumull property, organic-rich bog deposits in the form of peat are found overlying the channel facies material. This unit is definitively found on the

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[1] A nick point is a sudden change in elevation of the bed of a flowing body of water, causing the flow to become more turbulent and inducing erosion.

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XDP and Watumull properties and to the east in OBS-11 and OSB-12. It is not found in the eroded or elevated areas to the south and west.

Deep Zone – The deep zone is a gravel-rich series of discontinuous beds that are found throughout the study area. The beds under the elevated and low-lying erosional areas are not contemporaneous. The erosional area units were deposited as cut-and-fill structures during the waning flow of one of the Missoula Floods.

This zone is defined as occupying the section between the base of the fine-grained Shallow Zone and the underlying Confining Unit #1 (CU1). Since CU1 is not continuous over the area, the base of the Deep Zone has arbitrarily been defined at an elevation of 20 feet below sea level (-20 msl)

The Deep Zone has been subdivided into 3 sub-units; the Upper Deep Zone (20 to 30 feet bgs or approximately +70 to +60 msl), the Central Deep Zone (30 to 40 feet bgs or +60 to +50 msl), and the Lower Deep Zone (40 to 120 feet bgs or +50 to -30 msl). These are not actual hydrostratigraphic units; instead they represent stages in the investigation of the site. Lower depths were incrementally searched as shallow ones were found to be contaminated. The wells installed early in the investigation at the site identified as intermediate and deep are referred to stratigraphically as being in the upper and central deep zones.

The three sub-units of the Deep Zone are lithologically identical, being for the most part gravels with varying amounts of silt and sand in the matrix. There are rare discontinuous interbeds of sand up to a few feet thick found throughout the zone but they are not traceable between wells with any certainty.

Confining Unit #1 (CU1) – CU1 is a clay-rich layer, probably of lacustrine origin, that underlies only the more elevated portions of the site. It is found beneath the ridge to the south where MW-5 and MW-8 were installed and the immediate area of the XDP building. It is not found under the lower-lying erosional areas paralleling Highway 224. Of the 12 monitoring wells and temporary borings that are deep enough to intercept this unit, it is only found in 6 (OSB-5, OSB-7, OSB-8, OSB-11, OSB-12, and MW-19). It is generally gray to gray-green, plastic, and moist to dry. Despite its probably lacustrine origins, no lamination or bedding was noticed in cores and cuttings. The upper contact of CU1 is at approximately -20 msl and the unit varies in thickness from 10 feet in OSB-11 to 16 feet in OSB-7. It is occasionally intercalated with sand layers.

Sand and Gravel Unit – The Sand and Gravel Unit is defined as gravels set in a silt or sandy matrix and lying below CU1. Since CU1 is absent over a significant part of the study area it is difficult to determine the actual extent of this unit. It is definitely identifiable only in OSB-5, OSB-7 and MW-19. Thickness in those wells range from 10 feet in OSB7 to 40 feet in OSB-5. There are thick gravel sections seen in wells and borings in the erosional areas but the absence of CU1 shows that there has been erosion and re-deposition at least to -40 msl. Whether these gravels can be considered as part of the Sand and Gravel Unit is uncertain.

Confining Unit #2 (CU2) – CU2 is another clay layer of probable lacustrine origin. It is seen in OSB-5, OSB-7, MW-19 and OSB-9. Thicknesses range from only 2 feet in OSB-5 to at least 38 feet in OSB-7 (the base of the unit was not reached in OSB-7). The clay layer identified as CU2 in OSB-9 is at least 20 feet lower in elevation than in other wells. If this is the same unit it would indicate that fine-grained material settling out of the lacustrine environment was draping over an irregular, previously eroded surface with at least 20 feet of topographic variation.

2.2.3.2 Gradients

Horizontal – Horizontal gradients vary across the study area with depth. The Shallow Zone, which is found only in the elevated area around the XDP and Watumull properties, showed an outward radial pattern essentially following the surface topography (Figure 2-7). Since the operation of the Interim Remedial Measure (IRM) (see Section 2.5) began the flow has reversed and now is toward the extraction trench (Figure 2-8).

In the Upper and Central Deep Zones the gradient in the vicinity of the XDP building was to the west prior to the start of the IRM (Figure 2-9). As with the Shallow Zone, the flow direction reversed after IRM startup and the flow is now toward the extraction trench (Figure 2-10).

The Lower Deep Zone and the Sand and Gravel Zone show similar gradient patterns to one another. Near the XDP property flow is generally toward the west. Once the erosional area to the south is reached a northerly component is added turning the flow in a west-northwest direction. One well, OSB-8, shows lithology in the depth range of these two units that is very different from that seen in other wells. Instead of a series of gravels in a silty or sandy matrix, a thick sequence of silts, sands, and clays (from -10 msl to -160 msl) is encountered. The distinctly different lithology, especially since it is of a much finer-grained nature, makes inclusion of this well in a gradient map with the other wells of the study area debatable. If this well is not included in the maps, mapped flow in the deep units is toward the northwest which is consistent with contaminant distribution. Figures 2-11 and 2-12 show the gradient in these two zones when City Well 7 (CW-7) is pumping. When CW-7 is not pumping the gradient shifts more to the west-northwest under this interpretation.

Vertical – With rare exceptions vertical gradients across the entire study area are nearly flat or downward in the Deep Zone and Sand and Gravel Zone. In the low-lying erosional area gradients are also flat or downward except in the very lowest levels of OSB-6 where they are upward.

Please note that the above interpretation of groundwater flow is one of two current interpretations developed using data from the remedial investigation. The alternate interpretation presented in the draft FS is based on water level measurements and is largely driven by data collected at monitoring well OSB-8. The model of groundwater flow presented in the FS indicates groundwater contamination is not likely to migrate from the site to the OSB-10 area, however, it does not satisfactorily explain the distribution of contamination at the site observed during the remedial investigation. The presence of two different interpretations of gradient results in some uncertainty regarding whether or not the MIW site is the source of contamination found in the OSB-10 area. The other uncertainty is whether or not contamination, regardless of the source, in the OSB-9 area and OSB-10 area would migrate exclusively to the City Well 7 area.

### 2.2.4 Surface Water and Stormwater Features

Surface water features in the area of the site include the Willamette River, several creeks (e.g. Mount Scott Creek, Minthorn Creek and Kellogg Creek), small ponds and lakes. The Willamette River is located just over a mile to the west of the site. The river flows from south to north in the location where the river is closest to the site. The confluence of Minthorn Creek and Mount Scott Creek is located less than one-half mile southeast of the site and the confluence of Mount Scott Creek and Kellogg Creek is located approximately one mile south-southeast of the site. Stormwater from the site flows to the north to the storm drain on the northern end of the site and flows to the south to the storm drain on the southern end of the site. Groundwater does not discharge to surface water in the MIW study area so surface water was not included in the investigation.

## 2.3 SITE HISTORY

The Watumull and Revtek properties were initially a part of one undivided parcel owned by Walter and Alice Freeman. Between 1960 and 1980 parts machining was performed on the Freeman's property. The Freemans subdivided their land and in 1980 they deeded lots 8 and 9 of Freeman Industrial Park (the Watumull property) to Koll Northwest. The City constructed International Way between 1980 and 1984. The Lincoln Business Center was constructed in 1988 and is a complex of four buildings located on both sides of International Way used for commercial space. Building 4 of the Lincoln Business Center occupies tax lots 8 and 9. Watumull acquired these tax lots in 1996. Parts machining operations continued on the Revtek property from 1980 to 2002.

Machining operations on the site used cutting oils to cool, reduce friction, and remove metal pieces during machining. The process used solvents, including TCE (until 1979 or 1980), kerosene, and aqueous cleaners, to clean parts. For a period of time, a degreaser was located inside the building. Degreaser sludges and parts cleaning residues were placed outside the building. Waste from the degreasing operation appears to have been discharged to a sump which drained to a ditch to the northeast. Possible sources of contamination on the MIW property include the following: the former vapor degreaser, the former drain pipe and drainage ditch, cuttings storage and degreaser sludge disposal areas, the septic drainfield area, and former underground storage tanks (USTs) (Figure 2-2).

## 2.4 ENVIRONMENTAL INVESTIGATIONS

Environmental investigations were initiated at the site in 1989 as part of DEQ's area-wide groundwater investigation related to chlorinated volatile organic compounds (CVOCs) contamination in the City of Milwaukie wells. Several site investigations were conducted at the site between 1989 and 1998. Investigations included the following:

- Sampling of the inactive water supply well on the Revtek property which was part of the Milwaukie area-wide groundwater investigation (OHD, 1989);
- Preliminary Assessment (Golder, 1992)
- Preliminary Contamination Assessment, Revtek Property to identify the source of VOCs detected in the former site water supply well (Northwest Consultants of Oregon, 1993)
- Phase 1 Site Investigation, Revtek Property to further assess the source(s) of CVOCs and the nature and extent of CVOC-impacted groundwater (PTI, 1995);
- Phase II Site Investigation, Revtek Property to further characterize CVOC concentrations in groundwater and to further investigate on-site and nearby utility corridors and other drainage features that could influence groundwater flow (PTI, 1996);
- Phase III Site Investigation, Revtek Property to characterize CVOC concentrations in deeper groundwater (PTI, 1997);
- Phase I and Phase II Site Investigation, Milwaukie International Way to investigate, under the orphan site program, potential groundwater contamination to the north of the Revtek property on the Watumull property (Jacobs et al, 1998); and,
- Focused Source Investigation, Watumull and Revtek Properties to delineate potential CVOC source areas in shallow soils and groundwater on both properties (Exponent, 1998).

In December 1999, DEQ issued Order WMSCR-NWR-99-03 to three parties: Walter and Alice Freeman, XDP, Inc, and Watumull Properties Corporation. The Order requires investigation of the nature and extent of contamination and completion of Remedial Investigation (RI), Risk Assessment (RA), and Feasibility Study (FS) reports. The investigations performed for the remedial investigation include the following:

- Source Area Investigation to further delineate the extent of TCE and its breakdown products in shallow groundwater through installation of borings and sampling (MFA and Exponent, 2000a)
- Additional Geoprobe Investigation to further delineate the extent of CVOCs through soil and water sampling in borings installed on both properties (MFA and Exponent, 2000b)
- Reconnaissance Sampling, Installation, and Development of Shallow and Deep Monitoring Wells to further delineate the extent of CVOC contamination in the shallow and deep groundwater zones including installation of off-site wells OSB-1, 2 and 3 (MFA and Exponent, 2001a)
- Focused Shallow Groundwater Investigation to collect sufficient data to assess potential technologies for an IRM for the portion of the shallow groundwater zone near the Revtek-Watumull property boundary, to identify possible contaminant release pathways (i.e., the reported catch basin and drainage pipe associated with the recessed truck ramp and the former drainage ditch), and to complete the assessment of the nature and extent of VOCs in unsaturated soil and shallow groundwater in the northeast part of the Revtek property (MFA and Exponent, 2001b)
- Indoor Air Sampling (2001 to 2002 summarized in Integral and MFA 2006)
- Phase 1 and 2 Deep Groundwater Investigation which included installation of MW-19, OSB-5, -6, and -7 (URS, 2003a)
- Shallow Groundwater VOC and Non-VOC Investigations to further characterize the extent of CVOCs in shallow groundwater and the nature and extent of non-VOC contaminants (URS, 2003b)
- Well Survey (Bridgewater, 2004a) and Expanded Well Survey (Bridgewater, 2004b)
- Phase 3 Deep Groundwater Investigation which included drilling of reconnaissance off-site deep borings OSB-RI, -R2, and-R3 (URS, 2003c) and off-site monitoring wells OSB-7, -8, -9, and -10.
- Additional Shallow Groundwater Investigation to assess the backfill in the utility corridor beneath SE International Way and the distribution of VOCs in shallow groundwater along the alignment (URS, 2004a)
- Continuous Water-Level Monitoring to assess seasonal variations in water levels and groundwater flow directions in the lower deep and sand and gravel zones in the northwest portion of the study area, to assess the seasonal variations in groundwater gradients, and to identify the water-level response to pumping from City of Milwaukie production wells (URS, 2004b and URS 2006a)
- Supplemental Shallow Groundwater Investigation to investigate the area assumed to be upgradient of OSB-1 (URS, 2005b).
- Installation of OSB-11 and -12 documented in the Remedial Investigation Report (URS, 2005a)
- Sub-Slab Soil Gas Sampling to further investigate the indoor air pathway (summarized in Integral and MFA, 2006)

The primary reports and documents prepared for the project are listed in the Administrative Record (Appendix A). Summaries of the project investigations are presented in the Remedial Investigation and Risk Assessment Report (URS 2005c). The Draft Feasibility Study (URS 2006f) was prepared by URS Corporation and submitted to DEQ in September 2006.

## 2.5 INTERIM REMEDIAL MEASURES (IRM)

Two interim actions have been undertaken at the site.

### 2.5.1 1991 Soil Excavation

In 1991, when Production Parts was operating at the facility, an investigation was performed of the metal cuttings storage area located to the northwest of the Production Parts (now Revtek) building. Contaminated soil was determined to be the result of leakage of cutting oil from a dumpster which Production Parts used for metal scraps. Soil samples were collected and analyzed for petroleum hydrocarbons only. Eighteen "loads" of soil (approximately 180 cubic yards) were excavated (Figure 2-2) and disposed at the Hillsboro and Northern Wasco County landfills (D&L Excavating 1991).

### 2.5.2 Phase 1 Interim Remedial Measure (IRM)

In 2003 the Phase 1 IRM was constructed. The Phase 1 IRM consisted of selective excavation of soil in the source area and construction and operation of a groundwater extraction system. The purpose of the Phase 1 IRM was to reduce CVOC contaminant mass and control the spread of contamination in groundwater. A total of 363 tons of soil was excavated and disposed during the IRM. An extraction trench, to provide hydraulic control and contaminant recovery in shallow groundwater, and an extraction well (EXT-1), to provide hydraulic control and contaminant recovery in the shallow groundwater and upper and central deep groundwater zones were installed. A treatment system treats extracted groundwater and offgas vapors through air stripping, treatment of offgas from the air stripper with activated carbon and permanganate-impregnated zeolite, and treatment of water from the air stripper through carbon filters. Treated groundwater discharges to the sanitary sewer under a permit from the Clackamas County Service District. Routine operation of the treatment system began on June 16, 2004.

The groundwater extraction rate has averaged approximately 18 gpm since startup and fluctuates seasonally. Total CVOC concentrations in the influent groundwater have decreased substantially over time. On the first day of the system operation, the total influent CVOC concentration was 36,000 µg/L. Influent concentrations decreased by more than 75 percent to 8,600 µg/L during the first five weeks of operation and then decreased steadily during the first year of operation to less than 2,000 µg/L. The hydraulic capture of the IRM extraction well encompasses the IRM area and most of the Revtek property. Contoured groundwater elevations demonstrate capture. Figure 2-10 shows the contoured capture zone of the IRM extraction well in the central deep zone. Figure 2-8 presents the groundwater surface for the shallow zone in December 2005 showing the effect of the extraction trench. A description of the IRM is presented in *Summary of Phase I Interim Remedial Measure* (URS 2006b).

# 3. RESULTS OF ENVIRONMENTAL INVESTIGATIONS

## 3.1 NATURE AND EXTENT OF CONTAMINATION

Characterization of the nature and extent of contamination at the Milwaukie International Way site is presented in detail in the Remedial Investigation and Risk Assessment Report (URS 2005a). The following sections provide a summary of the nature and extent of contamination in soil, groundwater, and air. Figures 3-1 and 3-2 show sampling locations and groundwater well locations for the investigation, respectively.

### 3.1.1 Soil

The following chemicals were found in soil during soil sampling investigations at the site: volatile organic compounds (both chlorinated and non-chlorinated), semi-volatile organic compounds (SVOCs), TPH, and metals. The results of the investigations suggest that soils impacted with site contaminants are relatively localized near the primary sources of contamination and that the concentrations in soil are low or at background concentrations. See Table F-3 in the Remedial Investigation and Risk Assessment Report for the project (URS 2005a, Volume 2, Appendix F) for a data summary of all the chemicals of potential concern found in soil during the investigation. The following is a summary of the contaminants found in soil:

3.1.1.1 Chlorinated Volatile Organic Compounds

Target CVOCs, particularly PCE, TCE, cis-1,2-DCE and VC have been detected in soils primarily in the source area (or IRM area), north and south of the Watumull/XDP property boundary. This is in the general vicinity of the discharge from the drain line that originated in the truck ramp sump area. Solvent CVOCs leached to soils below the water table and into shallow groundwater. The identified area of impacted vadose zone soils is small, and detected concentrations are low. A significant volume of CVOC-impacted soil, both above and below the water table, was excavated as part of the IRM. Data from historical soil samples indicate that residual CVOC concentrations in some soil inside the IRM area that was not excavated might exceed the DEQ risk-based screening concentrations (RBCs) for leaching of contaminants from soil to groundwater. The historical sampling depths however were near or below the water table, and data indicate that there is minimal contaminant mass in unsaturated soil. Therefore, it is unlikely that residual CVOCs in unsaturated zone soil (inside or outside the IRM area) are a significant continuing source of CVOCs to groundwater.

Areas where degreaser sludges were placed may have also been sources of CVOCs to soil and subsequently to shallow groundwater. Soil in the former metal cutting area northwest of the Revtek building was excavated to remove petroleum and metals contamination, but sampling during the excavation and subsequent groundwater monitoring indicate the area was probably not a significant source of CVOCs.

Elevated CVOC concentrations in reconnaissance samples from shallow groundwater beneath the 1980 building expansion suggest that historical placement of metal cuttings and degreaser sludges may have been a source of CVOCs to soils, although CVOC concentrations in soil were either non-detect or low (i.e., less than 10 ug/kg) in this area. Leaching from soil is a possible source of CVOCs to groundwater, but the detected CVOCs could also have originated from southerly ("radial") flow from the source area at the former ditch.

Elevated CVOCs are likely in saturated soil below the water table in the IRM area although samples collected below the water table were typically water samples.

3.1.1.2 TPH, BTEX and SVOCs

TPH, BTEX and SVOCs were detected in isolated areas of shallow soils. The highest concentrations of gasoline-range hydrocarbons and associated BTEX constituents were found near the abandoned USTs at the southwest corner of the Revtek building. Lower concentrations were found in soils at the truck ramp and drain line, in the source area and at isolated geophysical anomalies. Diesel- and heavy oil-range hydrocarbons and associated SVOCs were found in the same general locations. Concentrations of TPH (gasoline-, diesel-, and heavy oil-range), BTEX, and SVOCs were generally below applicable regulatory criteria, usually by orders of magnitude. Due to the low concentrations of gasoline-range hydrocarbons and associated BTEX constituents in site soils, and the mobility of these compounds, shallow site soils serve as a minor source of gasoline-range hydrocarbons and BTEX compounds to site groundwater. As discussed below, concentrations of BTEX constituents are relatively low in shallow groundwater. Diesel- and heavy oil range hydrocarbons and associated SVOCs in site soils have not significantly impacted on-site groundwater.

3.1.1.3 Metals

Metals have been detected in site soils and in sediments from former wastewater conveyance lines. The detected metals are apparently associated with metal cuttings of primarily steel, aluminum, and brass. Metals detected above background levels in borings from the source area, the truck ramp, drain piping, and geophysical anomalies include arsenic, chromium, cooper, lead, mercury, nickel, and zinc. Other detected metals are antimony, beryllium, cadmium, selenium, silver, and thallium. Investigations evaluated metals in shallow soils and focused on previously-identified geophysical anomalies, areas where metal cuttings or degreasing sludges may have been placed or stored, or where there was field evidence of metal cuttings or shavings in soil. The investigation results indicated that concentrations of metals were generally below the applicable U.S. Preliminary Remediation Goals (PRGs) (USEPA 2004a) or below background soil concentrations (DEQ 2002). The only metals that were carried through into the human health risk assessment were lead and arsenic (see Section 3.5.1.4).

### 3.1.2 Groundwater

Groundwater was evaluated for the presence of VOCs (both chlorinated and non-chlorinated), petroleum hydrocarbons, BTEX, SVOCs and metals. Although some of the other contaminants were found during investigations in groundwater, the primary contaminants of concern at the site include the following chlorinated volatile organic compounds: tetrachloroethene, trichloroethene, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2 dichloroethene, and vinyl chloride. Both the shallow and deep groundwater are impacted on the Revtek and Watumull properties. Groundwater impacts off those two properties are found primarily in the deeper groundwater.

Five groundwater zones have been identified on the property: shallow, upper deep, central deep, lower deep, and sand and gravel (See Section 2.2.3.1). The data presented in the figures in this section are primarily taken from the Quarterly Groundwater Monitoring Report, Fourth Quarter, 2005 (URS 2006d).

3.1.2.1 Shallow Groundwater

The shallow groundwater zone consists of native silt, sand, and clay deposits that extend from groundwater surface to approximately 15 to 20 feet below ground surface (bgs). The highest concentrations of CVOCs in shallow groundwater are found within the IRM area although much of the shallow groundwater on site is impacted at lower concentrations. The highest historical TCE concentration in shallow groundwater (956,000 µg/L) was found in monitoring well MW18s in October 2002. MW-18s was removed in 2004 when the extraction trench was installed for the IRM. MW-12S is the well with the second highest TCE concentration historically at 194,000 µg/L in January 2002. By December 2005, 1.5 years after the IRM started operating, the TCE concentrations had dropped to not-detected (ND) in MW-12S (less than 100 µg/L). See Figure 3-3 for concentrations in shallow wells in December 2005.

The extent of CVOCs in shallow groundwater outside the IRM area is delineated to low concentrations in an area bounded by the southern portion of the Watumull property to the north, International Way to the east, the fire lane to the south and the western edge of the Revtek property. Detection of VC south of the fire lane indicates some transport of degradation intermediates. VC concentrations decrease to ND or very low concentrations downgradient. The extent of CVOCs in shallow groundwater appears to be delineated to non-detections or low concentrations, generally on the Watumull and Revtek properties.

3.1.2.2 Deep Groundwater Zone

The deep groundwater zone consists of clayey to clean gravels that extend from 20 feet to more than 100 feet bgs. The CVOC contamination in the upper deep zone is primarily in the source area and as contamination migrates downgradient it also migrates vertically downward so that in the OSB-3 area it is found in the lower deep at approximately 100 feet. At OSB-6, OSB-9 and OSB-10 the contamination appears to be primarily at the 90 to 120 foot depth interval.

Upper Deep Zone: This zone includes wells screened between 18.5 and 35 feet bgs: See Figure 3-4 for concentrations found in this zone in December 2005. MW-12I had the highest historical TCE concentrations in this zone at 110,000 µg/L. As of December 2005, after 1.5 years of IRM operation, the concentrations of TCE had dropped to not detected with cis-1,2-DCE and vinyl chloride at 1,500 µg/L and 170 µg/L, respectively.

Central Deep Zone: This zone includes wells screened between 28 to 40 feet bgs See Figure 3-5 for concentrations found in this zone in December 2005. MW-12D has had the TCE highest concentrations historically in this zone at 65,100 µg/L in January 1998. As of December 2005 after 1.5 years of IRM operation concentrations of TCE were 160 µg/L with cis-1,2-DCE and vinyl chloride at 240 and 9 µg/L, respectively.

Lower Deep Zone: This zone includes wells screened between 59 to 100 feet bgs. See Figure 3-6 for concentrations found in this zone in December 2005. MW-14D has had the highest TCE concentrations in this zone at 1,610 in December 2003. In December 2005 TCE, cis-1,2-DCE and vinyl chloride were 34, 36 and less than 0.5 µg/L, respectively. TCE concentrations in other wells in this zone in December 2005 include OSB-3 at 750 µg/L, OSB6-95 at 160 µg/L, OSB9-95 at 19 µg/L and OSB10-98 at 34 µg/L.

#### 3.1.2.3 Sand and Gravel Zone

This zone includes wells screened between 112.5 and 233 feet bgs. See Figure 3-7 for concentrations found in this zone in December 2005. MW-19-136 has had the highest TCE concentrations in this zone at 7.79 µg/L in September 2005. Concentrations in MW-19-136 in December 2005 of TCE, cis-1,2-DCE and vinyl chloride were not detected at less than 0.5, 5.2 and 12 µg/L, respectively.

#### 3.1.2.4 City of Milwaukie Well #7

Groundwater in CW-7 is impacted primarily with TCE. Although, contaminants migrating from the MIW site may contribute to impacts observed at CW-7 there are potentially other sources of TCE in the vicinity of the City well (Integral 2005a). The maximum concentration found in the City well was 6.1 ug/L in 1990. For 2005 and 2006 the concentrations have ranged between 1.1 and 1.5 ug/L. PCE was detected in 1998 twice at concentrations of 0.7 and 0.8 ug/L and 1,1-DCE was detected once in January 2006 at 0.5 ug/L.

### 3.1.3 Air

The RI included sampling of air from the Revtek and Watumull buildings and outdoor air at both properties to assess transport of CVOC vapors from vadose zone soil and shallow groundwater at the site. The indoor air pathway investigation also involved sub-slab soil vapor sampling under the Revtek and Watumull buildings to understand whether concentrations of CVOCs detected in indoor air were associated with volatilization of CVOCs from the subsurface or from elevated ambient concentrations found in outdoor air at the site, or associated with common cleaning or office products used in these buildings. CVOCs were detected in soil gas samples collected in the vicinity of the buildings. Modeling was conducted to estimate indoor CVOC concentrations through vapor intrusion into the building. Modeling results indicate that any elevated TCE levels in the buildings are not very likely attributable to vapor intrusion. Based on the results of these investigations it is unlikely that CVOCs will volatilize from groundwater and soil under the building and cause unacceptable CVOC concentrations in indoor air.

Outdoor air monitoring for site contaminants was included as part of IRM implementation. TCE concentrations at sampling locations have intermittently exceeded concentrations that represent an acceptable risk, with no apparent pattern to the occurrence of the relatively higher concentrations. The source of the CVOCs in outdoor air has not been identified but does not appear to be attributable to either the IRM operation or migration of vapors from shallow soil and groundwater contamination beneath the site.

A summary of the air pathway investigation is presented in the RI Addendum (URS 2006c) and the supplemental air report (Integral 2006 and Integral and MFA 2006).

## 3.2 CONTAMINANT FATE AND TRANSPORT EVALUATIONS

This section provides an overview of the contaminant fate and transport for the CVOCs released to the environment at the facility and serve as the basis for the exposure pathways considered in the baseline risk assessment for the site.

### 3.2.1 Unsaturated Zone Fate and Transport

Solvent usage at the facility historically included commercial grade TCE. TCE has a high vapor pressure, is moderately soluble, and in it's free phase form is denser than water. When released to the land surface it will readily volatilize to the atmosphere and infiltrate into the soil migrating vertically within the soil column through gravity drainage or with stormwater infiltration. Subsurface releases through leaks in tanks or piping will not volatilize to the atmosphere to the degree of a surface release.

TCE in pure form has a higher density and lower viscosity than water and the released chemical will migrate vertically through the soil column. When released as a mixture (e.g. with oils from degreasing operations) the degree of vertical transport may be reduced. The depth of migration is dependent upon a number of factors including the area of the release, the volume and timing of chemicals released, soil properties such as the presence of low permeability layers and rainfall recharge. If sufficient volume is released, the chemicals will continue to migrate downward through the water column of the aquifer(s) present beneath the site. A percentage of the chemicals released will remain within the soil column above the water table due to capillary forces or sorption to natural organic carbon within the soil matrix.

Under anerobic conditions and in the presence of suitable electron donors TCE can biodegrade by way of reductive dechlorination to less toxic daughter products. The presence of 1,1 DCE, cis and trans-1,2-DCE and vinyl chloride and the almost complete absence of TCE in shallow groundwater are evidence that biodegradation is occurring. Biodegradation in the shallow zone is facilitated by the presence of peat and other natural forms of organic carbon in the shallow zone.

Contaminants in the unsaturated zone will disperse through time through volatilization and/or dissolution with infiltrating rainfall. Contaminated soil gasses can migrate both laterally and to the surface and can affect indoor air quality if the release area is within or close to a building. Due to the fine grained silt deposits that comprise the vadose zone interval at the site and the degradation of TCE in the shallow zone, significant risk from upward and lateral migration of CVOCs beneath the site is unlikely. This finding is supported by the air pathway investigation work discussed in Section 3.1.3.

### 3.2.2 Saturated Zone Fate and Transport

A conceptual hydrogeologic model was developed for the site that describes the hydrogeology, the rate and direction of groundwater flow, and an understanding of chemical fate and transport to interpret the current and potential future distribution of site-related contaminants. The complexity of the MIW hydrogeologic setting, including the influences of supply well pumping and subsurface heterogeneities creates uncertainty in the conceptual model.

Groundwater contaminant concentrations and vertical distribution of contamination are commonly used to assess the current or historical presence of dense non-aqueous phase liquids (DNAPLs) within an aquifer system. In general, CVOC concentrations in groundwater that exceed one to two percent of the chemical's solubility are an indication that DNAPL is potentially present within the aquifer system. Contaminant concentrations in groundwater that increase with depth are also an indication of the historical presence of DNAPL within an aquifer. At the MIW site, DNAPL releases to groundwater appear to have occurred in the Shallow Zone and the Upper Deep Zone to a depth of approximately 30-40 feet bgs.

The DNAPL that enters the aquifer will occupy soil void spaces and will continue to slowly dissolve into groundwater and serve as a long-term source of groundwater contamination. Depletion of the residual DNAPL in the saturated zone may take many decades under natural processes.

3.2.2.1 Groundwater Contaminant Transport

Horizontal groundwater flow in shallow zone flows radially and appears to have transported contamination east of the historical source areas on the Revtek property at least to International Way and south and west to the fire lane, although significant concentrations are localized in the primary source area at the site. The absence of significant lateral transport of dissolved phase contamination is consistent with the limited area of recharge due to paving of the site, slow groundwater flow velocities, and chemical retardation from natural organic carbon present in the shallow zone silt.

CVOC contamination that entered the Deep Zone has been transported downgradient of the source in dissolved phase in the primary directions of groundwater flow. The predominant groundwater flow direction in deep groundwater is to the west and northwest. Based on the distribution of CVOCs downgradient of the site and documented hydraulic responses that occur during the pumping of the City of Milwaukie well #7, groundwater flow direction and perhaps contaminant transport is partially dependent on whether or not the city well is pumping. Downward vertical gradients within the Deep Zone have caused the dissolved phase CVOC plume to sink as it extends downgradient.

Based on pump test results, a value of 5.4 ft/day was found to best approximate the hydraulic conductivity of the Lower Deep Aquifer (URS, 2005a). For the conductivity of the Sand and Gravel Aquifer, the USGS suggests a value of 5-25 ft/day with a median value of 15 ft/day. Using these conductivities, travel time from the IRM area to the OSB-3 area in the deep zone and sand and gravel zone would be approximately 2.2 to 3.2 years. Travel time from OSB-10 to City Well 7 in the deep zone and sand and gravel zone would be approximately 4.8 to 6.5 years. (DEQ, 2006a)

Groundwater in the study area does not discharge to surface water, and surface water bodies are not impacted by site-related contaminants.

<u>Uncertainty in the Hydrogeologic Conceptual Model:</u> The complexity of the hydrogeologic setting, including the influences of production well pumping, subsurface heterogeneities, and the possibility of other sources of contamination in and near the study area, create uncertainties in the conceptual model and the extent of contamination from the MIW site. Uncertainties include complex and uncertain hydrogeology, influence of City of Milwaukie production pumping, analytical limitations, and possible regional sources of contamination. The continuous water-level monitoring program showed that pumping in City Well 7 affects water levels in some wells within the study area therefore the influence of city pumping on contaminant transport from the MIW site is uncertain. Uncertainty also results from the inability of typical analytical chemistry methods to detect CVOCs at concentrations equal to the DEQ RBCs. MIW is also located in an area where there may be other potential sources of contamination that might affect the city well. See Section 2.2.3.2 for additional discussion of uncertainty.

3.2.2.2 Contaminant Degradation Mechanisms

Under anaerobic and reducing conditions, biological degradation of dissolved phase TCE occurs from naturally occurring organisms in soil. TCE is sequentially converted to DCE (primarily cis-1,2-DCE) and vinyl chloride. Vinyl chloride is the final chlorinated breakdown product, which in turn may be converted to the non-chlorinated chemicals ethene and ethane. Initial metabolism of TCE typically involves a biochemical process referenced as reductive dehalogenation or dechlorination. Reductive dehalogenation of chlorinated ethenes is typified by the accumulation of degradation products and an increase in the concentrations of chloride ions. Cis-1,2-DCE is the predominant intermediate DCE isomer produced during this process. The most rapid biodegradation rates have been shown to occur under sulfate-reducing and methanogenic conditions typically where biodegradable material is present where oxygen in the subsurface is consumed.

The distribution of CVOCs in shallow groundwater at the site is consistent with a reductive dehalogenation process. Cis-1,2-DCE has been detected in shallow groundwater in the source area. Vinyl chloride has been detected in the source area indicating necessary organisms for degradation of TCE are present in site soil. Reductive dehalogenation is probably not occurring at appreciable rates in the Deep Zone groundwater outside of the source area due to the lack of significant organic carbon. The presence of cis-1,2-DCE downgradient of the source area can be explained through transport of dissolved phase degradation products from the source zone with groundwater.

## 3.3 REASONABLY LIKELY LAND AND WATER USE

The current and reasonably likely future uses of the site and adjacent properties are commercial and industrial. The City of Milwaukie (City) master plan preserves the local land use as commercial and industrial for the foreseeable future. Farther east, the current and reasonably likely future land uses are residential, parks, and open space. Farther west, across Highway 224, the land use is residential.

The survey of beneficial uses of groundwater was performed in three phases. The preliminary survey of a 2-mile radius from the site was performed in 2002 (Bridgewater, 2002). Beneficial uses of groundwater were identified as industrial, irrigation, and drinking water through discussions with the City of Miwaukie Water Division and a survey of water logs and water rights. Identified points of use include one industrial well located at the Oregon Cutting Systems, site, one irrigation well used for landscape watering, and the City of Milwaukie water supply wells number 4, 6, 7, and 8. City Well 7, located north of the MIW site, is the closest City well and pumps the most groundwater. Due to the presence of the city wells in the area, drinking water has been identified as the reasonably likely use for groundwater for the MIW project.

Following the preliminary survey, a door to door well survey was performed in two phases in 2003 and 2004 (Bridgewater 2004a and 2004b) to locate any groundwater use not identified in the preliminary survey within the survey area presented in Figure 2-13. Five wells were located in the two surveys. Four were not in use and one was in use for irrigation.

## 3.4 LOCALITY OF THE FACILITY

The locality of the facility (LOF) in the absence of any cleanup is “any point where a human or an ecological receptor contacts, or is reasonably likely to come into contact with, facility-related hazardous substances” (OAR 340-122-0115). The entire LOF for the MIW site includes the two adjoining properties located at 4288 SE International Way and 4252 SE International Way and properties to the east, west, north and south where site contaminants have migrated or might reasonably migrate in groundwater if no action is taken at the site. The approximate groundwater LOF is generally bounded as follows:

- To the east: SE International Way, including the right-of-way.
- To the south: Highway 224 and OSB-11.

- To the west: Contamination has been detected at OSB-5. The full extent has not been determined but to be conservative the area identified for future monitoring of use is to the west to Lake Road and S.E. 30th.
- To the northwest: Contamination has been detected at OSB-9. The full extent has not been determined but to be conservative the area identified for future monitoring of use is to Washington Street.
- To the north: The LOF to the north is uncertain. Contamination has been detected in OSB-10. To be conservative, the LOF is assumed to extend to City of Milwaukie Well 7 (CW-7) based on documented hydraulic responses measured in site wells from pumping of the city well that indicate that contamination could potentially reach the well.

## 3.5 SUMMARY OF RISK ASSESSMENTS

Baseline human health and ecological risk assessments were performed in accordance with OAR 340-122-0080 and -0084 to evaluate the potential risks to human health and the environment and the need for remedial action, or no action, at the site. The final baseline risk assessment is presented in the Remedial Investigation and Risk Assessment Report (URS 2005a). A summary of the human health and ecological risk assessments is provided in the following sections.

### 3.5.1 Human Health Risk Assessment (HHRA)

The Baseline HHRA was performed in accordance with the EPA's Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (1989c, 1991a,b, 2002), DEQ's Guidance for the Conduct of Deterministic Human Health Risk Assessments (DEQ 2000), DEQ's Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites (DEQ 2003), and other relevant guidance documents. The human health risk assessment included an evaluation of the chemicals found at the site to 1) determine which are the chemicals of potential concern, and 2) to perform the following: a toxicity assessment, an exposure assessment, risk characterization, and an uncertainty assessment.

#### 3.5.1.1 Chemicals of Potential Concern (COPCs)

The preliminary screening of chemicals of interest (COIs) was completed as allowed under OAR 340-122-0080(5) and DEQ Guidance for Conduct of Deterministic Human Health Risk Assessments (DEQ, 2000) and was based on frequency of detection, background concentration and concentration-risk screening. The soil and groundwater analytical data from investigations were screened to determine which COIs to retain as COPCs. COIs were designated as COPCs based on:

***Frequency of Detection*** – COIs that were detected in more than 5% of the samples site-wide for a given media.

***Background Concentrations*** – Inorganic (naturally-occurring metals) COIs that were detected at a maximum concentration greater than the established background value.

***Concentration-Risk Screen*** – COIs that were found at concentrations higher than the risk-based concentrations for soil and groundwater. The following describes the concentration risk screening for soil and groundwater samples.

For COPCs detected in more than 5% of the samples site-wide, the maximum detected concentration was compared to DEQ's RBCs (DEQ 2003) for the exposure pathways evaluated. The maximum detected concentration of each COI was divided by the respective RBCs then each quotient was summed to generate a risk ratio for each COI. If a risk ratio was greater than one, then the COI was retained as a COPC. In addition, the risk ratio for each COI in soil and groundwater was compared to the value of one divided by the total number of COIs to assess potential cumulative effects. If a risk ratio was greater than one divided by the total number of COIs, then the COI was retained as a COPC. Next, the risk ratios for each COI in soil and groundwater were summed to generate a total risk ratio for each COI. If a total risk ratio was greater than one, then the COI was retained as a COPC.

For the MIW site data screened to identify COPCs in soil include soil data from the Focused Shallow Groundwater Investigation and associated investigations (MFA and Exponent 2001b) and the Shallow Groundwater and Non-VOC investigations (URS 2003b). Soil data were collected before the IRM groundwater treatment system began operating in June 2004. However, the data set and risk calculations do not include soil data from sampling locations that were excavated during the IRM construction.

Data used to identify COPCs in groundwater included monitoring well data collected as part of the RI. The HHRA uses groundwater data collected from developed monitoring wells to the extent possible. However, reconnaissance groundwater data are used for shallow off-site groundwater east of and south of the site, since no monitoring well data are available. Reconnaissance groundwater samples were used to assess potential risk related to shallow groundwater east of International Way. The HHRA uses groundwater data collected before the IRM started operating to represent baseline conditions. Monitoring well data from the period approximately two years before June 2004, when the IRM system began operating, were used to evaluate baseline risks. Therefore, current risks are lower than those predicted in the risk assessment.

Assessment of current risks associated with vapor intrusion into buildings and inhalation by occupational workers was performed by modeling indoor air concentrations using sub-slab soil gas data.

#### 3.5.1.2 Exposure Assessment

The exposure assessment evaluated current or potential future exposure scenarios whereby people might be exposed to contaminants in affected media (e.g., soil, groundwater, or air). The exposure pathways quantitatively evaluated in the human health risk assessment are shown in Figure 3-8. The human receptors evaluated in the risk assessment included current and future on-site and off-site occupational workers, current and future off-site residents, and future excavation and construction workers. The principal exposure routes included ingestion and incidental inhalation through drinking water and showering, incidental ingestion and dermal contact through contact with soil and groundwater on site, and inhalation of site contaminants through volatilization from soil and groundwater.

The exposure point concentration (EPC) is the estimated concentration of a contaminant to which a person could be exposed at the site. Human health EPCs for each COPC in each medium were calculated for the MIW site and the conclusions presented in the risk assessment. EPCs were used to calculate the daily intake of a chemical, or dose, expressed as milligrams of chemical per kilogram body weight per day (mg/kg/day). EPCs for site contaminants are presented in the Remedial Investigation and Risk Assessment Report (URS 2005a).

#### 3.5.1.3 Toxicity Assessment

For the baseline risk assessment, human health effects were divided into two groups: non-carcinogens and carcinogens. The division is based on the mechanism of action associated with the COPCs. Toxicity factors for the assessment are typically obtained from EPA's Integrated Risk Information System (IRIS) and/or EPA's Health Effects Summary Tables (HEAST) although other sources (e.g., USEPA Region IX PRG Tables) may be used.

A reference dose, or RfD, is the toxicity value used in evaluating non-carcinogenic effects resulting from exposure to contaminants. The RfD is the estimate of a daily exposure that is unlikely to have an appreciable risk of any adverse health effect over a lifetime of exposure. For carcinogens, a slope factor (SF) is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a potential carcinogen.

3.5.1.4 Risk Characterization

The calculated intake of a chemical divided by its reference dose is called the hazard quotient (HQ). The sum of the individual chemical HQs for each pathway at the site is a hazard index (HI). A hazard index greater than one (1) suggests that the potential for an adverse effect cannot be ruled out, and further evaluation is therefore warranted. DEQ's limit for acceptable risk to non-carcinogens is an HI of 1.

Excess lifetime cancer risk (ELCR) is calculated by multiplying the intake of a carcinogenic chemical by its slope factor. The risk is expressed as a probability (for example, $3 \times 10^{-6}$ means an increase in cancer risk of three in one million). DEQ's acceptable risk level for individual chemicals is an excess lifetime cancer risk of $1 \times 10^{-6}$. For the cumulative risk resulting from summing the risks of more than one carcinogen at a site, the acceptable risk level is $1 \times 10^{-5}$.

Relevant results and conclusions of the baseline human health risk assessment with respect to soil are summarized below:

Five chemicals were identified as chemicals of concern in soil and were included in the baseline risk assessment calculations: trichloroethene, vinyl chloride, arsenic, lead, and benzo(a)pyrene. The maximum measured soil lead concentration did not exceed its industrial PRG, but was identified as being of potential concern on the basis of exceeding criteria for the cumulative risk of all chemicals combined. In subsequent risk calculations, lead was determined to pose negligible risk, based on a comparison of the estimated EPC to the PRG. Only arsenic and benzo(a)pyrene were determined to pose risks in exceedance of the regulatory threshold. Although arsenic concentrations were somewhat elevated in a few samples, concentrations across the site are consistent with background. Benzo(a)pyrene was detected in a single sample resulting in predicted risk slightly in exceedance of the regulatory threshold. However, benzo(a)pyrene is not believed to be an important chemical of concern or pose risks site-wide.

Relevant results and conclusions of the baseline human health risk assessment with respect to groundwater are summarized below.

Possible excess cancer risks for potentially complete exposure pathways include the following:

| Exposure Unit | Pathway, Receptor | Chemicals |
|---|---|---|
| On-site shallow groundwater inside IRM area 0 to 20 feet bgs | Vapor intrusion into buildings and volatilization to outdoor air, occupational workers. | TCE, PCE, VC |
| | Direct contact with groundwater in excavation, construction/excavation workers. | TCE, PCE, VC |
| On-site deep groundwater 20 to 180 feet bgs | Tap water ingestion and inhalation, potential future occupational workers. | TCE, PCE, VC |
| Off-site deep groundwater 20 to 180 feet bgs | Tap water ingestion and inhalation, potential off-site residents. | TCE, PCE, VC |

Possible non-cancer risks for potentially complete exposure pathways include the following:

| Exposure Unit | Pathway, Receptor | Chemicals |
|---|---|---|
| On-site shallow groundwater inside IRM area 0 to 20 feet bgs | Vapor intrusion into buildings, occupational workers. | TCE |
| | Direct contact with groundwater in excavation, construction/excavation workers. | TCE, *cis*-1,2-DCE, VC |
| On-site deep groundwater 20 to 180 feet bgs (MW-12D) | Tap water ingestion, occupational workers. | TCE, *cis*-1,2-DCE, VC |
| Off-site deep groundwater 20 to 180 feet bgs (OSB-3) | Tap water ingestion, potential off-site residents. | TCE, *cis*-1,2-DCE |

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3.5.1.5 Uncertainty Evaluation

This section summarizes uncertainties in the quantitative risk estimates for the site:

The exposure assessment is intended to be conservative, so that risks will not be underestimated. For example, the outdoor air exposure evaluation used the maximum concentration of TCE in groundwater even though the concentrations in shallow groundwater are significantly lower now that the IRM is operating. The concentrations in groundwater without the active extraction and treatment cannot be evaluated until the extraction is terminated.

3.5.1.6 Human Health Risk Assessment Summary

The following is a summary of the conclusions of the human health risk assessment:

- Site COCs: CVOCs are the only site-related chemicals at concentrations that result in an unacceptable risk.
- Indoor air pathway with migration from subsurface soils to the indoor air: Review of data collected for the indoor air pathway analysis suggests that the concentrations below the

Revtek and Watumull buildings are not at concentrations that, if they were to migrate into indoor air, would result in an unacceptable risk.

- Outdoor air pathway: CVOC concentrations in shallow groundwater were predicted to result in unacceptable risk in the outdoor air. However, concentrations in shallow groundwater are lower that those used in the risk assessment due to the IRM operation and therefore concentrations in the outdoor air currently would not be expected to exceed acceptable risk levels due to migration from shallow groundwater. Furthermore, there is no apparent pattern to the occurrence of the relatively higher concentrations of CVOCs measured in outdoor air. While the source of the CVOCs in outdoor air has not been definitively identified, it does not appear to be attributable to either the IRM operation or migration of vapors from shallow soil and groundwater contamination beneath the site.
- Unsaturated soil: CVOCs in unsaturated soil do not cause unacceptable risk.
- Shallow groundwater: CVOCs in shallow groundwater potentially pose an unacceptable risk to future excavation workers exposed to groundwater via direct contact and inhalation. CVOCs in shallow groundwater pose an unacceptable risk for use as drinking water if they migrate to the deep groundwater at concentrations high enough to result in unacceptable risk. If buildings are constructed over the IRM area in the future without adequate protections, CVOCs in shallow groundwater might cause unacceptable indoor air risks.
- Deep groundwater: CVOCs in deep groundwater pose an unacceptable risk for use as drinking water.

### 3.5.2 Ecological Risk Assessment (ERA)

This section presents the ERA, which includes a Level I Scoping ERA for the site. The ERA was completed in accordance with DEQ's (2001a) *Guidance for Ecological Risk Assessment*. The ecological risk assessment (ERA) is a process of determining whether site-related chemicals may affect ecological receptors. In Oregon the ERA consists of different levels of assessment: Level 1 Scoping, Level II Screening, and Level III Baseline. For the Milwaukie International Way site only the Level I assessment was performed.

Based on the results of the Level 1 scoping ERA further assessment was not required. This conclusion was based on the following:

- The site has a high level of human activity and disturbance that limits the frequency and duration of exposure to species that may forage in the area.
- Exposure of ecological receptors is reduced by the presence of relatively unsuitable wildlife habitat. The majority of the site is made up of disturbed habitat or is paved, with the exception of a few mature deciduous trees. The site has no surface water features or wetlands.
- Adverse effects to individual animals (i.e., non-threatened and /or endangered species) that may be negatively impacted by exposure to site contaminants will not adversely affect local populations of these species.
- Individual animals that may be negatively impacted by exposure to site contaminants will not compose a substantial portion of any predator species' diet. Therefore, higher-tier predators that could potentially prey on animals (e.g., small rodents) at the site will not be adversely affected by indirect exposure to site contaminants.
- Given their typical home ranges, birds that visit the site are likely to ingest negligible amounts of surficial soil in the course of foraging.

### 3.5.3 Identification of Potential Hot Spots

The section includes an evaluation of potential hot spots of contamination at the site. Media evaluated with respect to potential hot spots at the site include shallow and deep groundwater and soil.

#### 3.5.3.1 Groundwater

Hot spots in groundwater are defined under OAR 340-122-0115(31)(a), which states: "for groundwater or surface water, hazardous substances having a significant adverse effect on beneficial uses of water or waters to which the hazardous substances would be reasonably likely to migrate and for which treatment is reasonably likely to restore or protect such beneficial uses within a reasonable time frame". Oregon's environmental cleanup law requires that remedies treat hot spots of contamination to the extent feasible. The intent of the hot spot rule is to encourage treatment of groundwater with the highest concentrations.

OAR 340-112-0115(51) defines significant adverse effect as follows:

(a) Applicable or relevant federal, state or local water quality standards, criteria, or guidance;
(b) In the absence of applicable or relevant water quality standards, criteria, or guidance, the acceptable risk level; or
(c) If subsections (a) and (b) of this section do not apply, the concentration of a hazardous substance indicated by available published peer-reviewed scientific information to have a significant adverse effect on a current or reasonably likely future beneficial use of water.

For CVOCs in drinking water, the maximum contaminant levels (MCLs) are the significant adverse effect level and the hot-spot criteria (DEQ 1998a). MCLs for the target CVOCs are as follows (USEPA 2004b):

| CVOC | MCL (μg/L) |
|---|---|
| PCE | 5 |
| TCE | 5 |
| *cis*-1,2-DCE | 70 |
| VC | 2 |

Concentrations of TCE, PCE, *cis*-1,2-DCE, and VC in shallow and deep groundwater exceed the MCLs. The potential groundwater hot spot area includes at least the IRM area, the eastern portion of the Revtek property approximately to International Way, OSB-1 to the southwest (but not as far as OSB-11), OSB-5 to the west, and OSB-9 and OSB-10 to the north-northwest.

#### 3.5.3.2 Soil

For media other than water (i.e., soil), a hot spot exists if the site presents an unacceptable risk and if the contamination is highly concentrated, highly mobile, or cannot be reliably contained.

A "highly concentrated" hot spot for human exposure is a chemical concentration in soil 100 times higher than the acceptable risk levels for carcinogens (i.e., ELCR of $1 \times 10^{-6} \times 100$ = ELCR of $1 \times 10^{-4}$) and 100 times higher than the acceptable risk level for noncarcinogens (i.e., hazard index [HI] of $1.0 \times 10$ = HI of 10). Any concentrations of COCs in soil that exceed hot spot criteria may constitute a hot spot area on site, which would have to be preferentially treated or excavated and disposed off-site during the remediation phase. The low concentrations in the unsaturated zone also support the conclusions that mobility and containment are not an issue for that zone.

Individual and cumulative carcinogenic and non-carcinogenic risks were less than the DEQ hot spot criteria in soil exposure units. Therefore, there are no hot spots in unsaturated soil.

Soils in the saturated zone of the IRM area are a hot spot as long as residual concentrations can desorb to groundwater and then migrate downgradient at concentrations above the MCL. The FS technology assessment considered excavation of soil below the water table as a remedial option but assumed that a remedy designed to address elevated CVOC concentrations in groundwater in the source area will address CVOCs in saturated soil.

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# 4. REMEDIAL ACTION OBJECTIVES

This section describes the remedial action objectives and associated cleanup and hot spot levels derived for the site based on the beneficial land and water uses and potential exposure pathways identified in the risk assessment. Estimates of the area and volume of groundwater contamination at the site that exceeds hot spot levels are presented, and other laws that may be applicable in the development of remedial alternatives are also identified. This information provides the basis for the remedial action alternatives developed in the FS and presented in Section 5.

## 4.1 REMEDIAL ACTION OBJECTIVES

The following site-specific remedial action objectives (RAOs) were developed for soil, groundwater and air for the purpose of achieving protection of human health and the environment, as required by OAR 340-122-040:

**RAO 1 – Soil-Exposure**: Prevent human exposure to COCs in surface and subsurface soil by direct contact, incidental ingestion, and inhalation for on-site workers and construction workers that would results in an unacceptable excess lifetime cancer risk (ELCR) greater than 1 x $10^{-6}$ for individual chemicals, 1 x $10^{-5}$ cumulative risk for each pathway and an HI greater than 1.

Current conditions appear to currently satisfy RAO 1. Therefore, no active treatment was included in the FS for unsaturated soil. Remedy elements include means to protect against possible exposures during future site work or development in the event localized pockets of soil contamination are discovered during these activities.

**RAO 2 – Soil-Contamination Source**: Treat soil source area(s) to levels that protect the deep aquifer beneficial use as a source of domestic/municipal drinking water supply.

**RAO 3 – Groundwater – Dermal Contact, Inhalation, Ingestion:** Prevent human exposure to COCs in groundwater by direct contact, incidental ingestion, and inhalation for on-site workers and construction workers that would result in an unacceptable ELCR greater than 1 x $10^{-6}$ for individual chemicals, 1 x $10^{-5}$ cumulative risk for each pathway, and an HI greater than 1.

**RAO 4 – Groundwater - Ingestion**: Remediate shallow and deep groundwater to levels protective of the beneficial use as a domestic/municipal drinking water supply.

**RAO 5 – Groundwater-Migration**: Control migration of contaminated groundwater containing chemicals of concern (COCs) as necessary to protect the groundwater beneficial use.

**RAO 6 - Air**: Prevent human inhalation exposure to COCs that volatilize from soil and groundwater and migrate to indoor and/or outdoor air that would result in an unacceptable ELCR greater than 1 x $10^{-6}$ for individual chemicals, 1 x $10^{-5}$ cumulative risk for each pathway, and an HI greater than 1.

## 4.2 RISK-BASED CLEANUP LEVELS (RBCLs)

The RBCLs for groundwater at the MIW site are the DEQ RBCs applicable to the identified exposure pathways (DEQ 2003). Attaining the RBCLs will meet the acceptable risk levels, and RBCLs are the ultimate cleanup goals. Drinking water is the reasonably likely use of deep groundwater in the LOF. Shallow groundwater is not suitable as a water supply because yields are very low, as indicated by the low yield of the IRM groundwater extraction trench. For shallow groundwater, the lowest DEQ RBCs for a particular exposure pathway are the applicable RBCLs. The risk assessment identifies current potentially complete exposure pathways. The lowest RBCLs for COCs in shallow groundwater are vapor intrusion RBCs. The lowest RBCLs for deep groundwater are DEQ tap water RBCs. Table 4-1 presents the RBCs and MCLs for the specific pathways and the chemicals of concern for groundwater and air.

## 4.3 CALCULATION OF REMEDIATION VOLUMES

The aerial extent and volume of the MIW groundwater plume are uncertain. An estimate of the aerial extent from the source area to the OSB-9 and OSB-10 area is 70 acres. The aerial extent beyond wells OSB-8, OSB-9 and OSB-10 is unknown. The estimated volume of the TCE plume that exceeds the MCL hotspot threshold, based on an average plume thickness of 100 feet and an effective soil porosity of 30 percent, is 685 million gallons.

## 4.4 APPLICABLE LAWS AND STANDARDS

The selected remedy will comply with all applicable federal, state, and local laws and standards as described below:

**Oregon Hazardous Substance Remedial Action Rules (OAR 340-122)** establish standards and processes for conducting state-led cleanups of sites contaminated with hazardous substances. These include are the guidelines for conducting this FS and selecting remedial actions at the site.

**Oregon Hazardous Waste Management Act (ORS 466) -** This act and its implementing administrative regulations (OAR 340-100-0001 *et seq*.) govern the generation, transportation, treatment, storage, and disposal of hazardous wastes. These rules may have applicability at the site if remedial actions generate characteristic or listed hazardous wastes (including environmental media such as contaminated soils and/or groundwater). The act incorporates the requirements of the federal Resource Conservation and Recovery Act (RCRA) program.

**Oregon Occupational Safety and Health Code (OAR 437)** contains health and safety training requirements for on-site workers. It also contains permissible exposure limits for conducting work at the site.

**Oregon Well Construction Rules (OAR 690-240)** establish state standards for installing, maintaining, and decommissioning groundwater monitoring and recovery wells at the site.

**Safe Drinking Water Act (40 CFR Part 141)** establishes the federally enforceable MCLs in public drinking water sources.

**Oregon Groundwater Quality Protection Rules (OAR-340-40)** for re-injection or land application of treated water.

**Oregon Underground Injection Program Rules (OAR-340-44)** for injection of amendments associated with in-situ bioremediation alternatives.

**Oregon Water Pollution Control Act (ORS 468B and OAR 340-045)** This act and the implementing administrative rules govern discharge of pollutants to surface waters. This act incorporates the federal Clean Water Act (CWA) programs, including the NPDES permitting system.

**Oregon Solid Waste Management (ORS 459 and OAR 340-093 and 340-095) –** This statute and implementing rules govern the management of solid wastes, including the permitting of disposal sites, and are applicable to the on-site and off-site management and disposal of the contaminated soils and groundwater.

**Oregon Groundwater Quality Protection Act** (ORS 468B and OAR 340-040). This act and the implementing administrative rules constitute Oregon's groundwater protection program. The program incorporates the federal Safe Drinking Water Act requirements and maximum contaminant level (MCL) standards. The groundwater protection program policy states that the rules are not to be used as cleanup standards, but they may be used to evaluate non-degradation of existing groundwater resources and may be considered for remedial actions that include the use of underground injection control (UIC) systems for treated groundwater or storm water disposal.

**Oregon Occupational Safety and Health Code (OAR 347).** These codes, analogous to the federal Occupational Safety and Health Administration codes, contain health and safety requirements that must be met during implementation of any remedial action. These standards are intended to protect construction and utility workers at the site.

**Local permits/regulations (City of Milwaukie and Clackamas County). -** The substantive requirements of local permits and regulations will be complied with including, but not limited to those for plumbing or electrical permits.

# 5. DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES

This section provides a description of the remedial action alternatives developed for the Milwaukie International Way site. Prior to development of the remedial action alternatives general response actions (GRAs) and remedial technologies were screened as described in the FS. This process is presented in the draft FS. The GRAs included no action, engineering and institutional controls, and removal, treatment and disposal, and any combination of the preceding actions as appropriate. Table 5-1 provides a summary of the treatment technologies that were retained in the FS as potential components of the selected remedy.

## 5.1 CONSIDERATIONS FOR ALTERNATIVE SELECTION

The following criteria were used in the draft FS to guide remedial alternative development:

- The remedy must control and treat high concentration areas of the plume (on site and off site) to prevent possible exposure and to prevent future transport of contamination.
- Analysis must demonstrate that CVOCs in downgradient portions of the LOF do not cause concentrations that exceed the RBCs in existing groundwater supply wells.
- Proposed monitoring must demonstrate remedy performance relative to performance objectives.

Based on these criteria, the groundwater contaminant plume was divided into three zones as shown in Figure 5-1. It is assumed that the entire area covering all three zones contains concentrations that represent potential hot spots. Performance criteria in terms of minimum treatment concentrations were developed for each zone that would achieve RAO-4 for CW-7. These criteria were developed due to recognized technical impracticability of restoring source zones with residual DNAPL to either MCLs or RBCs, or dissolved phase plumes to the RBC for TCE that is below EPA analytical method detection limits.

The remedial technologies and alternatives evaluated below include active groundwater treatment for on- and off-site groundwater areas. A target concentration for active treatment can be higher than the RBCL if: 1) the MCL target for hot spot treatment is higher than the RBCL; 2) it is not feasible to attain the RBCL by active treatment; or 3) other components of the remedy would ensure protectiveness until the ultimate cleanup goals are reached (DEQ 1998b).

An important question in assessing the scope and cost of alternatives is when to cease active treatment (e.g., groundwater pumping). The goal of active treatment is to mitigate current potential exposures and reach concentrations so that additional natural attenuation will result in the ultimate cleanup goals in a reasonable amount of time. The target concentrations for active treatment must prevent unacceptable exposures under current exposure scenarios, protect an off-site beneficial use, and result in a stable and contracting plume under further natural attenuation after active treatment ceases. The MCL is the target for active treatment of hot spots in deep groundwater.

The goals for active treatment in groundwater are delineated in three zones as described below. Goals for active remediation are proposed site-specific contaminant concentrations that must be attained at particular locations before active treatment in groundwater ceases. Soil in the unsaturated zone is not impacted above risk-based concentrations, but treatment in shallow groundwater may also address saturated soil and the capillary zone. The following sections summarize the rationale and goals for active treatment.

#### 5.1.1.1 Zone 1 – On-Site

In shallow groundwater on site, the possible exposures result from volatilization from shallow groundwater to indoor or outdoor air and from direct contact with groundwater in an excavation. Of the DEQ generic RBCs for these exposure pathways, the RBC for vapor intrusion to indoor air (e.g., TCE = 110 µg/L) is the most restrictive and is the on-site treatment target for Zone 1.

Groundwater beneath the site could be used for an industrial or occupational water supply. However such use is unlikely because of low yield in the shallow zone and limits can be placed on-site for groundwater use. Modeling presented in Appendix D of the draft FS indicates active treatment of Zone 1 to the vapor intrusion RBC would result in residual TCE concentrations being reduced in the Deep Zone to levels below the hot spot level of 5 µg/L prior to entering Zone 3.

#### 5.1.1.2 Zone 2 – West of Site and East of Highway 224

Zone 2 (MIW "mid plume") generally refers to an area between the Revtek and Watumull properties and the west side of Highway 224. Zone 2 is entirely within the industrial reserve or beneath Highway 224. In Zone 2, the only potential exposure is volatilization of CVOCs from shallow groundwater and inhalation in indoor air by occupational workers (e.g., TCE = 110 µg/L). Shallow groundwater CVOC concentrations in Zone 2 are well below the vapor intrusion RBC in Zone 2. Groundwater CVOC concentrations in the Deep Aquifer currently exceed the MCL hot spot threshold for TCE of 5 ug/L. The target concentrations for active groundwater treatment in Zone 2, therefore, are the MCLs to prevent transport that would result in concentrations that would exceed MCLs farther down gradient.

#### 5.1.1.3 Zone 3 – West of Highway 224, North of International Way

Zone 3 includes the distal end of the dissolved phase CVOC plume located west and northwest of Zone 2. Drinking water is the primary reasonably likely use for Zone 3 and areas further downgradient that are considered part of the LOF by DEQ. One active irrigation well was found during the well survey for MIW. In addition, the zone of influence of the City of Milwaukie well No. 7 (CW-7) has been found to encompass all of the deep zone and sand and gravel wells in the MIW study area. Accordingly, DEQ has determined that the goal for Zone 3 in order to be protective must ensure that the drinking water RBC for TCE is not exceeded in groundwater drawn from CW-7 in the future. Modeling was performed by DEQ to evaluate the potential impact (DEQ 2006b). The modeling results indicate that reducing TCE within impacted intervals of Deep and Sand and Gravel aquifers in Zone 3 to a weighted average concentration of 1.5 µg/L through active treatment in Zones 1 and 2 would protect CW-7 from impacts at levels exceeding the RBCs.

Please note that the alternate interpretation of groundwater gradient from Zone 2 to Zone 3, put forth by URS as discussed in Section 2.2.3.2, suggests that contamination from the site would be unlikely to migrate to the OSB-10 area. DEQ has determined that since one interpretation of the data suggests that contamination might reach CW-7 from the site that, to be conservative, consideration of such migration must be included in the remedy for the site.

## 5.2 COMMON REMEDIAL COMPONENTS

This section describes the remedial action components that apply to each of the remedial action alternatives, except Alternative 1, No Action. Common elements include monitoring, deed restrictions including groundwater use controls and worker protection, and periodic review of the remedy.

### 5.2.1 Long-Term Groundwater and Remedy Performance Monitoring

All alternatives, except for the no-action alternative, include long-term CVOC groundwater monitoring and remedy performance reporting. The monitoring program would include periodic monitoring of shallow and deep groundwater. The scope and duration of the monitoring varies somewhat among the alternatives, but each alternative includes similar elements. Performance monitoring reports will include but not be limited to the following:

- Groundwater elevation and isoconcentration maps
- Assessment of hydraulic control
- Assessment of amendment circulation for alternatives that include in-site bioremediation
- Assessment of contaminant trends
- Analysis of CVOC concentration trends and groundwater flow patterns
- Evaluation of protectiveness and progress toward restoration of the beneficial use
- Performance evaluation relative to MCLs, RBCLs and contingency triggers.

A monitoring plan, developed as part of the remedial design, will provide details on the monitoring program, such as sampling methodology, sampling frequency and specific monitoring locations.

### 5.2.2 Air Monitoring

The selected remedy will include periodic ambient air monitoring to ensure fugitive emissions from the air stripper are identified and controlled. The monitoring will include focused outdoor air sampling, additional assessment of possible fugitive emissions, and background ambient air monitoring.

### 5.2.3 MIW Properties Deed Restrictions

Deed restrictions will include restrictions on groundwater use, requirements for protection of workers potentially exposed to site contaminants, and requirements for analysis of the need to address vapor intrusion for future development on site.

### 5.2.4 Off-Site Properties Groundwater Use Controls

Control of exposure to groundwater contamination from the site in downgradient properties will be managed through coordination with Oregon Water Resources and periodic review of new uses of groundwater within the locality of the facility

### 5.2.5 Periodic Review

Periodic review of the remedy will be required. Review of groundwater use within the locality of the facility is required, including periodic notice to property owners of the groundwater contamination in the area. Five year reviews will be performed to evaluate the effectiveness of the remedial action.

### 5.2.6 Contingencies

All alternatives will include contingencies to address potential problems with remedy effectiveness. Examples of contingencies include: 1) installation of additional extraction wells if the capture zone of the groundwater extraction system does not meet design expectations; and 2) treatment of soil gas in the source area if treatment of groundwater in the source area does not result in reductions in outdoor air concentrations and the detections are attributed to CVOC volatilization from soil and groundwater. A contingency plan will be developed during remedial design.

## 5.3 SUMMARY AND DEVELOPMENT OF ALTERNATIVES

This section discusses the development of remedial alternatives for the site. The development of remedial action alternatives involves combining or assembling the remedial technologies into viable site-specific remedial actions. Alternatives were assembled from retained technologies to meet general treatment objectives that align with the RAOs. Table 5-2 provides a summary of the alternatives and their evaluation.

### 5.3.1 Alternative 1: No Action

Alternative 1 is the no-action alternative. Under this alternative, the IRM treatment system would be shut down and decommissioned as would the monitoring wells.

### 5.3.2 Alternative 2: Existing IRM

Alternative 2 consists of operating the existing IRM and monitoring the plume outside the zone of influence of the IRM. The existing IRM includes hydraulic control through groundwater extraction and treatment. Groundwater extraction is accomplished with an extraction well in the upper deep zone (EXT-1) and the extraction trench in the shallow groundwater. Treatment includes air stripping and carbon adsorption. No groundwater extraction and treatment would occur off site (i.e., off the Watumull and Revtek properties).

### 5.3.3 Alternative 3a - Existing IRM, Additional Hydraulic Control, and Monitoring of Natural Attenuation

Alternative 3a is the same as Alternative 2 with an additional downgradient extraction well in Zone 2. The additional extraction well (EXT-2) would be located near Highway 224 and northeast of OSB-3 and would provide hydraulic control further downgradient in the plume and prevent further downgradient migration of CVOCs from the OSB-3 area. With the upgradient source controlled, concentrations farther downgradient (e.g., OSB-5, -6, -8, -9, and -10 area) would be addressed through monitored natural attenuation.

### 5.3.4 Alternative 3b - Existing IRM, Additional Hydraulic Control, On-Site Source Area Groundwater Treatment, and Monitoring of Natural Attenuation

Alternative 3b is identical to Alternative 3a, except in situ treatment is added in the source area. In-situ treatment in the shallow groundwater is likely to be accomplished through in-situ bioremediation with direct injection of bioremediation amendments in a grid pattern of injection points. Management of the upper deep zone is likely to be accomplished with either an extraction well or groundwater circulation wells. Prior to full scale implementation of the in-situ remedy, pilot tests may be implemented to determine the most effective amendments and the most effective distribution system for the amendments. The approaches considered in the draft FS were micro-scale iron and edible oil amendments. The distribution system considered was GCW wells for the deep zone.

### 5.3.5 Alternative 4a - Existing IRM, Additional Hydraulic Control, Downgradient Hydraulic Control and Treatment

Alternative 4a is a pump and treat alternative identical to Alternative 3a, except that hydraulic control and mass removal are added in Zone 3 (west of Highway 224 and in the OSB-9 and -10 areas). The method of hydraulic control and treatment beyond Treatment Zone 2 will be evaluated during remedial design.

### 5.3.6 Alternative 4b - Existing IRM, Additional Hydraulic Control, On-Site Source Area Groundwater Treatment, Downgradient Hydraulic Control and Treatment

Alternative 4b is identical to Alternative 4a, except in-situ treatment is added in the source area as described in Alternative 3b. In-situ treatment in the source area will be accomplished through in-situ bioremediation. Prior to full scale implementation, pilot tests may be implemented to determine the most effective amendments and the most effective distribution system for the amendments.

### 5.3.7 Monitored Natural Attenuation for Alternatives 3a and 3b.

Natural attenuation is defined as a reduction in contaminant concentrations by chemical, physical, and biological mechanisms without active remediation (e.g., groundwater pumping). Mechanisms of natural attenuation can be biotic or abiotic. Biotic natural attenuation results from intrinsic biodegradation of contaminants by indigenous microorganisms that use the contaminants as a food source or as an electron acceptor in metabolic processes. A number of conditions must be met to support intrinsic biodegradation of the site CVOCs, such as presence of microbial nutrients, suitable oxidation-reduction conditions, and availability of a suitable electron donor (in the case of reductive dechlorination of CVOCs). Abiotic natural attenuation results from chemical and physical processes such as dilution, volatilization, and transformation (e.g., chemical oxidation or reduction). The significant reductions in contaminant concentrations before IRM groundwater extraction began, and the presence of TCE degradation products demonstrate ongoing natural attenuation.

Ongoing quarterly groundwater monitoring includes sampling of seven monitoring wells to assess possible mechanisms of natural attenuation. Monitoring parameters include the following:

Biological Parameters and Collection

| Parameter | Rationale | Collection |
|---|---|---|
| DO, ORP, pH | Biological conditions | Routine field parameters |
| VOCs | PCE, TCE, *cis*-1,2-DCE, VC | Routine testing |
| Dissolved Gases Methane, ethane, ethene | Degradation end products | Supplemental bio screening |
| Organic carbon, | Electron donor | Supplemental bio screening |
| Inorganics Chloride, nitrate, dissolved iron, dissolved manganese, sulfate | Redox conditions, electron acceptors | Supplemental bio screening |

The presence of degradation products in groundwater at the MIW site clearly indicates that natural attenuation is ongoing by reductive dechlorination in at least some parts of the groundwater plume, particularly the on-site shallow groundwater. The low DO and predominantly negative redox potentials are conducive to reductive dechlorination. The presence of TCE degradation intermediates (cis-1,2-DCE and VC) and occasional detections of ethene and ethane are strong indications that the TCE is biodegrading by reductive dechlorination. The relatively low TOC in groundwater, and correspondingly low BOD, may indicate limited supply of electron donor. The contribution of other attenuation mechanisms is uncertain.

Natural attenuation will likely be effective in reducing contaminant concentrations in off-site portions of the plume after the upgradient source is eliminated. Groundwater extraction in the source area and/or mid-plume areas will control CVOCs from upgradient that are sourced at MIW. Without a continuing contamination source, natural attenuation processes are expected to result in decreasing contaminant concentrations, a contracting contaminant plume, and eventual restoration of the groundwater to RBCLs. Addition of supplements, such as a carbon source, may greatly increase degradation rates where other conditions are conducive to reductive dechlorination.

### 5.3.8 Alternatives Summary

All alternatives include the following common elements: long-term groundwater monitoring and groundwater remedy performance monitoring, air monitoring, deed restrictions, periodic review, and contingencies. The following summarizes the differences between the alternatives:

Alternative 1: No action except to decommission the existing IRM and monitoring wells.

Alternative 2: Pump and treat in Zone 1.

Alternatives 3a: Pump and treat in Zones 1 and 2 and MNA in Zone 3.

Alternative 3b: Pump and treat in Zones 1 and 2, MNA in Treatment Zone 3, and in-situ bioremediation in the source area including parts of Zone 2.

Alternative 4a: Pump and treat in Zones 1, 2, and 3.

Alternative 4b: Pump and treat in Zones 1, 2, and 3 and in-situ bioremediation in the source area including Zone 2. A contingency in this alternative would be to inject amendments in Zone 3.

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# 6. CRITERIA FOR EVALUATION OF ALTERNATIVES

The evaluation of remedial action alternatives includes the following three criteria:

- The protectiveness of the alternative based upon the standards of OAR 340 340-122-0040;
- The feasibility of the alternatives based upon the balancing factors set forth in OAR 340-122-0090(3).
- Remediation of hot spots of contamination to the extent feasible based upon the criteria set forth in OAR 340-122-0090(4)

These three criteria are described below.

## 6.1 PROTECTIVENESS

The protectiveness of the remedial action alternatives is evaluated relative to the site-specific RAOs defined in Section 4.2. A remedial action alternative may achieve protection through treatment; excavation and off-site disposal; engineering controls; institutional controls; other protective methods; or a combination of these.

## 6.2 BALANCING FACTORS

The balancing factors considered include effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. These are described in further detail below.

### 6.2.1 Effectiveness

Each remedial action alternative is assessed for its effectiveness in achieving protection, by considering the following criteria, as appropriate:

- Magnitude of risk from untreated waste or treatment residuals remaining at the facility absent any risk reduction achieved through on-site management of exposure pathways. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bioaccumulate, and propensity to degrade;
- Adequacy of any engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances remaining at the facility;
- For hot spots in water, the extent to which the remedial action restores or protects existing and reasonably likely future beneficial uses of water;
- Adequacy of treatment technologies in meeting treatment objectives; and
- Time until the remedial action objectives would be achieved.

### 6.2.2 Long Term Reliability

Each remedial action alternative is assessed for its long-term reliability, by considering the following criteria, as appropriate:

- Reliability of treatment technologies in meeting treatment objectives;
- Reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances, taking into consideration the characteristics of the hazardous substances to be managed and the effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure; and
- Nature, degree, and certainties or uncertainties of any necessary long-term management (e.g., operation, maintenance, and monitoring).

### 6.2.3 Implementability

Each remedial action alternative is assessed for the ease or difficulty of implementing the remedial action, by considering the following criteria, as appropriate:

- Practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays;
- The ability to monitor the effectiveness of the remedy;
- Consistency with federal, state and local requirements; activities needed to coordinate with other agencies; and the ability and time required to obtain any necessary authorization from other governmental bodies; and
- Availability of necessary services, materials, equipment, and specialists, including the availability of adequate off-site treatment, storage, and disposal capacity and services, and availability of prospective technologies.

### 6.2.4 Implementation Risk

Each remedial action alternative is assessed for the risk from implementing the remedial action, by considering the following, as appropriate:

- Potential impacts on the community during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
- Potential impacts on workers during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
- Potential impacts on the environment during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures; and
- Time until the remedial action is complete.

### 6.2.5 Reasonable Cost

Each remedial action alternative is assessed for the reasonableness of cost of the remedial action, by considering the following, as appropriate:

- Cost of the remedial action, including: direct and indirect capital costs; annual operation and maintenance costs; costs of any periodic review requirements; and net present value of all of the above;
- Degree to which the costs of the remedial action are proportionate to the benefits to human health and the environment created through risk reduction or risk management;
- With respect to hot spots of contamination in water, the degree to which the costs of the remedial action are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial uses of water; and
- The degree of sensitivity and uncertainty of the costs.

## 6.3 REMEDIATION OF HOT SPOTS

The evaluation of remedial action alternatives, with respect to the remediation of hot spots of contamination in media other than water, considers the treatment or excavation and off-site disposal at an authorized disposal facility or the combination of treatment or excavation, to the extent such measures are feasible based on the criteria in OAR 340-122-0085(7), and the balancing factors set forth in OAR 340-122-0090(3) and previously described. For hot spots of contamination in water, the evaluation of feasibility of treatment is based on criteria in OAR 340-122-0085(5) and the balancing factors set forth in OAR 340-122-0090(3) and described above.

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# 7. EVALUATION OF REMEDIAL ACTION ALTERNATIVES

This section evaluates the remedial action alternatives developed in Section 5 consistent with the requirements of OAR 340-122-085(4). The alternatives are compared for achieving protectiveness, against the balancing factors, and for remediation of hot spot contamination, in Section 7.1, 7.2, and 7.3, respectively. The results of the comparative evaluation provide the basis for the selected remedial action alternative described in Section 8.

The alternatives developed in Section 5 have many similar features. For example Alternatives 2 through 4b all include groundwater pump and treat to varying degrees. Because of this the detailed individual comparison against the balancing factors is not necessary and the evaluation of alternatives can be limited to the comparative analysis. Table 5-2 provides a summary of the detailed analysis for each alternative.

## 7.1 EVALUATION OF ACHIEVING PROTECTIVENESS

Alternative 1, no action, would not achieve protectiveness as source zone contamination above RBCs for protection of workers would remain and groundwater contamination in the deep aquifer would not be addressed resulting in contamination at levels exceeding RBCs for drinking water. Alternatives 2 through 4b include engineering and institutional controls to achieve protectiveness while RAOs are attained. Each of these alternatives is protective provided these controls are effectively implemented.

Comparative analysis of protectiveness of Alternatives 2 through 4b was completed by considering what level of exposure might occur if engineering and institutional controls failed in a like manner for pathways of concern. Alternatives that resulted in more effective treatment or reduced concentrations faster would, under this context, be more protective. Failure of on-site controls would likely result in a greater degree of chemical exposure than off-site. For on-site exposure pathways, Alternatives 3b and 4b are more protective than Alternatives 2, 3a, and 3b. For off-site drinking water pathway, Alternatives 4a and 4b would achieve RAOs in a shorter time frame than Alternatives 3a or 3b, and are therefore considered more protective. Integrating these findings yields a relative protectiveness rating of Alternative 4b being the most protective, followed by Alternative 3b, Alternative 4a, Alternative 3a, and Alternative 2.

## 7.2 COMPARATIVE ANALYSIS OF BALANCING FACTORS

This section provides a comparison of the six alternatives against the five balancing factors: effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. All of the alternatives, except Alternative 1, include hydraulic control in different areas depending on the alternative, and all the common components. Therefore the differences relate primarily to the remedial timeframe, the extent of the hydraulic control area, and the inclusion of in-situ bioremediation.

### 7.2.1 Effectiveness

Alternative 1 is not effective because it does not treat hot spots or achieve the RAOs in a reasonable time frame. Alternative 2 is the least effective because it only treats groundwater in the source area. Alternative 3a improves effectiveness over Alternative 2 by including additional groundwater extraction for mass removal and hydraulic control in the OSB-3 area. Alternative 3a, however, would be a long-term remedy subject to the inherent limitations of pump and treat. Alternative 3a does not include in situ treatment in the source area (other than pumping) to minimize volatilization exposures and quickly reduce CVOC concentrations in on-site groundwater and the OSB-3 area.

Alternative 3b increases effectiveness over Alternative 3a by including aggressive treatment of groundwater in the source area downgradient. In-situ treatment would increase the degradation rate, thereby minimizing the potential for volatilization of CVOCs into indoor or outdoor air and more quickly eliminating the source of CVOCs in the downgradient area.

Alternatives 4a and 4b are similar to 3a and 3b but they include groundwater treatment by pumping or GCWs in the OSB9 and/or OSB10 area. Active treatment in this area would improve effectiveness of mass removal and treatment of hot spot concentrations in this area, as compared to natural attenuation. Based on the above considerations, the relative effectiveness of the alternatives starting from most effective is as follows: 4b, 4a, 3b, 3a, and 2.

### 7.2.2 Long-Term Reliability

Long-term reliability is the ability of the treatment technology and engineering and institutional controls to maintain protectiveness over time and considers the long-term management required to maintain reliability. Long-term reliability does not apply to Alternative 1 because no actions are implemented. The long-term reliability of Alternative 2 is high because the pump-and treat technology is reliable and because the institutional controls are reliable. Likewise, the groundwater pumping and institutional controls elements of the other alternatives are also reliable, and there is little long-term management or implementation uncertainty for these elements of the alternatives.

For Alternatives 3b and 4b, the estimated reliability of the in-site treatment technologies is high, but there is some uncertainty about the reliability of the proposed in situ treatment technologies. The long-term management requirements of Alternatives 3b and 4b are higher than for Alternatives 3a and 4a because maintenance and monitoring of the GCWs that may be used to distribute amendments and monitoring of the biotreatment process itself is somewhat more complex than for pump and treat remedies unless hydraulic control is managed by extraction wells.

The most significant uncertainty of any of the alternatives is the treatment time and the effect of technology alternatives on the treatment time. Case studies, however, indicate substantial increases in removal rates and substantial reductions in treatment times for the proposed in-situ treatment technologies are possible.

Based on the above considerations the relative ranking of the alternatives for long-term reliability is as follows with the most reliable first: 2, 4b, 3b, 4a, and 3a.

### 7.2.3 Implementability

Alternatives 1 and 2 would be easy to implement. The additional groundwater extraction and treatment elements of Alternatives 3a, 3b, 4a, and 4b would be more difficult to implement, but difficulties are not insurmountable. Groundwater extraction and treatment elements would require design, construction, and operation. Alternatives 4a and 4b would be most difficult to implement because of the added active groundwater extraction and treatment in Zone 3 and all the added treatment system components. Difficulties include the inherent challenges associated with groundwater extraction and treatment systems, gaining access to private property, permitting requirements, and monitoring of remedy effectiveness. Based on the above considerations, the relative ranking for implementability for alternatives is as follows: 2, 3a, 3b, 4a, and 4b.

### 7.2.4 Implementation Risk

The primary implementation risk for all the alternatives except Alternative 1 would be the same since all the remaining alternatives use the same groundwater extraction and treatment system which includes the air stripping treatment system. The risks would be low as long as: 1) the treatment system is controlled so that fugitive emissions are not an issue, and 2) management of air and water treatment systems attached to the air stripper is effective to eliminate unacceptable emissions out of the system.

Alternatives 3b and 4b would have the potential added risk associated with management and use of amendments for the in-situ bioremediation system and the potential for rapid generation of daughter products that are more toxic than the primary chemicals. The risk can be avoided through close monitoring of the biodegradation process to enhance full degradation to the complete treatment end products.

### 7.2.5 Reasonableness of Cost

Alternative 2 has the lowest cost ($3,272,000), but the alternative is not effective in meeting the RAOs in a reasonable timeframe. Alternative 3b has the lowest cost ($3,494,000) of the remaining alternatives. Alternative 3b treats high CVOC concentrations on site and in the OSB-3 area and would be effective in treating the groundwater hot spot. Alternative 3a at $3,943,000 is less cost effective than Alternative 3b because it is more expensive and does not include the benefits of in-situ treatment which should decrease the remedial action timeframe and address the potential issue of volatilization of site contaminants to outdoor air.

The relative cost effectiveness of Alternatives 4a ($4,959,000) and 4b ($4,083,000) is similar to the relative cost effectiveness of Alternatives 3a and 3b. Alternatives 4a and 4b are more expensive because they include groundwater extraction and treatment west of Highway 224 and in the OSB-10 area.

The additional costs of hydraulic control and/or treatment in Zone 3 represented by Alternatives 4a and 4b are not justified for the following reasons:

1) There is some uncertainty as to whether the contamination historically detected in CW-7 is from the site (See Section 2.2.3.2);
2) Assuming contamination in the vicinity of OSB-9 and OSB-10 is from the MIW site, there is also uncertainty regarding sorption and degradation processes occurring along the migration pathway between these wells and CW-7;
3) The diffuse nature of the contaminant plume and the relatively high hydraulic conductivities of the Deep and Sand and Gravel aquifers in Zone 3 would require pumping large quantities of water with multiple extraction wells to treat the area and to offset pumping influences from CW-

7;

4) The groundwater used by the City is already being treated due to contamination in several wells providing wellhead protection regardless of the source of contamination; and,
5) Active treatment in Zone 3 would increase total costs by approximately $1 million or 25 percent to address a small percentage of the mass of contamination at the site. Focusing funds on treatment of the high source area contamination will be more cost effective and result in a reduced timeframe for the remedy which should reduce concentrations in OSB-9 and OSB-10 if the contamination in that area is indeed from the MIW site.

The costs for Alternatives 4a and 4b are disproportionate in comparison to Alternatives 3b because they do not appreciably increase the overall protectiveness or effectiveness of the remedy. As described above, Alternative 3b is comparatively more protective and effective than Alternative 3a. Therefore, Alternative 3b is the preferred alternative for the site.

Table 7-1 provides a summary of the costs all six alternatives.

## 7.3 REMEDIATION OF HOT SPOTS

Alternative 1 does not result in remediation of hot spots. The other alternatives remediate hot spots to different degrees. Alternative 4b is the most aggressive alternative in addressing hot spots as it includes hydraulic control in Zone 3 as well as the in-situ treatment that will address both Zones 1 and 2 in addition to hydraulic containment in all three treatment zones. Alternative 4a is next as it includes hydraulic containment and groundwater treatment in all three zones. Alternative 3b is also aggressive in addressing hot spots as it includes the active treatment of the source area in addition to hydraulic containment. However, it is less aggressive than Alternative 4b and 4a because Zone 3 is managed through monitored natural attenuation.

# 8. SELECTED REMEDIAL ACTION

On the basis of the DEQ evaluation of the alternatives summarized in Section 7, the selected remedial action alternative is Alternative 3b, which provides the best balance of protectiveness, effectiveness, implementability, long-term reliability, short-term risk and reasonableness of cost. The estimated present worth for the selected remedial action is $3,500,000. Table 8-1 provides a detailed list of costs for the alternative.

Alternative 3b prevents human exposure to CVOCs in groundwater at concentrations greater than the RBCLs by treating impacted groundwater and implementing institutional controls. It protects, and ultimately restores, the beneficial uses of groundwater in the LOF, and it treats the groundwater hot spot by groundwater pump and treat and enhanced in-situ treatment in Zones 1 and 2 and natural attenuation in Zone 3. As discussed below, the selected remedy includes contingencies to expand groundwater extraction in the distal portion of the plume if monitoring shows that natural attenuation processes are not effective in reducing CVOC concentrations in a timely manner. This phased approach is appropriate given the increased costs that would be incurred to actively remediate the distal portion of the plume and the presence of wellhead treatment that is already in place for the city water supply system to ensure overall protectiveness of the remedy during the implementation.

## 8.1 DESCRIPTION OF THE SELECTED REMEDIAL ACTION

The components of the selected remedial action for the Milwaukie International Way site are presented in the sections below.

### 8.1.1 Groundwater Extraction and Treatment

The selected remedial action assumes continued operation of the Phase 1 IRM groundwater extraction and treatment system and installation of a second extraction well in the deep aquifer and in-situ bioremediation within the source area. The IRM extraction system consists of an extraction trench and one groundwater extraction well. Design and startup reports (URS 2003d, 2003e, 2004c) describe the design, construction, and initial operation of the IRM treatment system. EXT-1 pumps at a typical rate of 8 to 25 gpm. The trench pumps intermittently at a rate of approximately 6 gpm, resulting in an average extraction rate of less than 1440 gallons per day during the wet time of the year or after precipitation. The pumping regime from EXT-1 and the extraction trench might be modified to be compatible with the in-situ remedy discussed in Section 8.1.2 below.

The new groundwater extraction well (EXT-2) would be installed near OSB-3. A pipe would convey extracted groundwater to the existing treatment system. The design intent of the new extraction well is to capture groundwater in the mid plume to a depth of approximately 100 feet bgs. The assumed depth of EXT-2 is approximately 80 feet, with a screened interval of 50 to 70 feet bgs. The estimated pumping rate of EXT-2 is 20 to 25 gpm, as indicated by groundwater flow modeling. An aquifer pumping test would be completed to confirm that the optimum sustainable groundwater pumping rate and zone of groundwater capture.

The estimated groundwater extraction rate for the remedy is 50-60 gpm, with 25 gallons per minute for EXT-1, 25 gallons per minute for EXT-2 and up to 6 gpm from the shallow recovery trench. Actual rates will likely vary over time to reflect reduced pumping as the contaminant plume shrinks.

The existing treatment system treats extracted groundwater and offgas vapors through air stripping, treatment of offgas from the air stripper with activated carbon and permanganate-impregnated zeolite, and treatment of water from the air stripper through carbon filters. During remedial design, DEQ will assess what, if any, additional capacity is required in the air stripper to treat the additional groundwater and whether or not carbon adsorption is necessary for further treatment of groundwater following air stripping.

Treated groundwater is currently discharged to the sanitary sewer. Treated groundwater will either continue to be discharged to the sanitary sewer in a manner similar to the current IRM discharges or will be discharged to surface water via the on-site storm sewer system connected to the municipal stormwater system subject to the discharge requirements specified below. Any decision to modify the existing discharge will be made during remedial design based on a cost-benefit analysis and municipal wastewater treatment plant operational capacity. Pursuant to ORS 465.315(3), DEQ as the implementing party is exempt from the requirement to obtain an NPDES permit for the discharge of treated groundwater for the selected remedy. Contaminant discharge limits for total CVOCs will not exceed 50 µg/L, and will not exceed the freshwater chronic ambient water quality criteria specified in OAR 340-41, Table 20. Compliance monitoring shall be performed on a quarterly (3 month) frequency. During initial system startup, monitoring will be conducted on at least a monthly schedule until such time as required to optimize treatment system performance. Substantive requirements related to monitoring locations and frequency, compliance points and reporting shall be specified in the O&M Plan for the final remedy.

Subject to DEQ approval, treated groundwater may be beneficially reused (i.e. for industrial process water or irrigation) provided the applicable regulatory requirements of the Oregon Water Resources Department are satisfied.

The current IRM operation and maintenance plan would be modified to reflect incorporation of the additional extraction well. Figure 8-1 presents the groundwater extraction and treatment system with the proposed location of EXT-2 and the proposed conveyance line alignment.

### 8.1.2 Source Area In-Situ Bioremediation

In-situ bioremediation is the technology selected for enhanced treatment of the source area at the site. A conceptual design for in-situ bioremediation for cost estimation purposes was presented in the draft FS for the site as follows: three groundwater circulation wells will distribute treatment amendments in on-site deep, and perhaps shallow, groundwater. Pumping from EXT-2 would draw amendments farther downgradient and provide hydraulic control of CVOCs in groundwater. The design of the GCWs assumes upper and lower screen intervals of 25 to 40 feet bgs and 65 to 80 feet bgs, respectively. Preliminary design estimates indicate that a pumping rate of 20 to 25 gpm in GCWs will produce a zone of influence of 60 feet. The treatment amendments considered in the draft FS include microscale iron and edible oil.

In addition to amendment distribution by GCWs, treatment amendments will be introduced to shallow groundwater and soil in the source area through an estimated 20 direct push borings installed to a depth of 16 to 20 feet (Figure 8-2). Targeted timing of injections when the groundwater levels are high, and possibly artificially raising the water table by injecting treated groundwater or by other means, will expand the treatment zone into shallower soils to enhance treatment of any CVOCs that are at shallow depths in the shallow soil and groundwater zone.

During remedial design further evaluation of the optimum in-situ bioremediation approach would be performed which may deviate from the conceptual design presented in the FS.

An operation and maintenance plan will be prepared for the site for the in-situ bioremediation technology.

### 8.1.3 Institutional Controls

#### 8.1.3.1 Groundwater Monitoring

Groundwater analytical sampling will be conducted on a quarterly, semiannual, or annual basis, depending on location. Groundwater samples would be analyzed for CVOCs by EPA Method 8260 to provide data on reduction of CVOCs concentrations within the plume and geochemical parameters necessary to properly engineer the in-situ bioremediation in the source zone. Modifications to the sampling program are expected as the remedy proceeds in operation and maintenance. Water-level measurements will be collected quarterly initially in selected wells and piezometers. A groundwater monitoring plan will be prepared during remedial design.

The objectives of groundwater monitoring are as follows;

- Monitor groundwater within the source area to assess concentrations, trends, and the rate of CVOC mass removal.
- Monitor groundwater in downgradient wells to assess contamination reductions to protective levels.
- Assess hydraulic regime and demonstrate that groundwater hydraulics have not changed in a way as to destabilize the plume.

A groundwater monitoring data report will document each routine sampling event and the annual report (Section 8.1.6) will provide a full review of the data describing remedy performance.

The selected remedy does not include monitoring for natural attenuation parameters in Zone 3 as biotic and abiotic processes are not likely to be a significant mechanism for concentration reduction in this portion of the plume. Monitoring of these parameters would be considered as part of contingency measures implementation should CVOC concentrations fail to attenuate significantly in response to active treatment implemented in Zones 1 and 2.

#### 8.1.3.2 Air Monitoring

The selected remedy will include periodic ambient air monitoring to ensure fugitive emissions from the air stripper are identified and controlled. The monitoring will include focused outdoor air sampling, additional assessment of possible fugitive emissions, and background ambient air monitoring.

8.1.3.3 Milwaukie International Way Properties Deed Restrictions

An Easement and Equitable Servitude (EES) would be placed on the Watumull and Revtek properties that would include the following:

- Restrictions on groundwater use;
- Health and safety procedures to protect workers during subsurface maintenance activities;
- Soil management requirements to ensure contaminated soil is properly managed; and,
- Review of the requirement for vapor barriers in buildings if development is planned.

8.1.3.4 Off-Site Properties Groundwater Use Controls

Control of exposure to groundwater contamination from the site will be managed in two ways. First, DEQ will coordinate to the extent possible with Oregon Water Resources Department (WRD) to inform well drillers of the contamination in the vicinity of the MIW site. Second, a review of WRD records will be performed annually to determine whether or not there are new uses of groundwater within the locality of the facility. In addition, notification will be provided at least every five years to property owners in the LOF. The notification area will be reduced as the plume contracts.

### 8.1.4 Periodic Reviews

DEQ will conduct periodic reviews on an annual basis for the first five years of remedy implementation to ensure that the remedial action remains protective for present and future public health, safety, and welfare, and the environment and to determine whether modifications to the remedy are warranted. Subsequent periodic reviews will be performed at least every five years. Periodic reviews will include the evaluation of site monitoring data, progress reports, inspection and maintenance reports, land and beneficial water uses for the site and site vicinity, compliance with institutional controls, and any other relevant information. Monitoring data will be evaluated on an annual basis to confirm that the established RAOs for the site are being attained and that the monitoring program is adequate. DEQ may implement contingency measures in the event that the monitoring data or other information suggests that the remedy will not successfully address the RAOs in a timely fashion.

### 8.1.5 Contingencies

Contingencies will be considered if the remedy does not perform as expected or if water supply wells are developed within the LOF. Examples of possible contingency triggers include the following:

- Hydraulic or treatment failure of the groundwater extraction systems.
- Increasing contaminant concentrations or unexpected expansion of CVOCs in groundwater downgradient of the site.
- Conclusion that the groundwater monitoring network is inadequate to assess performance.
- Detection of CVOCs in indoor or outdoor air attributable to the site at unacceptable concentrations.
- Lack of evidence indicating significant biodegradation or natural attenuation.

Examples of contingent actions include upgrading or adding to the groundwater extraction system, adding monitoring points or increasing monitoring frequency, treatment of soil gas in the source area, or conducting additional assessment or modeling to evaluate changing conditions.

## 8.2 SATISFACTION OF PROTECTION AND FEASIBILITY REQUIREMENTS

### 8.2.1 Protectiveness

The selected remedial action for soil and groundwater is protective of human health and the environment as long as the institutional controls are maintained and effective. In addition, the fact that the City of Milwaukie is treating the water at the wellhead provides further assurance that the remedy is protective just in the event the distribution of contamination in Zone 3 is more extensive than currently understood or that the source of this contamination is from a source other than the MIW site. The acceptable risk levels for human health prescribed by the Oregon Environmental Cleanup Statute and implementing rules are $1x10^{-6}$ excess lifetime cancer risk for individual carcinogens, $1x10^{-5}$ for cumulative carcinogens, and a hazard index of one for non-carcinogens. The selected remedy manages soil and groundwater contamination such that the residual risk is below the $1x10^{-6}$.

### 8.2.2 Balancing Factors

Remedial actions selected by DEQ are based on a balance of effectiveness, implementability, long-term reliability, short term risk, and reasonableness of cost. As discussed in Section 7.0 the selected alternative provides the best balance of these criteria considering existing actions in the area and limited resources for the remedy.

### 8.2.3 Remediation of Hot Spots

The selected remedy includes treatment, to the extent practicable, of contaminated groundwater above hot spot concentrations. Most of the MIW plume found in Zones 1, 2, and 3 is considered within the groundwater hot spot (i.e., above the MCL). The selected remedy does not include active groundwater treatment in Zone 3, however it does include monitoring contamination in that zone that is predicted to attenuate to MCLs through physical processes.

### 8.2.4 Land Use and Beneficial Water Use

DEQ has evaluated current and reasonably anticipated future land uses at the site and surrounding properties when selecting the remedial action. DEQ also considered present and potential future land uses at the site in determining risk-based cleanup levels for the site. The selected remedial action takes into account that the land use in Zones 1 and 2 is commercial and industrial and the land use in Zone 3 and the remainder of the LOF is residential on the west side of Highway 224 and commercial/industrial on the east side of Highway 224.

# 9. PUBLIC NOTICE AND COMMENTS

DEQ's notice of the recommended remedial action was published in the Secretary of State's Bulletin and The Oregonian on December 1, 2006. Copies of the RI and FS reports, DEQ's Staff Report for the Recommended Remedial Action and other pertinent project documents were made available for public review at DEQ's Northwest Region Office in Portland. The staff report was also made available on DEQ's website.

A 30-day public comment period began on December 1, 2006 and ended on January 2, 2007. No comments were submitted to DEQ.

# 10. CONSIDERATION OF PUBLIC COMMENTS

No comments were submitted to DEQ as a result of the public comment period.

# 11. DOCUMENTATION OF SIGNIFICANT CHANGE

Since no comments were submitted during the public comment period, no significant changes were made to the staff report in preparing the Record of Decision.

# 12. FINAL DECISION OF THE DIRECTOR

The selected remedial action for the Milwaukie International Way site is protective; to the maximum extent practicable, is cost reasonable, effective, implementable and reliable; and remediates hot spots to the extent feasible. The selected remedy therefore satisfies the requirements of ORS 456.315 and OAR 340-122-0040 and 0090. The detailed evaluation of how the selected remedial action meets the regulatory requirements is provided in Sections 5, 6, 7 and 8.

## 13. DIRECTOR'S SIGNATURE

Dick Pedersen
Oregon Department of Environmental Quality
Northwest Region Administrator

1/25/07
Date

# Table 4-1
# Summary of DEQ RBCs and EPA MCLs
# Milwaukie International Way

| Media, Pathway | | | units | Chemical and Concentration | | | |
|---|---|---|---|---|---|---|---|
| | | | | PCE | TCE | *cis*-1,2-DCE | VC |
| Groundwater | Volatilization to outdoor air (occupational) | DEQ RBCs | µg/L | 8,600 | 650 | 1,600,000 | 6,200 |
| Groundwater | Vapor intrusion to indoor air (occupational) | DEQ RBCs | µg/L | 1,300 | 110 | 410,000 | 840 |
| Air | Indoor/outdoor air (occupational) | DEQ RBCs | µg/m$^3$ | 1.9 | 0.10 | 150 | 2.6 |
| Groundwater | Direct exposure excavation worker | DEQ RBCs | µg/L | 240 | 130 | 7,600 | 1,100 |
| Groundwater | Tap water occupational workers | DEQ RBCs | µg/L | 0.63 | 0.17 | 240 | 0.49 |
| Groundwater | Tap water off-site residents | DEQ RBCs | µg/L | 0.091 | 0.029 | 61 | 0.024 |
| Groundwater | EPA MCL | | µg/L | 5 | 5 | 70 | 2 |

## Table 5-1
## Summary of Retained Active Treatment Technologies
## Milwaukie International Way

| Technology | Amendments (if applicable) and Remedy Options | Process and Delivery |
|---|---|---|
| Groundwater Pump and Treat | Additional downgradient mid-plume extraction well (east of Hwy 224 is likely. Groundwater extraction for distal plume control unlikely and difficult to implement. | Groundwater from mid-plume extraction well treated using existing IRM treatment system. Conveyance alignment through storage units and down fire lane to existing conveyance. |
| Nano-scale Zero-Valent Iron | Nano-scale zero-valent iron slurry treats CVOCs by chemical reduction. Nano-scale particles have high reactive surface and can be distributed through aquifer materials. | GCWs or direct injection to introduce the amendments into the subsurface. Groundwater pumping can distribute material once in the aquifer. |
| In-Situ Anaerobic Bioremediation | Emulsified Oils (EOS), EHC, HRC, Molasses and others. Amendments can provide carbon source, source of free electrons, microbial inoculum, and nutrients. EHC combines carbon source with zero-valent iron. | GCWs or direct injection to introduce the amendments into the subsurface. Groundwater pumping can distribute amendments once in the aquifer. |
| Groundwater Circulation Wells (GCWs) | GCWs are an option for delivery of amendment for on-site treatment such as bio amendments, zero-valent iron, or oxidants. GCWs are also an option for control and treatment of the distal plume by in-well stripping or amendment delivery. | Amendments introduced at wellhead before re-injection into upper well screen. Amendments distributed by advection cell established around the well. |
| Monitored Natural Attenuation | None | Monitoring ongoing natural degradation of CVOCs |

# Table 5-2
## Alternatives Summary
## Milwaukie International Way

| Alternative | Actions | Technology Options | Evaluation Criteria: Protectiveness | Effectiveness | Reliability | Implementability | Cost | Comments |
|---|---|---|---|---|---|---|---|---|
| **Alternative 1**<br><br>No Action | • Shutoff groundwater extraction.<br>• Decommission treatment system. | None. | Low | Low | N/A | Easy | $1.3M | Action would not provide removal of CVOCs in groundwater or hydraulic control of contaminant plume. |
| **Alternative 2**<br><br>Existing IRM System **(Baseline Remedy)** | • Extract groundwater from IRM well EXT-1 and extraction trench.<br>• Test and document rate of contaminant attenuation by anaerobic intrinsic biodegradation.<br>• Monitor groundwater to document continued natural attenuation and to assess rate of mass removal.<br>• Develop contingency plan to allow modifications to remedy if rate of natural attenuation is not adequate.<br>• Implement institutional controls. | Continue groundwater pump and treat. No additional technology applied. Continue attenuation monitoring. | Moderate | Low | High | High | $3.3M | Existing system provides local hydraulic control of contaminant plume and mass removal of CVOCs. Continued monitoring would document hydraulic control and contaminant attenuation. Action would not provide removal of CVOCs or hydraulic control of downgradient contaminant plume. Push-pull test and monitoring would assess MNA in downgradient plume. |
| **Alternative 3a**<br><br>Baseline remedy, additional hydraulic control well(s), and MNA in distal plume | • Extract groundwater from existing IRM wells.<br>• Install additional downgradient well (EXT-2) between OSB-1 and OSB-3 to hydraulically control source area plume and prevent further migration.<br>• Monitor groundwater within source area plume to confirm ongoing natural attenuation and to assess rate of mass removal.<br>• Monitor groundwater at distal wells to confirm natural attenuation and concentration reduction.<br>• Implement institutional controls. | Continue groundwater pump and treat system. Addition of downgradient control well(s). Continue attenuation monitoring in source and distal areas of the plume. | Moderate | High | Moderate | Moderate | $3.9M | Existing system provides local hydraulic control of contaminant plume and mass removal of CVOCs. Expanded groundwater pumping would increase contaminant mass removal and provide a much larger capture zone. Site data demonstrate ongoing anaerobic intrinsic biodegradation that will continue to reduce CVOCs in on-site groundwater. Treatment duration is long, and implementation risk from volatilization of CVOCs from on-site shallow groundwater is uncertain. Viability of natural attenuation element of remedy would require quantification of biodegradation rate. |
| Alternative 3b<br><br>Baseline remedy, on-site source area treatment, additional hydraulic control well(s), MNA in distal plume | • Extract groundwater from existing IRM wells.<br>• Add additional downgradient well (EXT-2) between OSB-1 and OSB-3 to further mass removal, hydraulically control source area plume and prevent further migration.<br>• Perform in-situ push-pull tests to determine reaction kinetics for overall reductive dechlorination.<br>• Install and test GCWs in source area to distribute bio amendments.<br>• Treat source area by amendment addition for biological or chemical reduction.<br>• Monitor groundwater within source area plume to confirm contaminant reduction and mass removal.<br>• Monitor groundwater at distal wells to confirm natural attenuation and concentration reduction.<br>• May require shallow zone treatment based on level of protectiveness determined from further evaluation. May include additional soil sampling and soil gas survey.<br>• Implement institutional controls. | GCWs or direct push injection for amendment distribution. In-situ tests may indicate effectiveness. GCW or direct push methods may be used alone or in combination.<br><br>Recommendations of source area treatment include addition of amendments to stimulate in-situ bioremediation (e.g., EOS, EHC, or HRC), nano-scale iron, excavation, or a combination of technologies.<br><br>May conduct push-pull test to evaluate and compare the overall degradation rates of the different amendments could be accomplished in a one to two month testing period, including weekly sampling and lab analysis. | High | High | Moderate to High | Moderate | $3.5M | Existing system provides local hydraulic control of contaminant plume and mass removal of CVOCs. Expanded groundwater pumping would increase contaminant mass removal and provide a much larger capture zone. Site data demonstrate ongoing anaerobic intrinsic biodegradation. Push-pull test would better identify expected degradation rates. Addition of in-situ bio amendments or other in-situ treatment will increase degradation rates of CVOCs, reduce treatment duration, and reduce residual risk by volatilization. GCWs can be used to distribute amendments. Direct injection of amendments could also be an alternative method of delivery to the aquifer. |

## Table 5-2
## Alternatives Summary
## Milwaukie International Way

| Alternative | Actions | Technology Options | Evaluation Criteria: Protectiveness | Effectiveness | Reliability | Implementability | Cost | Comments |
|---|---|---|---|---|---|---|---|---|
| **Alternative 4a**<br><br>Baseline remedy, additional hydraulic control well(s), control and treatment in distal plume | • Extract groundwater from existing IRM wells.<br>• Install additional downgradient well (EXT-2) between OSB-1 and OSB-3 to hydraulically control source area plume and prevent further migration.<br>• Monitor groundwater within source area plume to confirm contaminant reduction and mass removal.<br>• Hydraulically control and remove contaminant mass at distal end of plume to be protective of City pumping wells as necessary.<br>• Monitor groundwater at distal wells to demonstrate effective hydraulic control.<br>• Implement institutional controls. | Continue groundwater pump and treat system. Addition of downgradient control well(s). Install GCWs for possible amendment distribution or ex situ groundwater treatment in distal plume. Enhanced treatment by amendment addition is an option. Groundwater extraction and ex situ treatment is an effective but expensive option. | Moderate | High | Moderate | Difficult | $5.0M | Existing system provides local hydraulic control of contaminant plume and mass removal of CVOCs. Expanded groundwater pumping would increase contaminant mass removal and provide a much larger capture zone. Site data demonstrate ongoing anaerobic intrinsic biodegradation that will continue to reduce CVOCs in on-site groundwater. Treatment duration is long, and implementation risk from volatilization of CVOCs from on-site shallow groundwater is uncertain. Initial analysis indicates that distal treatment is not necessary, but any treatment in the distal plume should be as simple as possible to meet RAOs. |
| **Alternative 4b**<br><br>Baseline remedy, on-site source area treatment, additional hydraulic control well(s), control and treatment in distal plume | • Extract groundwater from existing IRM wells.<br>• Add additional downgradient well (EXT-2) between OSB-1 and OSB-3 to further mass removal, hydraulically control source area plume and prevent further migration.<br>• Monitor groundwater within source area plume to confirm contaminant reduction and mass removal.<br>• Monitor groundwater at distal wells to evaluate effectiveness of remediation technology.<br>• Install and evaluate GCWs in source area to distribute bio amendments.<br>• May require shallow zone treatment based on level of protectiveness determined from further evaluation. May include additional soil sampling and soil gas survey.<br>• Perform in-situ push-pull tests to determine reaction kinetics for overall reductive dechlorination<br>• Hydraulically control and remove contaminant mass at distal end of plume to be protective of City pumping wells as necessary.<br>• Implement institutional controls. | Options for in-situ treatment and amendment delivery in source area as for Alternative 3b.<br><br>Install GCWs or pump and treat for distal plume as for Alternative 4b. | High | High | Moderate to High | Difficult | $4.1M | Existing system provides local hydraulic control of contaminant plume and mass removal of CVOCs. Expanded groundwater pumping would increase contaminant mass removal and provide a much larger capture zone. Site data demonstrate ongoing anaerobic intrinsic biodegradation. Push-pull test would better identify expected degradation rates. Addition of in-situ bio amendments or other in-situ treatment will increase degradation rates of CVOCs and reduce treatment duration. Initial analysis indicates that distal treatment is not necessary, but any treatment in the distal plume should be as simple as possible to meet RAOs. |

## Table 7-1
## Summary of Alternative Costs
## Milwaukie International Way

| Item | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3a | 3b | 4a | 4b |
| **Capital Costs** | | | | | | |
| Work plans, reports, meetings | $5,000 | $35,000 | $85,000 | $95,000 | $105,000 | $115,000 |
| Remedy evaluation and testing | $0 | $0 | $10,000 | $65,000 | $40,000 | $70,000 |
| Implement remedy | $0 | $0 | $198,000 | $650,000 | $494,000 | $935,000 |
| Contingency (15% on capital costs) | $1,000 | $5,000 | $44,000 | $122,000 | $96,000 | $168,000 |
| Subtotal Capital Costs | $6,000 | $40,000 | $337,000 | $932,000 | $735,000 | $1,288,000 |
| **Recurring and Future Costs** | | | | | | |
| Operation and maintenance | $0 | $1,803,000 | $2,100,000 | $1,151,000 | $2,510,000 | $1,209,000 |
| Groundwater monitoring, DEQ oversight | $5,000 | $916,000 | $942,000 | $918,000 | $1,066,000 | $1,058,000 |
| Decommissioning and closure | $360,000 | $91,000 | $94,000 | $159,000 | $97,000 | $163,000 |
| Contingency (15% on future costs) | $55,000 | $422,000 | $470,000 | $334,000 | $551,000 | $365,000 |
| Subtotal Recurring and Future Costs | $420,000 | $3,232,000 | $3,606,000 | $2,562,000 | $4,224,000 | $2,795,000 |
| **Total Alternative Cost** | $426,000 | $3,272,000 | $3,943,000 | $3,494,000 | $4,959,000 | $4,083,000 |

**Notes:**

**Alternative 1:** No Action.

**Alternative 2:** Continue IRM system operation (Baseline Remedy). 20 years operation, and 10 years post remedy monitoring.

**Alternative 3a:** Continue IRM system operation with downgradient extraction well. 20 years operation and 10 years post remedy monitoring.

**Alternative 3b:** Continue IRM system operation with downgradient extraction well, MNA downgradient and source area treatment. 6 years operation and 10 years post remedy monitoring.

**Alternative 4a:** Continue IRM system operation with downgradient extraction well, control and treatment downgradient. 20 years operation and 10 years post remedy monitoring.

**Alternative 4b:** Continue IRM system operation with downgradient extraction well, control and treatment downgradient and source area treatment. 6 years operation and 10 years post remedy monitoring.

Future and recurring costs are net-present value at a discount rate of 7.5 percent.

## Table 8-1
## Cost Detail - Alternative 3b
## Milwaukie International Way

**Alterantive 3b:** Baseline Remedy plus Additional Hydrualic Control Well(s), MNA Downgradient, and On-Site Source Area Treatment

| CAPITAL COSTS | | | | | |
|---|---|---|---|---|---|
| Item | Assumptions | Unit Cost | Units | Quantity | Cost |
| **Work plans, reports, meetings** | | | | | |
| RD/RA scoping | RD/RA scoping and meetings with DEQ | $20,000 | lump | 1 | $20,000 |
| RD/RA work plan | Remedy work plan after ROD | $40,000 | lump | 1 | $40,000 |
| Construction and O&M plans | Source and mid-plume workplans, design | $35,000 | lump | 1 | $35,000 |
| | | | | **Subtotal** | **$95,000** |
| **Remedy Evaluation and Testing** | | | | | |
| Workplan and scoping | Test design, access | $10,000 | lump | 1 | $10,000 |
| Downgradient well pump test | Pump test, storage tank, transport to bldg. | $10,000 | lump | 1 | $10,000 |
| Degradation rate study of amendments | Insitu push-pull test of select amendments | $15,000 | lump | 1 | $15,000 |
| GCW assessment | GCW testing downgradient | $15,000 | lump | 1 | $15,000 |
| MNA review, and assessment | Sampling and lab analysis | $15,000 | lump | 1 | $15,000 |
| | | | | **Subtotal** | **$65,000** |
| **Implement Remedy** | | | | | |
| Downgradient Well | Installation of new extraction and conveyance | $189,000 | lump | 1 | $189,000 |
| Groundwater circulation wells | Install three new GCWs | $92,000 | lump | 1 | $92,000 |
| Utility and conveyance construction | trench, piping, and utilities to GCWs | $91,200 | lump | 1 | $91,200 |
| Completion of GCWs | Install pumps, motors and controls | $15,000 | lump | 1 | $15,000 |
| Injection of bioamendments | Initial distribution of amendments at GCWs | $135,000 | lump | 1 | $135,000 |
| Shallow zone treatment | Introduction of amendments in IRM area | $20,000 | lump | 1 | $20,000 |
| Installation of piezometers | Install three new piezos for GCW evaluation | $85,000 | lump | 1 | $85,000 |
| Permitting, fees | City permitting and planning | $7,500 | lump | 1 | $7,500 |
| Access agreements | Negotiate agreements and coordination | $15,000 | lump | 1 | $15,000 |
| | | | | **Subtotal** | **$650,000** |
| Contingency | Percent of capital costs | 15 | percent | — | $122,000 |
| | | | | **SUBTOTAL CAPITAL COSTS** | **$932,000** |

## Table 8-1
## Cost Detail - Alternative 3b
## Milwaukie International Way

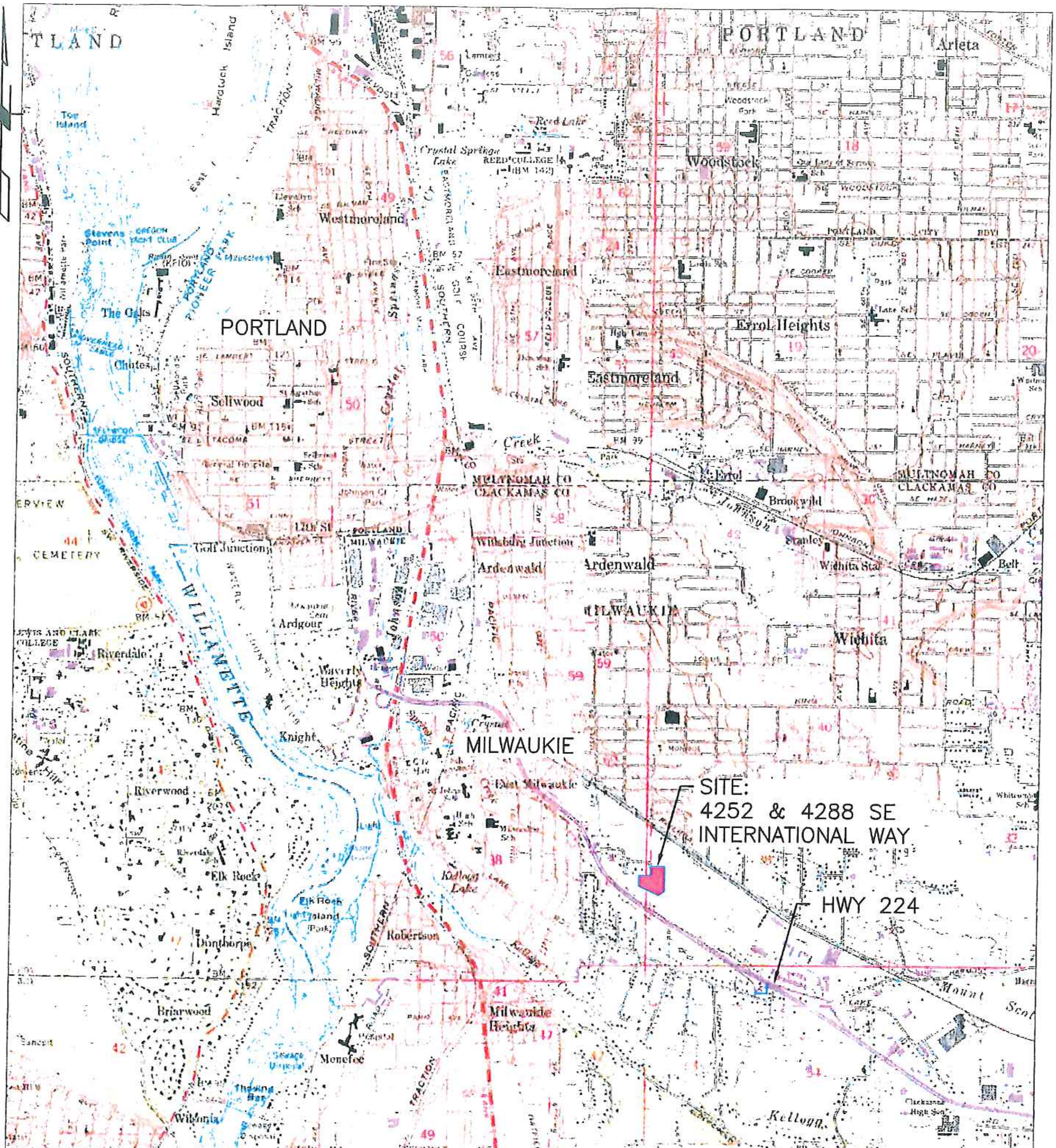
| RECURRING AND FUTURE COSTS | | | | | |
|---|---|---|---|---|---|
| Item | Assumptions | Interval | Years | Cost per Year or Event | Project Cost (NPV) [1] |
| **Operation and Maintenance** | | | | | |
| Ongoing system operation | Operate existing IRM treatment system | annual | 1 | $160,000 | $148,800 |
| Ongoing expanded system operation | Operate expanded groundwater extraction | annual | 2 - 6 | $192,000 | $722,600 |
| Bio system operation, monitoring, reporting | Operate and maintain GCW system | annual | 2 - 6 | $35,000 | $131,700 |
| Reporting, management, consulting | Performance reporting, general consulting | annual | 2 - 6 | $20,000 | $75,300 |
| Reporting, management, consulting | Performance reporting, general consulting | annual | 7 - 16 | $2,500 | $11,100 |
| System components replacement | Equipment replacement | future | 3 | $12,500 | $10,100 |
| Additional bio amendments | Future bio applications | future | 4 | $68,000 | $50,900 |
| | ***Total Operation and Maintenance*** | | | | **$1,151,000** |
| Operation contingency | Contingency groundwater pumping (see text) | annual | 7 - 10 | $192,000 | $416,700 |
| **Groundwater Monitoring and Reporting, DEQ oversight** | | | | | |
| Groundwater monitoring | 18 wells quarterly, 30 wells semiannual | annual | 1 - 6 | $142,000 | $666,500 |
| Groundwater monitoring | 15 wells semiannual, 20 wells annual | annual | 7 - 10 | $35,921 | $78,000 |
| Natural attenuation monitoring | Post-remedy biomonitoring; 15 wells semi-annual | annual | 11 - 16 | $15,000 | $34,200 |
| DEQ oversight | Annual estimate (RD/RA, const., startup) | annual | 1 - 6 | $25,000 | $117,300 |
| DEQ oversight | Annual estimate (O&M, reporting, review) | annual | 7 - 16 | $5,000 | $22,200 |
| | ***Total Groundwater Monitoring*** | | | | **$918,000** |

**Table 8-1**
**Cost Detail - Alternative 3b**
**Milwaukie International Way**

| RECURRING AND FUTURE COSTS | | | | | |
|---|---|---|---|---|---|
| Item | Assumptions | Interval | Years | Cost per Year or Event | Project Cost (NPV) [1] |
| **Decommissioning and Closure** | | | | | |
| Decommission monitoring wells | Decommission 18 wells after 6 years | future | 7 | $108,000 | $65,100 |
| | Decommission 5 wells after 10 years | future | 11 | $30,000 | $13,500 |
| | Decommission final 15 monitoring wells | future | 17 | $90,000 | $26,300 |
| Decommission treatment system | Equipment, conveyance, building | future | 17 | $100,000 | $29,200 |
| GCW well abandonment | Decommission of GCW wells | future | 17 | $10,000 | $2,900 |
| Closure reporting, NFA notice | Site closure reporting, final sampling | future | 17 | $75,000 | $21,900 |
| | ***Total Decommissioning and Closure*** | | | | **$159,000** |
| **Contingency** | Percent of recurring and future costs | 15 | percent | — | $334,000 |
| | | | **SUBTOTAL RECURRING AND FUTURE COSTS** | | **$2,562,000** |
| | | | **TOTAL PRESENT VALUE COST (2006 DOLLARS)** | | **$3,494,000** |

Discount factors: NPV = cost multiplied by discount factor ($f$).
Present worth: $f = (1 + i)^{-n}$.
Equal series present worth: $f = (1 + i)^{n} - 1 / i(1 + i)^{n}$.
$i$ = interest rate = 0.075.
Calculated cost rounded to nearest $100.

Sums are rounded to nearest $1,000.




Source: USGS Quadrangle map for Gladstone, OR (1984)
Lake Oswego, OR (1984)

0 1500 3000
SCALE FEET

**Site Location**

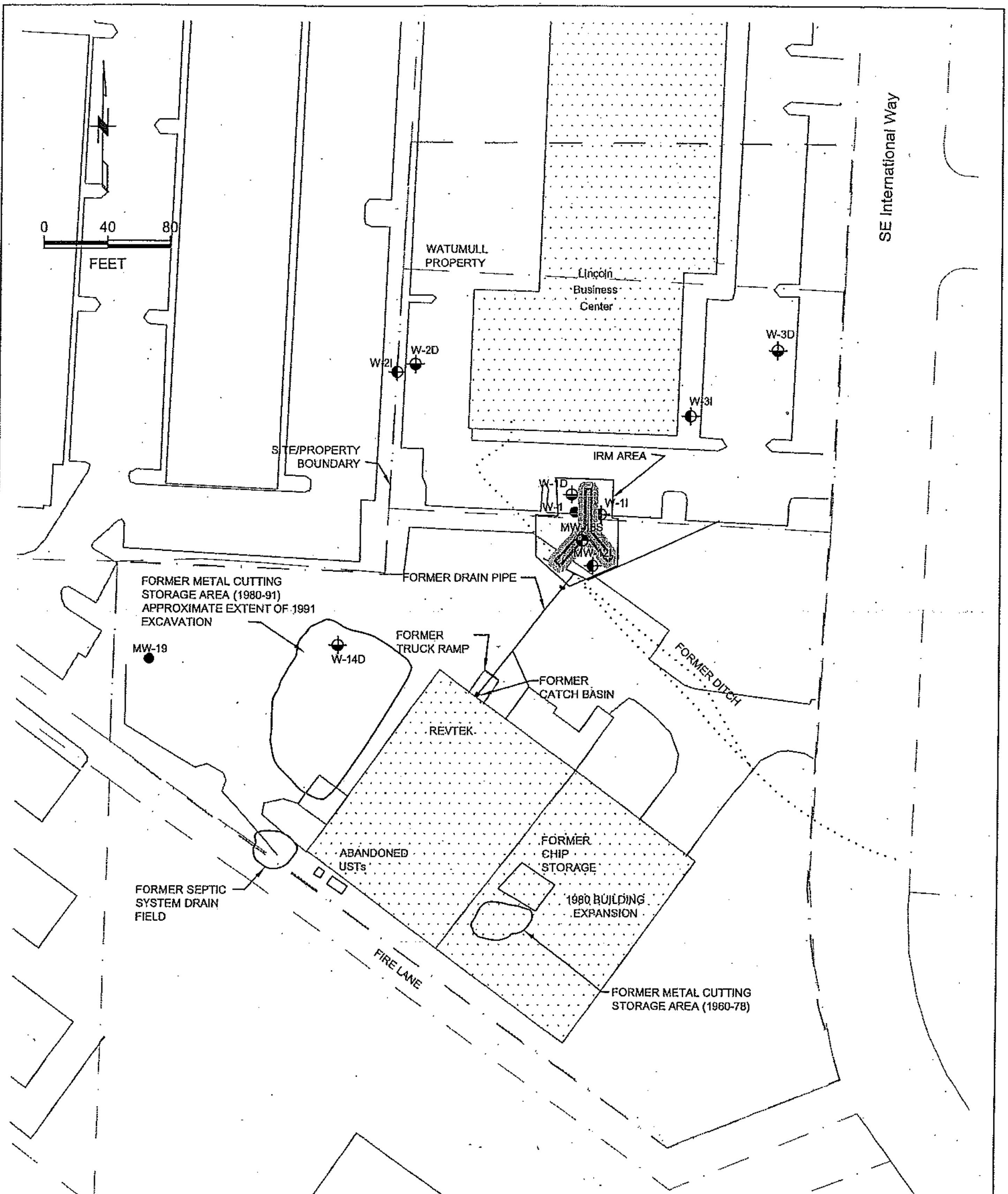
URS

August 2006
25695795

Milwaukie International Way Site
Milwaukie, OR

Figure 2-1

O:\25694284 Milwaukie International\RI-FS Report\Feasibility Study\Draft-outline\Figures\FIG 1-1VICINITY.dwg Sep 11, 2006 - 8:17am




SOURCE: Base Map Source: MFA
Locations are approximate

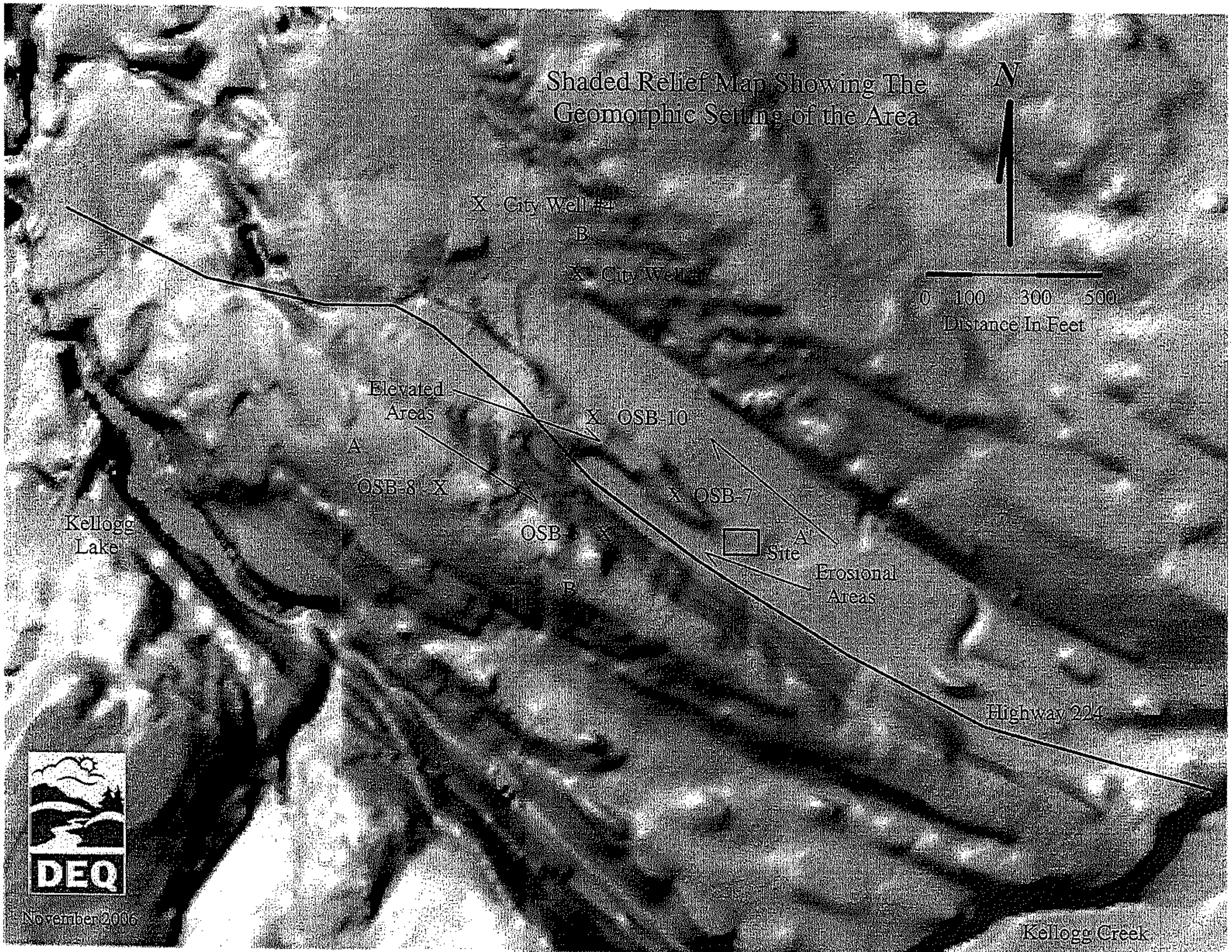
**Site Map**

URS

August 2006
25695795

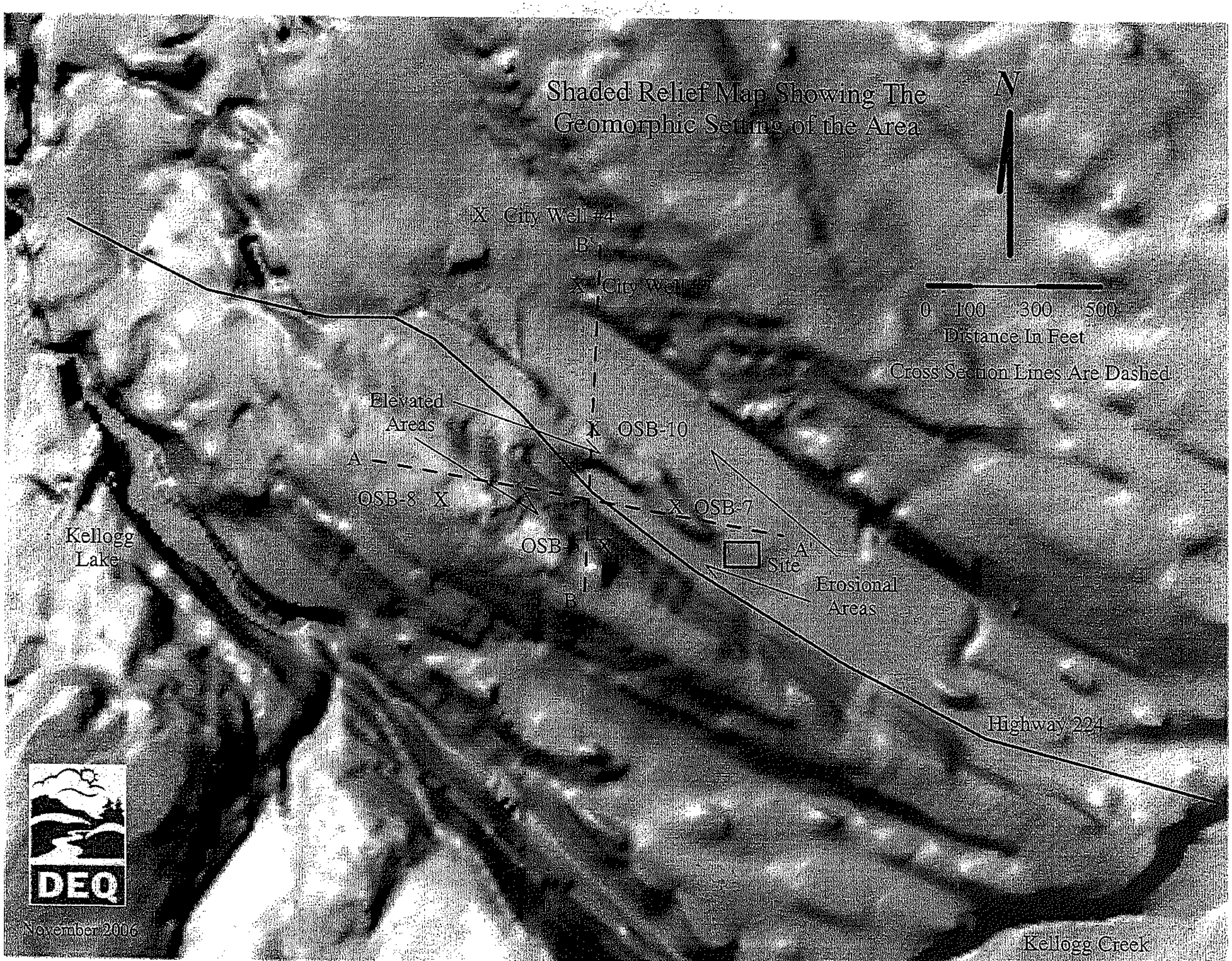
Milwaukie International Way
Milwaukie, OR

Figure 2-2



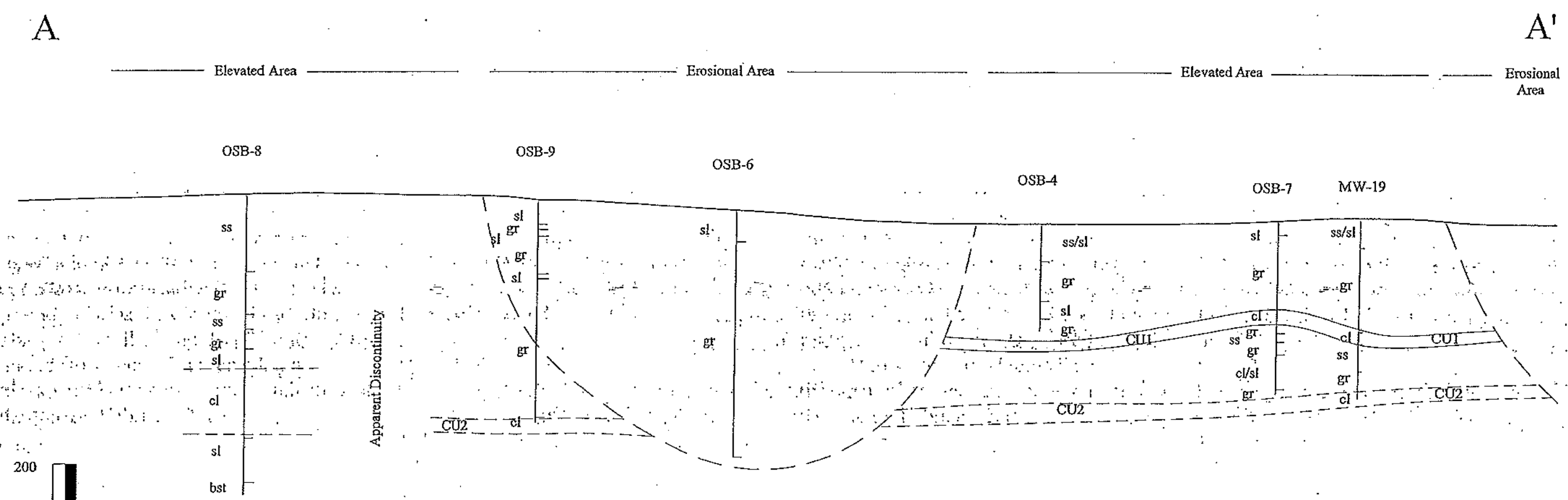

Milwaukie International Way

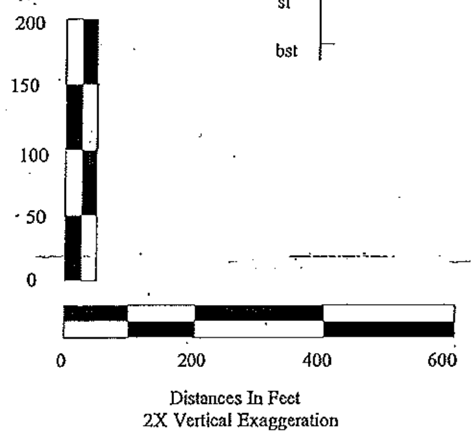
Figure 2-3




Milwaukie International Way

Figure 2-4




REGISTERED PROFESSIONAL GEOLOGIST
OREGON
KENNETH A. CAMERON
G578

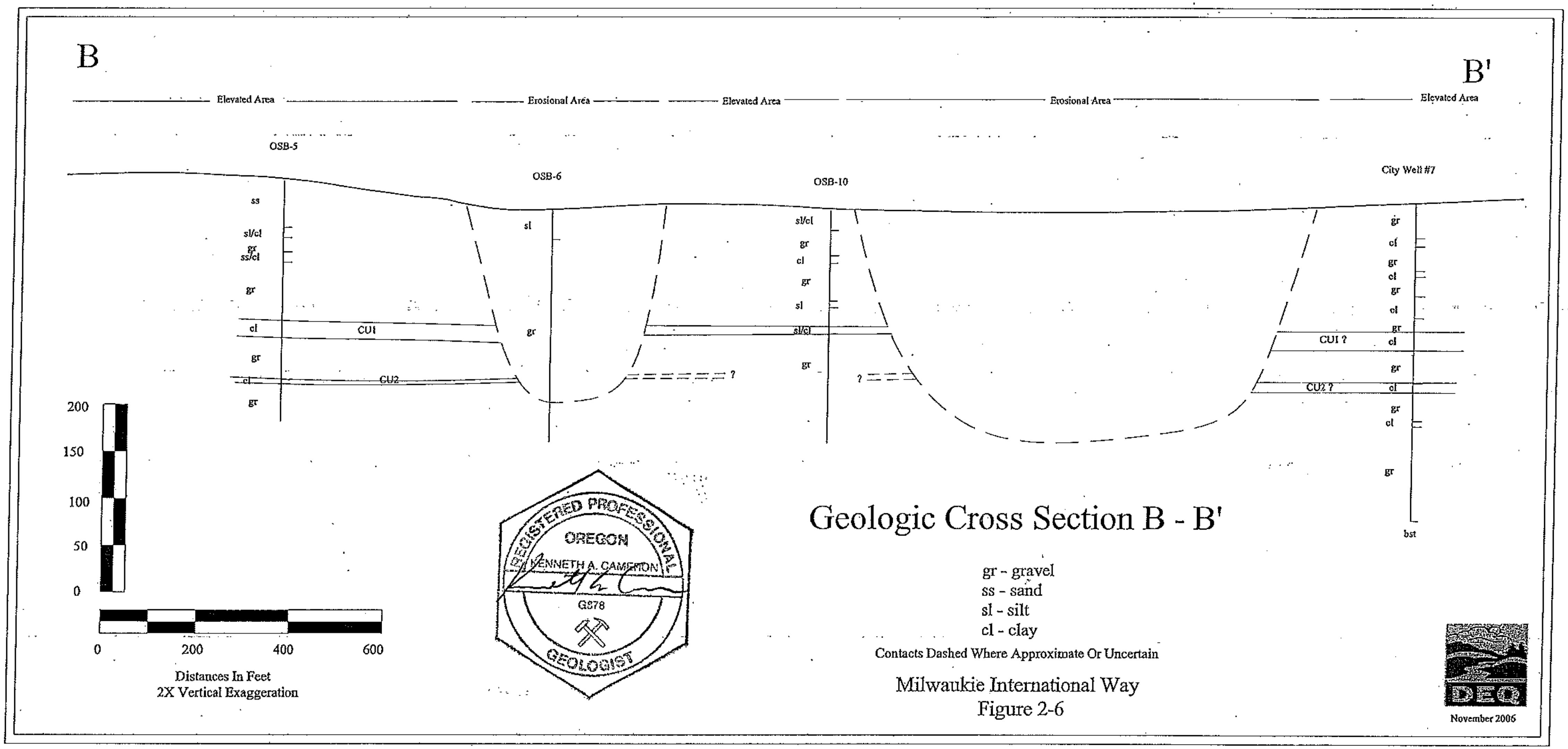
# Geologic Cross Section A - A'

gr - gravel
ss - sand
sl - silt
cl - clay

Contacts Dashed Where Approximate Or Uncertain

Milwaukie International Way
Figure 2-5

DEQ
November 2006

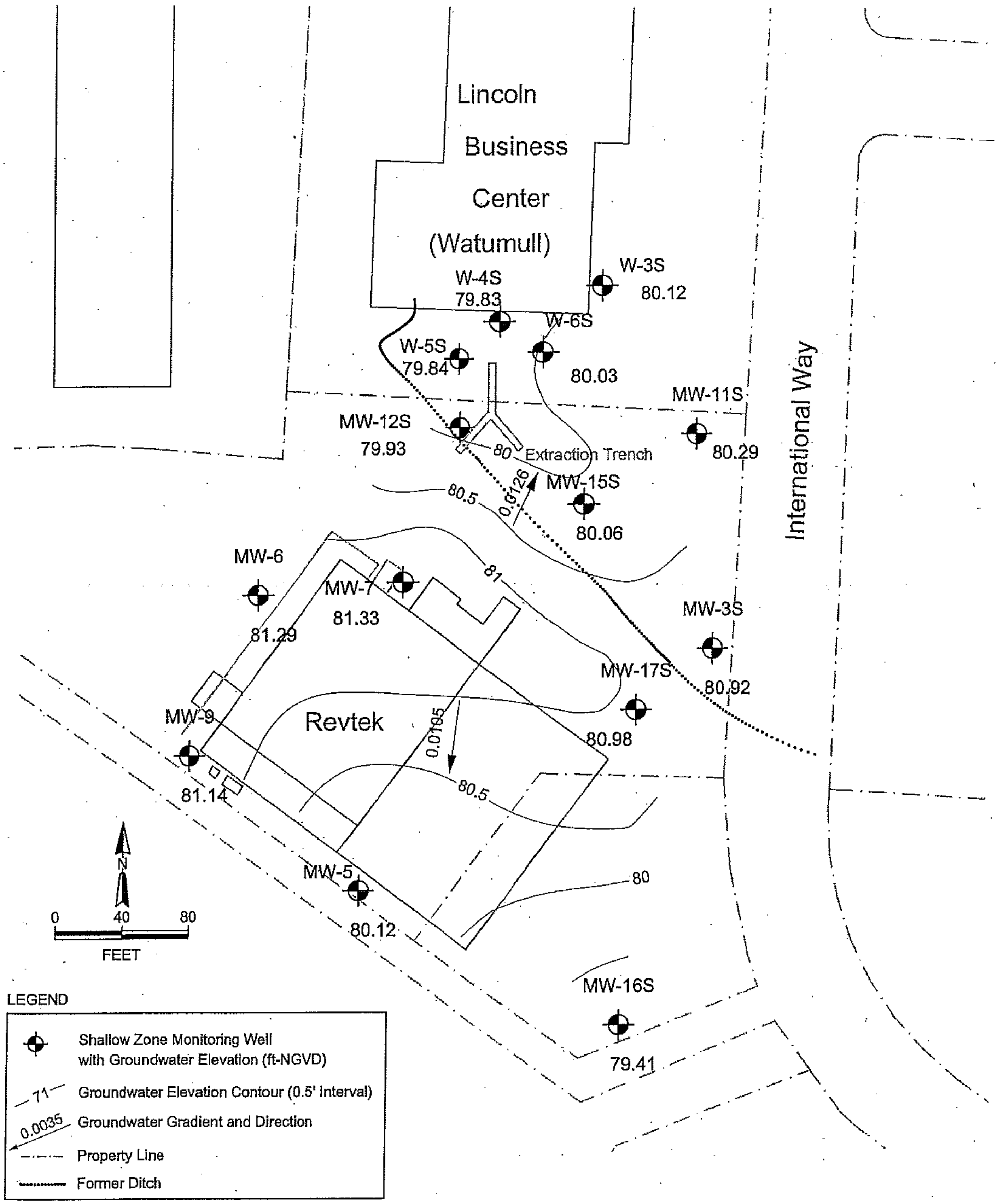



# Geologic Cross Section B - B'

gr - gravel
ss - sand
sl - silt
cl - clay

Contacts Dashed Where Approximate Or Uncertain

Milwaukie International Way
Figure 2-6




**Groundwater Surface - Shallow Zone, 9/03**

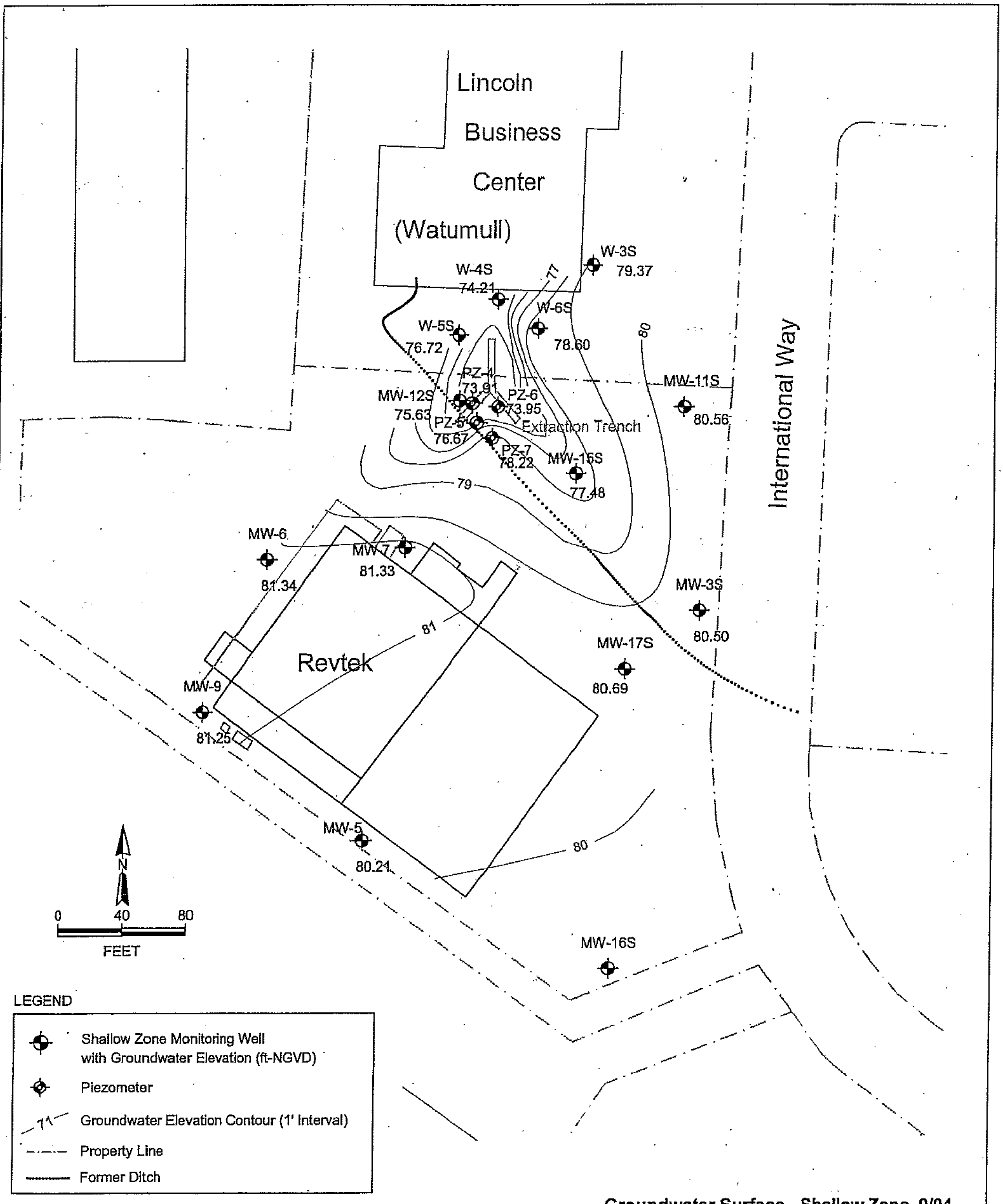
Sampled 9/22/03

URS

August 2006
25695795

Milwaukie International
Milwaukie, OR

Figure 2-7




URS

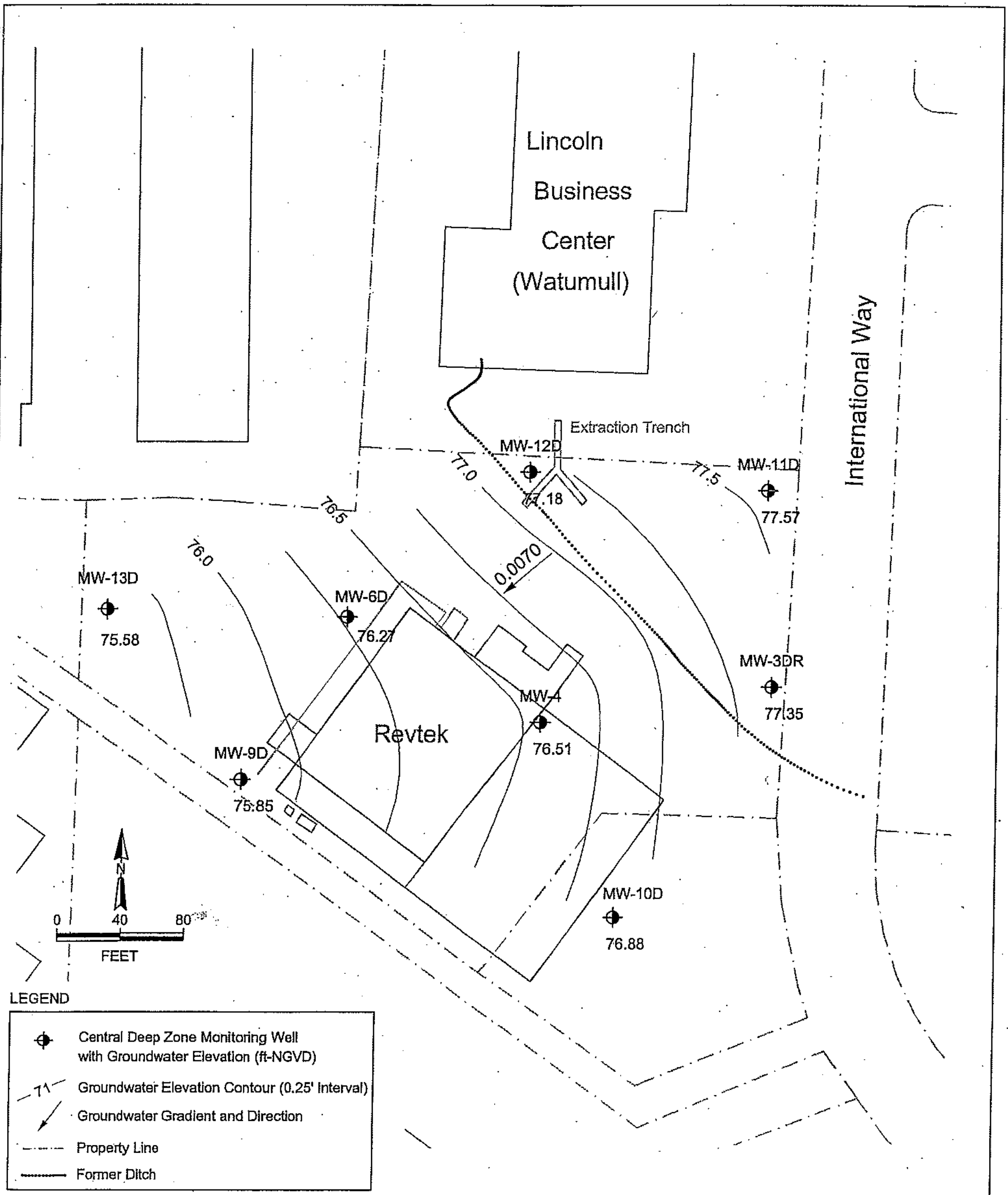
**Groundwater Surface - Shallow Zone, 9/04**

Measured 9/13/04 during ongoing extraction pumping

August 2006
25695795

Milwaukie International
Milwaukie, OR

Figure 2-8




**Potentiometric Surface - Central Deep Zone, 9/03**

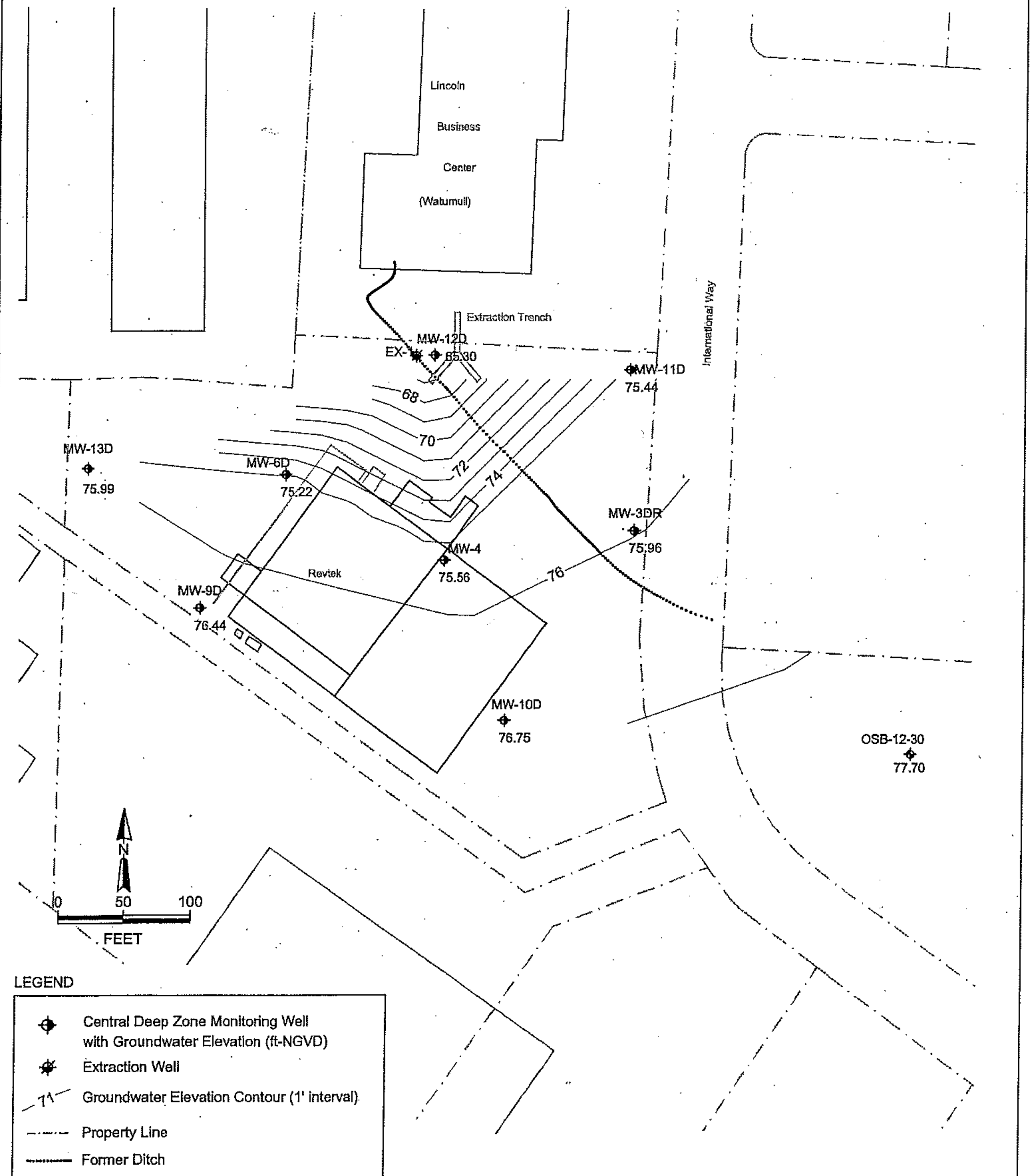
Sampled 9/22/03

URS

August 2006
25695795

Milwaukie International
Milwaukie, OR

Figure 2-9




**Potentiometric Surface - Central Deep Zone, 6/05**

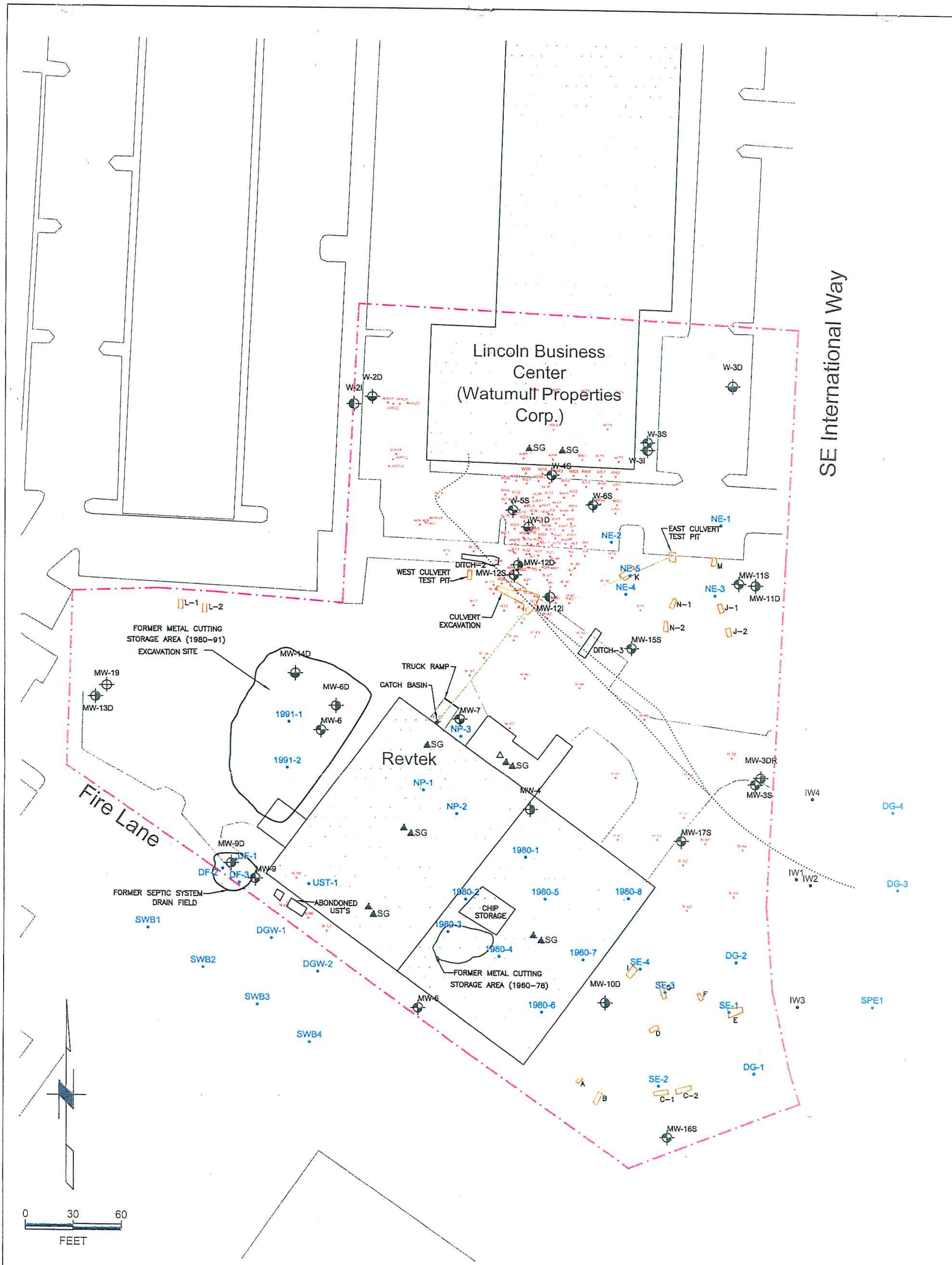
Measured 6/6/05

August 2006
25695795

Milwaukie International
Milwaukie, OR

URS

Figure 2-10




LEGEND

- Monitoring Well
- Soil borings from MFA and Integral investigations
- Shallow GW Investigation Soil boring
- International Way investigation Soil boring
- Air Sample Location
- Outdoor Air Sample Location
- SG Subgrade Air Sample
- Ditch Excavation
- Geophysical Anomoly Test Pit Locations

- Site
- Former Ditch
- Former Drain Pipe

URS

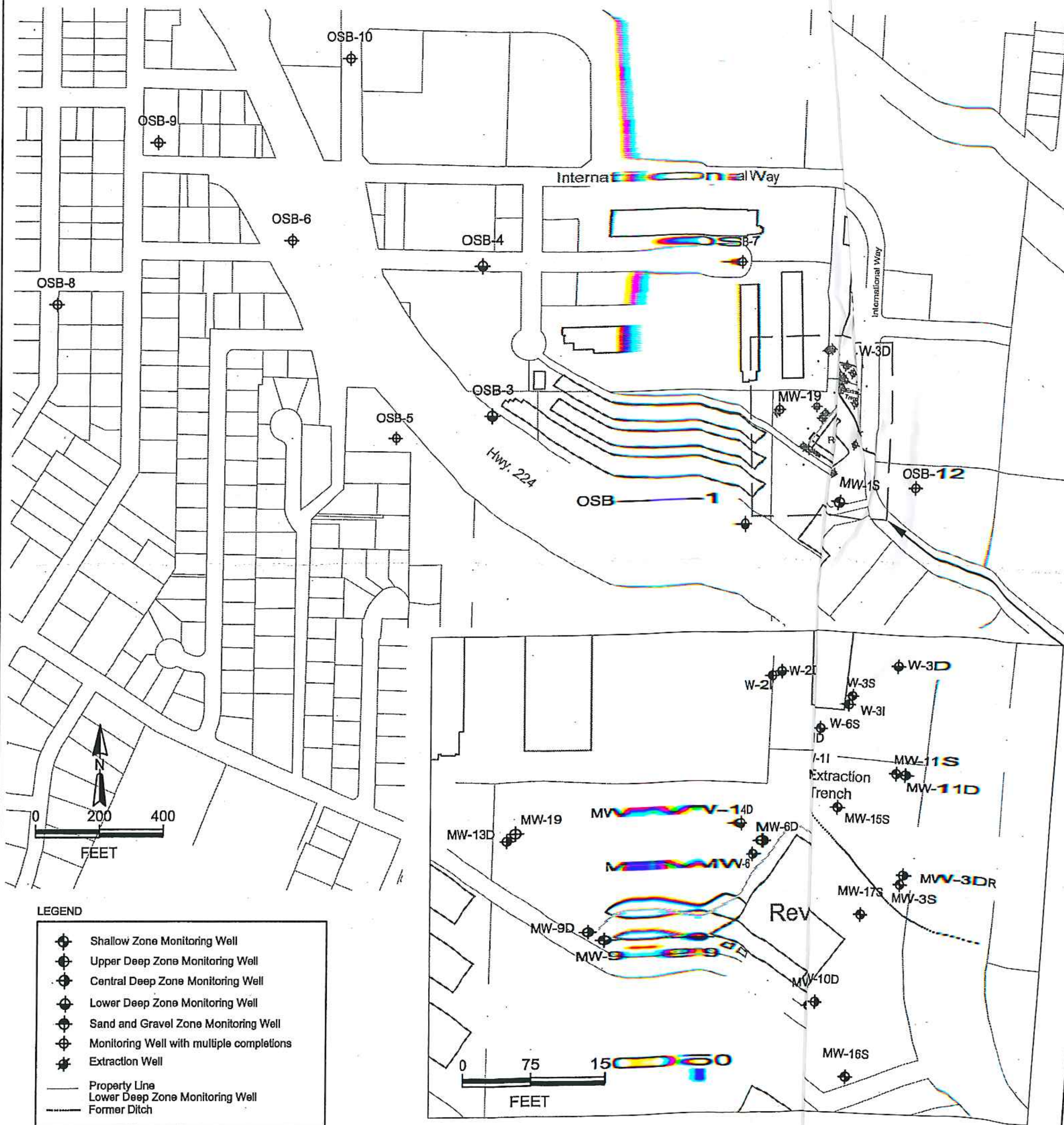
**Soil, Groundwater and Air Sampling Locations**

December 2005
25694284

Milwaukie International
Milwaukie, OR

Figure 3-1

O:\25694284 Milwaukie International\CAD\DWG\RI-FS\FIG 3-2.dwg Dec 29, 2005 – 2:34pm




Note: MW-18S and MW-1S were decommissioned in October 2002.

**Well Location Map**

URS

June 2006
25694284

Milwaukie International
Milwaukie, OR

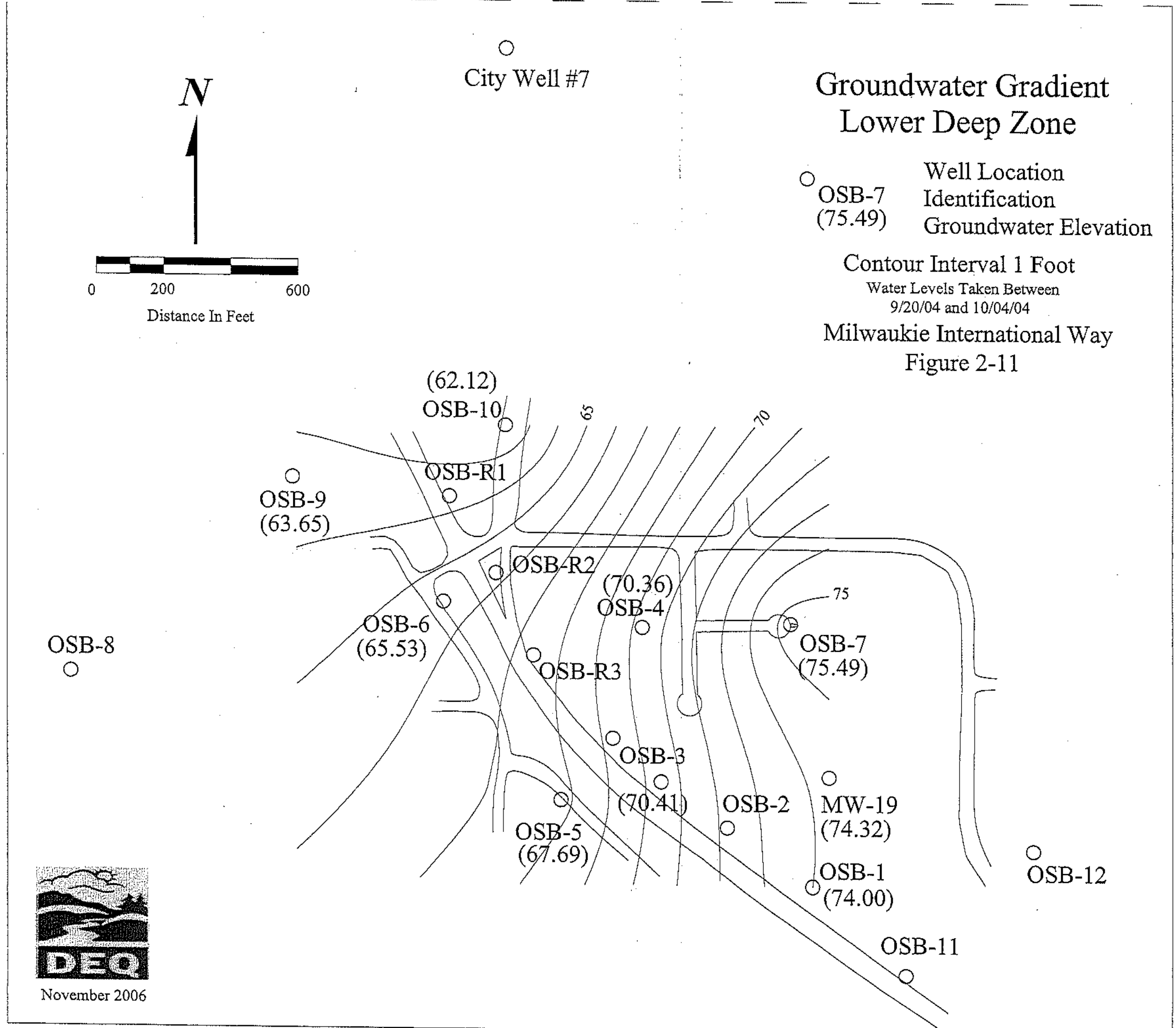
Figure 3-2

# Groundwater Gradient
# Lower Deep Zone

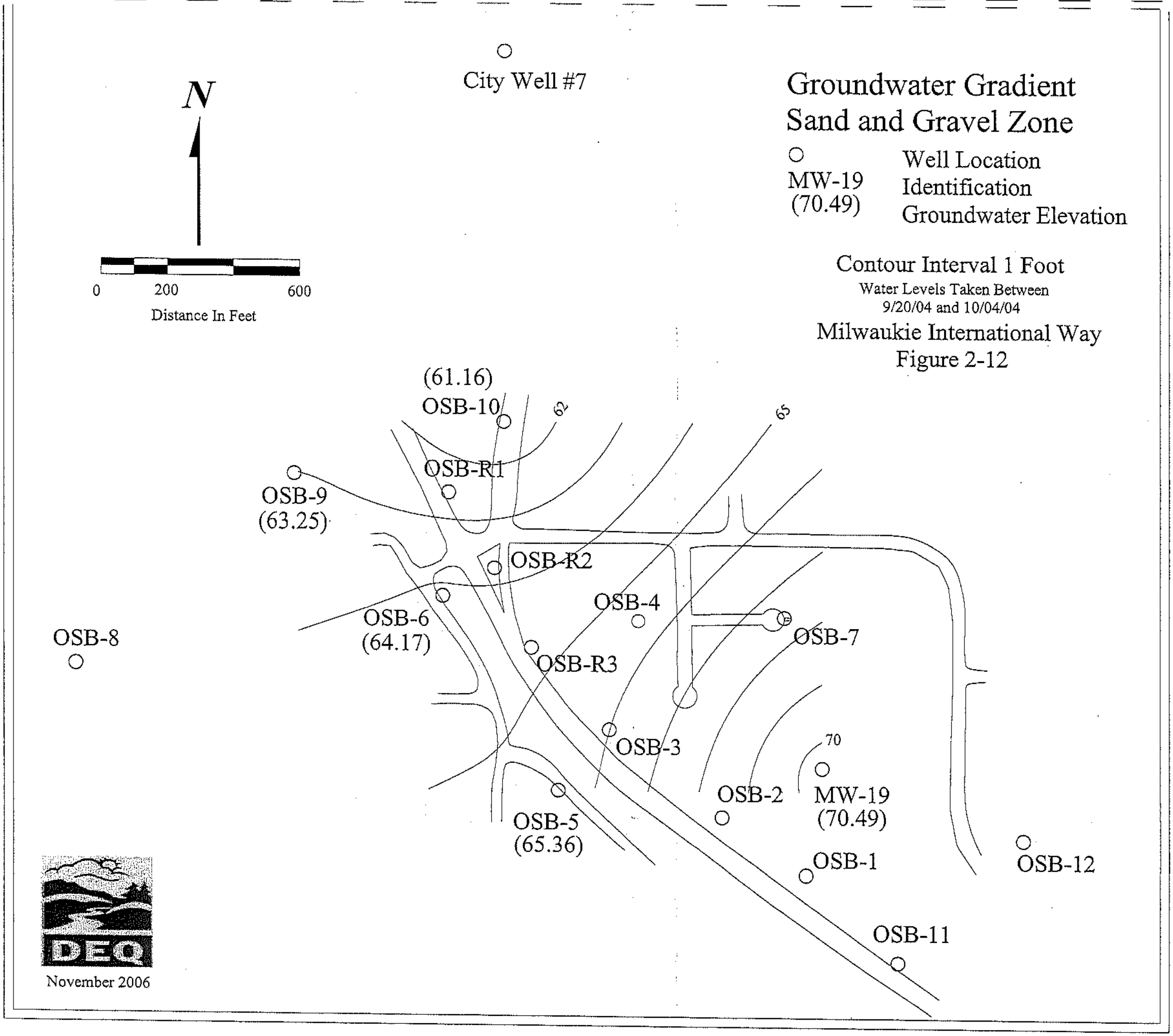
OSB-7 Well Location
(75.49) Identification
Groundwater Elevation

Contour Interval 1 Foot
Water Levels Taken Between
9/20/04 and 10/04/04

Milwaukie International Way
Figure 2-11




November 2006


Groundwater Gradient
Sand and Gravel Zone
MW-19
(70.49)
Well Location
Identification
Groundwater Elevation
Contour Interval 1 Foot
Water Levels Taken Between
9/20/04 and 10/04/04
Milwaukie International Way
Figure 2-12
N
0
200
600
Distance In Feet
City Well #7
(61.16)
OSB-10
62
65
70
OSB-R1
OSB-9
(63.25)
OSB-R2
OSB-4
OSB-7
OSB-6
(64.17)
OSB-8
OSB-R3
OSB-3
OSB-2
MW-19
(70.49)
OSB-5
(65.36)
OSB-1
OSB-12
OSB-11
DEQ
November 2006

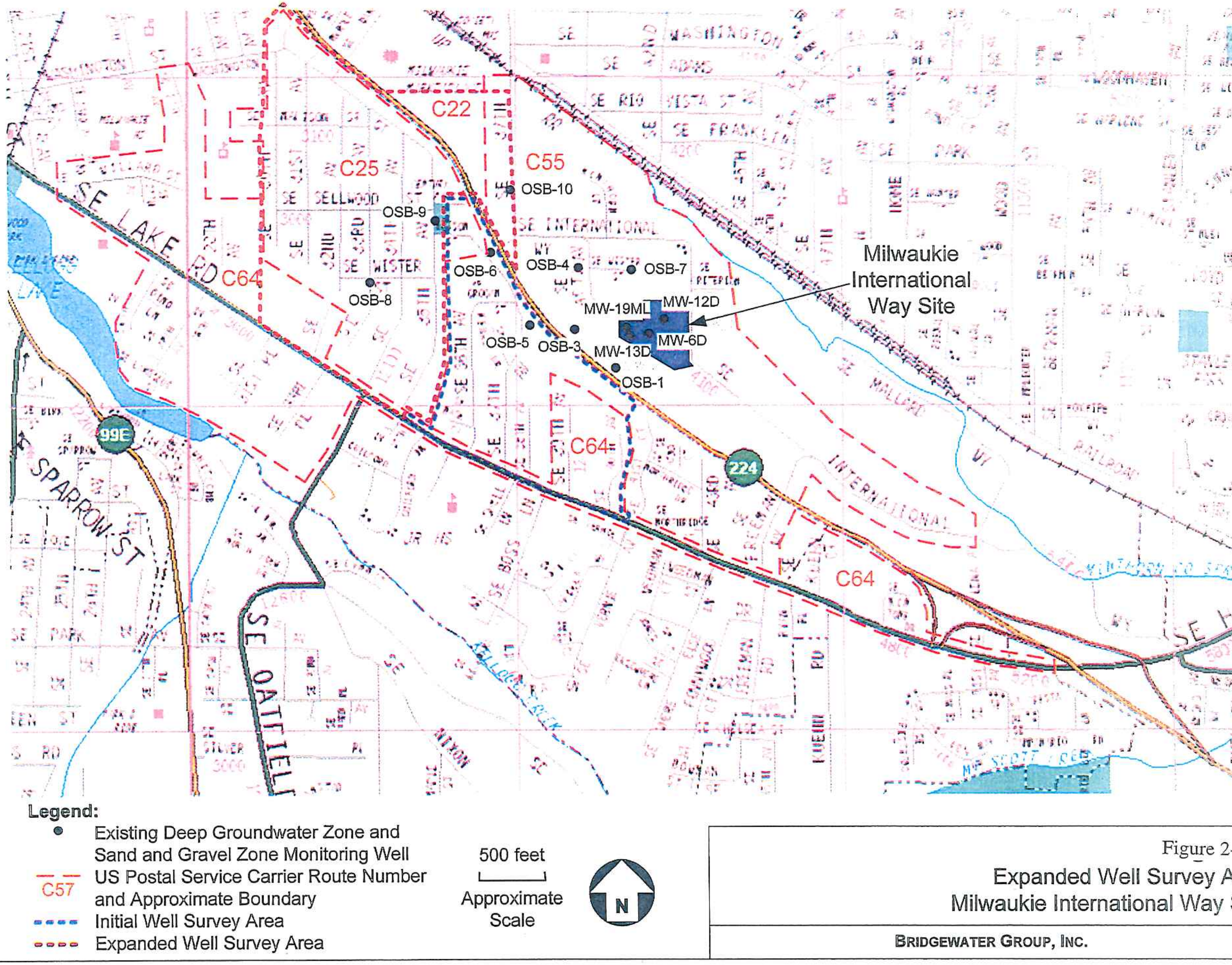
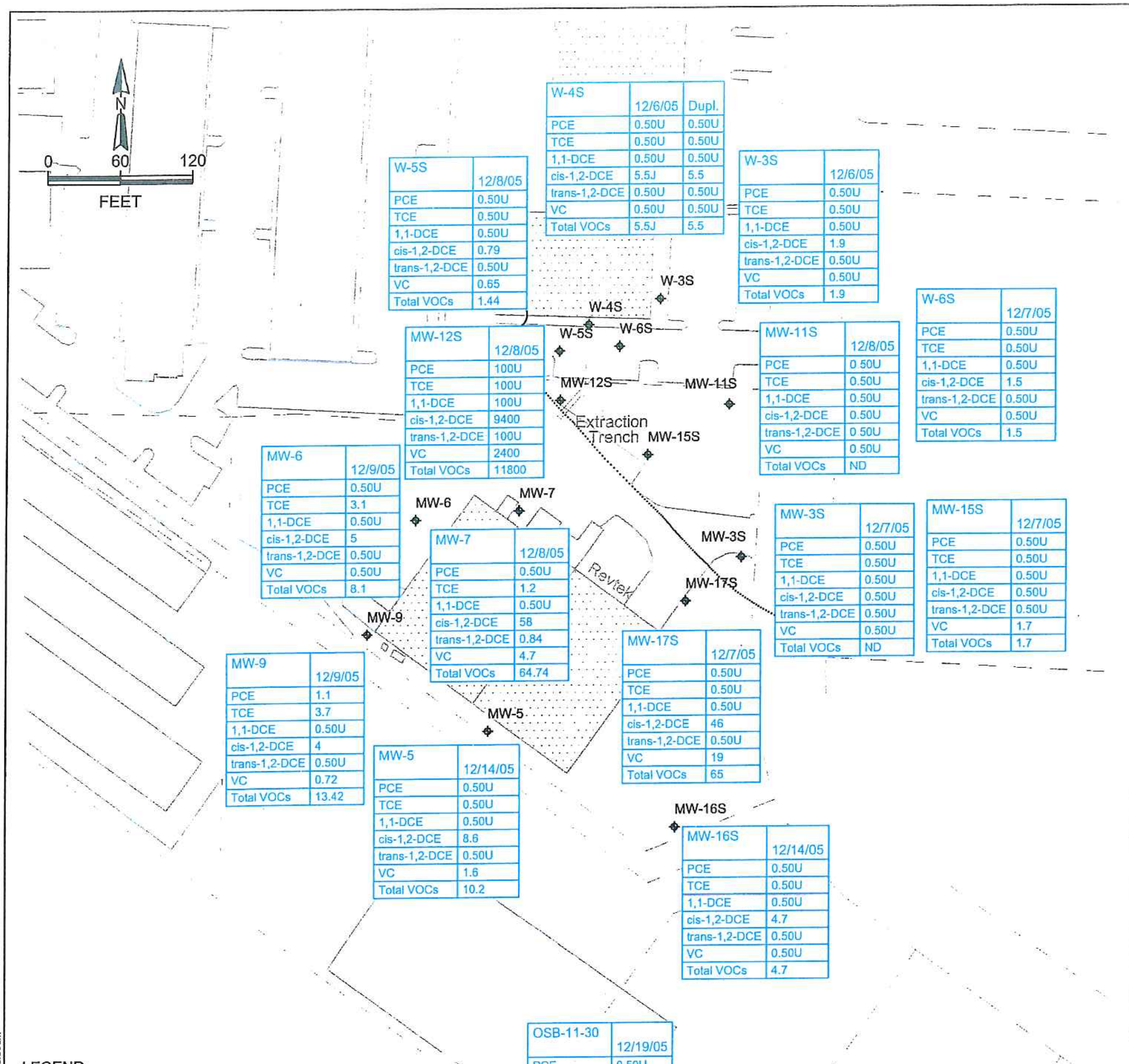



Figure 2-13
Expanded Well Survey Area
Milwaukie International Way Site

BRIDGEWATER GROUP, INC.




| W-4S | 12/6/05 | Dupl. |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 0.50U |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 5.5J | 5.5 |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | 5.5J | 5.5 |

| W-5S | 12/8/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.79 |
| trans-1,2-DCE | 0.50U |
| VC | 0.65 |
| Total VOCs | 1.44 |

| W-3S | 12/6/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 1.9 |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 1.9 |

| W-6S | 12/7/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 1.5 |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 1.5 |

| MW-12S | 12/8/05 |
|---|---|
| PCE | 100U |
| TCE | 100U |
| 1,1-DCE | 100U |
| cis-1,2-DCE | 9400 |
| trans-1,2-DCE | 100U |
| VC | 2400 |
| Total VOCs | 11800 |

| MW-11S | 12/8/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| MW-6 | 12/9/05 |
|---|---|
| PCE | 0.50U |
| TCE | 3.1 |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 5 |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 8.1 |

| MW-7 | 12/8/05 |
|---|---|
| PCE | 0.50U |
| TCE | 1.2 |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 58 |
| trans-1,2-DCE | 0.84 |
| VC | 4.7 |
| Total VOCs | 64.74 |

| MW-3S | 12/7/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| MW-15S | 12/7/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 1.7 |
| Total VOCs | 1.7 |

| MW-17S | 12/7/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 46 |
| trans-1,2-DCE | 0.50U |
| VC | 19 |
| Total VOCs | 65 |

| MW-9 | 12/9/05 |
|---|---|
| PCE | 1.1 |
| TCE | 3.7 |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 4 |
| trans-1,2-DCE | 0.50U |
| VC | 0.72 |
| Total VOCs | 13.42 |

| MW-5 | 12/14/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 8.6 |
| trans-1,2-DCE | 0.50U |
| VC | 1.6 |
| Total VOCs | 10.2 |

| MW-16S | 12/14/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 4.7 |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 4.7 |

| OSB-11-30 | 12/19/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 3 |

LEGEND

- Shallow Zone Monitoring Well
- Property Line
- Former Ditch

Notes: Total VOCs can include detections of VOCs unrelated to the site.

CVOC units are ug/L.
U = Non-detection, with detection limit shown
J = Estimate
ND = Not detected

**VOCs in Groundwater, Shallow Zone, 12/05**

URS

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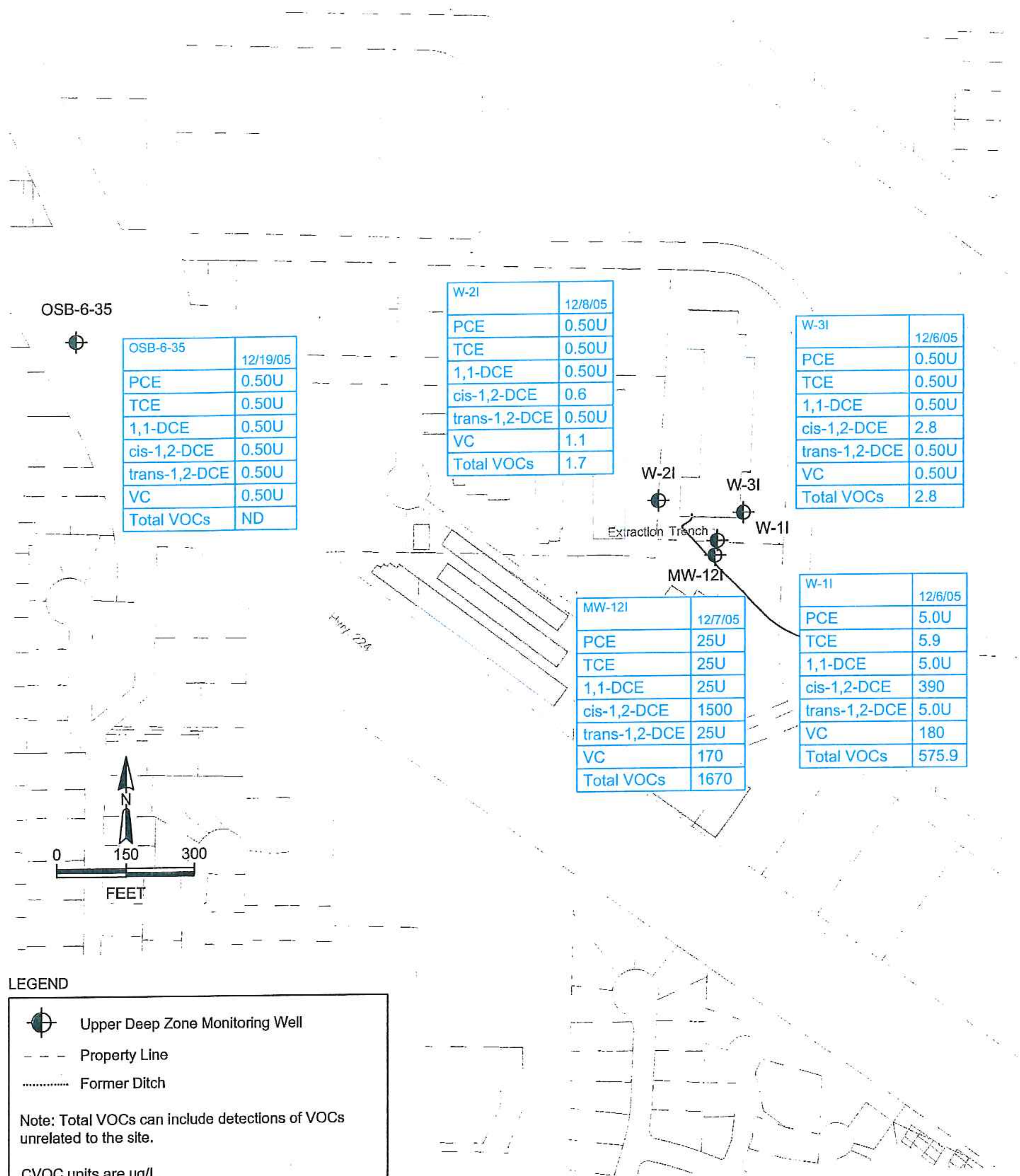
Figure 3-3

O:\25694284 Milwaukie International\Milwaukie-GIS\Quarterly\05Q4\FIG7shvoc.dwg May 24, 2006 - 8:50am




| OSB-6-35 | 12/19/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| W-2I | 12/8/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.6 |
| trans-1,2-DCE | 0.50U |
| VC | 1.1 |
| Total VOCs | 1.7 |

| W-3I | 12/6/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 2.8 |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 2.8 |

| MW-12I | 12/7/05 |
|---|---|
| PCE | 25U |
| TCE | 25U |
| 1,1-DCE | 25U |
| cis-1,2-DCE | 1500 |
| trans-1,2-DCE | 25U |
| VC | 170 |
| Total VOCs | 1670 |

| W-1I | 12/6/05 |
|---|---|
| PCE | 5.0U |
| TCE | 5.9 |
| 1,1-DCE | 5.0U |
| cis-1,2-DCE | 390 |
| trans-1,2-DCE | 5.0U |
| VC | 180 |
| Total VOCs | 575.9 |

LEGEND

- Upper Deep Zone Monitoring Well
- Property Line
- Former Ditch

Note: Total VOCs can include detections of VOCs unrelated to the site.

CVOC units are ug/L.
U = Non-detection, with detection limit shown
J = Estimate

## VOCs in Groundwater, Upper Deep Zone, 12/05

URS

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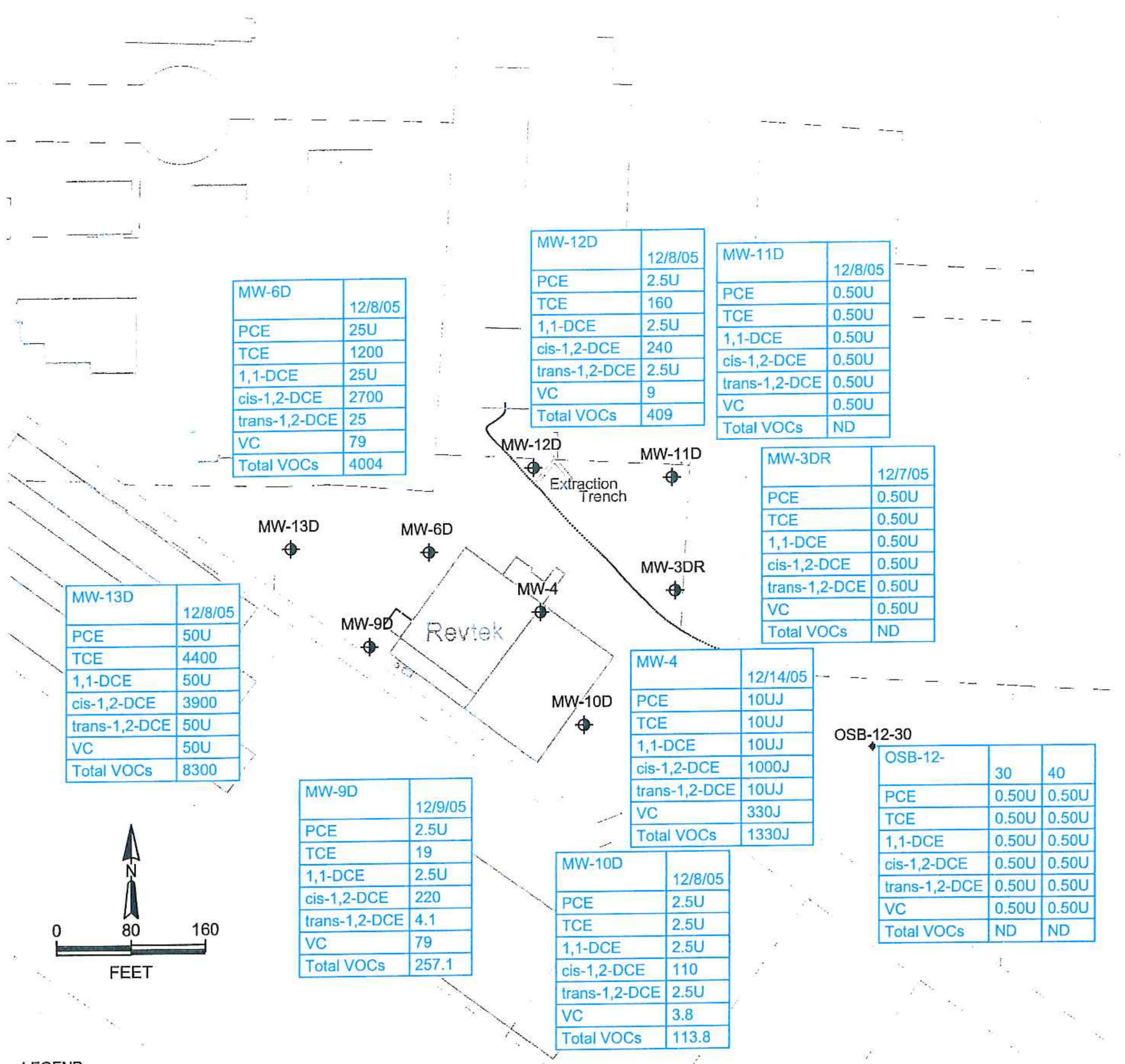
Figure 3-4

O:\25694284 Milwaukie International\Milwaukie-GIS\Quarterly\0504\FIG3 u-deep vocs.dwg May 24, 2006 - 8:48am




| MW-6D | 12/8/05 |
|---|---|
| PCE | 25U |
| TCE | 1200 |
| 1,1-DCE | 25U |
| cis-1,2-DCE | 2700 |
| trans-1,2-DCE | 25 |
| VC | 79 |
| Total VOCs | 4004 |

| MW-12D | 12/8/05 |
|---|---|
| PCE | 2.5U |
| TCE | 160 |
| 1,1-DCE | 2.5U |
| cis-1,2-DCE | 240 |
| trans-1,2-DCE | 2.5U |
| VC | 9 |
| Total VOCs | 409 |

| MW-11D | 12/8/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| MW-3DR | 12/7/05 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| MW-13D | 12/8/05 |
|---|---|
| PCE | 50U |
| TCE | 4400 |
| 1,1-DCE | 50U |
| cis-1,2-DCE | 3900 |
| trans-1,2-DCE | 50U |
| VC | 50U |
| Total VOCs | 8300 |

| MW-4 | 12/14/05 |
|---|---|
| PCE | 10UJ |
| TCE | 10UJ |
| 1,1-DCE | 10UJ |
| cis-1,2-DCE | 1000J |
| trans-1,2-DCE | 10UJ |
| VC | 330J |
| Total VOCs | 1330J |

| OSB-12- | 30 | 40 |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 0.50U |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 0.50U | 0.50U |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | ND | ND |

| MW-9D | 12/9/05 |
|---|---|
| PCE | 2.5U |
| TCE | 19 |
| 1,1-DCE | 2.5U |
| cis-1,2-DCE | 220 |
| trans-1,2-DCE | 4.1 |
| VC | 79 |
| Total VOCs | 257.1 |

| MW-10D | 12/8/05 |
|---|---|
| PCE | 2.5U |
| TCE | 2.5U |
| 1,1-DCE | 2.5U |
| cis-1,2-DCE | 110 |
| trans-1,2-DCE | 2.5U |
| VC | 3.8 |
| Total VOCs | 113.8 |

LEGEND

- Central Deep Zone Monitoring Well
- Property Line
- Former Ditch

Notes: VOC result tables include the sample depth. Total VOCs can include detections of VOCs unrelated to the site.

CVOC units are ug/L.
U = Non-detection, with detection limit shown
J = Estimate

## VOCs in Groundwater, Central Deep Zone, 12/05

URS

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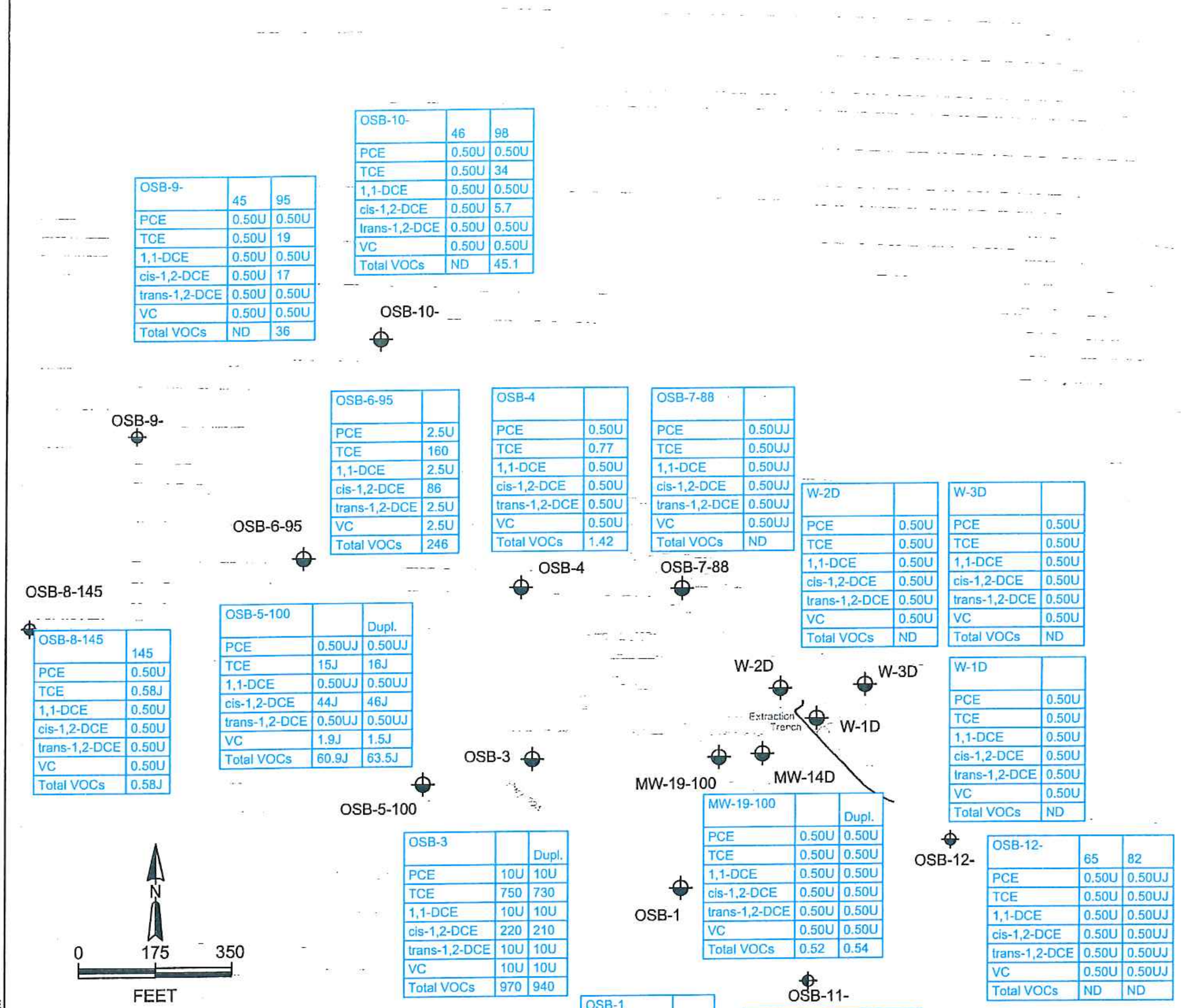
Figure 3-5

o:\25694284 Milwaukie International\Milwaukie-GIS\Quarterly\0504\FIG3c-deep vocs.dwg May 24, 2006 - 9:14am




| OSB-10- | 46 | 98 |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 34 |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 0.50U | 5.7 |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | ND | 45.1 |

| OSB-9- | 45 | 95 |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 19 |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 0.50U | 17 |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | ND | 36 |

| OSB-6-95 | |
|---|---|
| PCE | 2.5U |
| TCE | 160 |
| 1,1-DCE | 2.5U |
| cis-1,2-DCE | 86 |
| trans-1,2-DCE | 2.5U |
| VC | 2.5U |
| Total VOCs | 246 |

| OSB-4 | |
|---|---|
| PCE | 0.50U |
| TCE | 0.77 |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 1.42 |

| OSB-7-88 | |
|---|---|
| PCE | 0.50UJ |
| TCE | 0.50UJ |
| 1,1-DCE | 0.50UJ |
| cis-1,2-DCE | 0.50UJ |
| trans-1,2-DCE | 0.50UJ |
| VC | 0.50UJ |
| Total VOCs | ND |

| W-2D | |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| W-3D | |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| OSB-8-145 | 145 |
|---|---|
| PCE | 0.50U |
| TCE | 0.58J |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | 0.58J |

| OSB-5-100 | | Dupl. |
|---|---|---|
| PCE | 0.50UJ | 0.50UJ |
| TCE | 15J | 16J |
| 1,1-DCE | 0.50UJ | 0.50UJ |
| cis-1,2-DCE | 44J | 46J |
| trans-1,2-DCE | 0.50UJ | 0.50UJ |
| VC | 1.9J | 1.5J |
| Total VOCs | 60.9J | 63.5J |

| W-1D | |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| MW-19-100 | | Dupl. |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 0.50U |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 0.50U | 0.50U |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | 0.52 | 0.54 |

| OSB-3 | | Dupl. |
|---|---|---|
| PCE | 10U | 10U |
| TCE | 750 | 730 |
| 1,1-DCE | 10U | 10U |
| cis-1,2-DCE | 220 | 210 |
| trans-1,2-DCE | 10U | 10U |
| VC | 10U | 10U |
| Total VOCs | 970 | 940 |

| OSB-12- | 65 | 82 |
|---|---|---|
| PCE | 0.50U | 0.50UJ |
| TCE | 0.50U | 0.50UJ |
| 1,1-DCE | 0.50U | 0.50UJ |
| cis-1,2-DCE | 0.50U | 0.50UJ |
| trans-1,2-DCE | 0.50U | 0.50UJ |
| VC | 0.50U | 0.50UJ |
| Total VOCs | ND | ND |

| OSB-1 | |
|---|---|
| PCE | 2.5U |
| TCE | 7.3 |
| 1,1-DCE | 2.5U |
| cis-1,2-DCE | 95 |
| trans-1,2-DCE | 2.5U |
| VC | 3 |
| Total VOCs | 105.3 |

| OSB-11- | 62 | 97 |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 0.50U |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 0.50U | 0.50U |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | ND | 3.1 |

| MW-14D | |
|---|---|
| PCE | 0.50U |
| TCE | 34 |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 36 |
| trans-1,2-DCE | 0.78 |
| VC | 0.50U |
| Total VOCs | 70.78 |

LEGEND

- Lower Deep Zone Monitoring Well
- – – – Property Line
- ........... Former Ditch

Notes: VOC result tables include the sample depth. See Table 5 for sample date.
Total VOCs can include detections of VOCs unrelated to the site.

CVOC units are ug/L.
U = Non-detection, with detection limit shown
J = Estimate

**VOCs in Groundwater, Lower Deep Zone, 12/05**

URS

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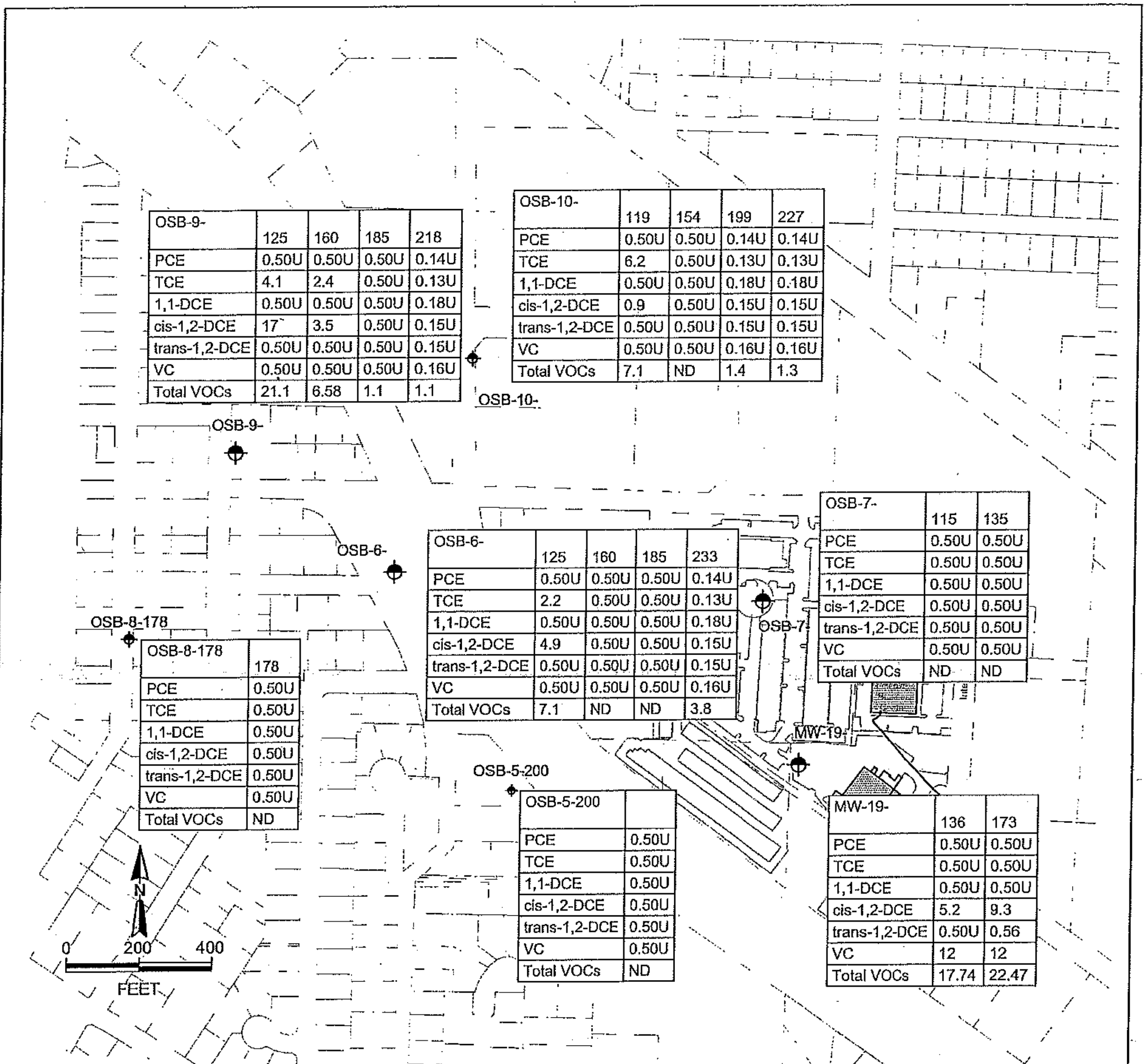
Figure 3-6

o:\25694284 Milwaukie International\Milwaukie-GIS\Quarterly\0504\FIG10 l-deep vocs.dwg May 26, 2006 - 1:46pm




| OSB-9- | 125 | 160 | 185 | 218 |
|---|---|---|---|---|
| PCE | 0.50U | 0.50U | 0.50U | 0.14U |
| TCE | 4.1 | 2.4 | 0.50U | 0.13U |
| 1,1-DCE | 0.50U | 0.50U | 0.50U | 0.18U |
| cis-1,2-DCE | 17 | 3.5 | 0.50U | 0.15U |
| trans-1,2-DCE | 0.50U | 0.50U | 0.50U | 0.15U |
| VC | 0.50U | 0.50U | 0.50U | 0.16U |
| Total VOCs | 21.1 | 6.58 | 1.1 | 1.1 |

| OSB-10- | 119 | 154 | 199 | 227 |
|---|---|---|---|---|
| PCE | 0.50U | 0.50U | 0.14U | 0.14U |
| TCE | 6.2 | 0.50U | 0.13U | 0.13U |
| 1,1-DCE | 0.50U | 0.50U | 0.18U | 0.18U |
| cis-1,2-DCE | 0.9 | 0.50U | 0.15U | 0.15U |
| trans-1,2-DCE | 0.50U | 0.50U | 0.15U | 0.15U |
| VC | 0.50U | 0.50U | 0.16U | 0.16U |
| Total VOCs | 7.1 | ND | 1.4 | 1.3 |

| OSB-7- | 115 | 135 |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 0.50U |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 0.50U | 0.50U |
| trans-1,2-DCE | 0.50U | 0.50U |
| VC | 0.50U | 0.50U |
| Total VOCs | ND | ND |

| OSB-6- | 125 | 160 | 185 | 233 |
|---|---|---|---|---|
| PCE | 0.50U | 0.50U | 0.50U | 0.14U |
| TCE | 2.2 | 0.50U | 0.50U | 0.13U |
| 1,1-DCE | 0.50U | 0.50U | 0.50U | 0.18U |
| cis-1,2-DCE | 4.9 | 0.50U | 0.50U | 0.15U |
| trans-1,2-DCE | 0.50U | 0.50U | 0.50U | 0.15U |
| VC | 0.50U | 0.50U | 0.50U | 0.16U |
| Total VOCs | 7.1 | ND | ND | 3.8 |

| OSB-8-178 | 178 |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| OSB-5-200 | |
|---|---|
| PCE | 0.50U |
| TCE | 0.50U |
| 1,1-DCE | 0.50U |
| cis-1,2-DCE | 0.50U |
| trans-1,2-DCE | 0.50U |
| VC | 0.50U |
| Total VOCs | ND |

| MW-19- | 136 | 173 |
|---|---|---|
| PCE | 0.50U | 0.50U |
| TCE | 0.50U | 0.50U |
| 1,1-DCE | 0.50U | 0.50U |
| cis-1,2-DCE | 5.2 | 9.3 |
| trans-1,2-DCE | 0.50U | 0.56 |
| VC | 12 | 12 |
| Total VOCs | 17.74 | 22.47 |

LEGEND

- Sand and Gravel Zone Monitoring Well
- Property Line
- Former Ditch

Notes: VOC result tables include the sample depth.
Total VOCs can include detections of VOCs unrelated to the site.

CVOC units are ug/L.
U = Non-detection, with detection limit shown
J = Estimate

**VOCs in Groundwater, Sand and Gravel Zone, 12/05**

URS

May 2006
25694284

Milwaukie International
Milwaukie, OR

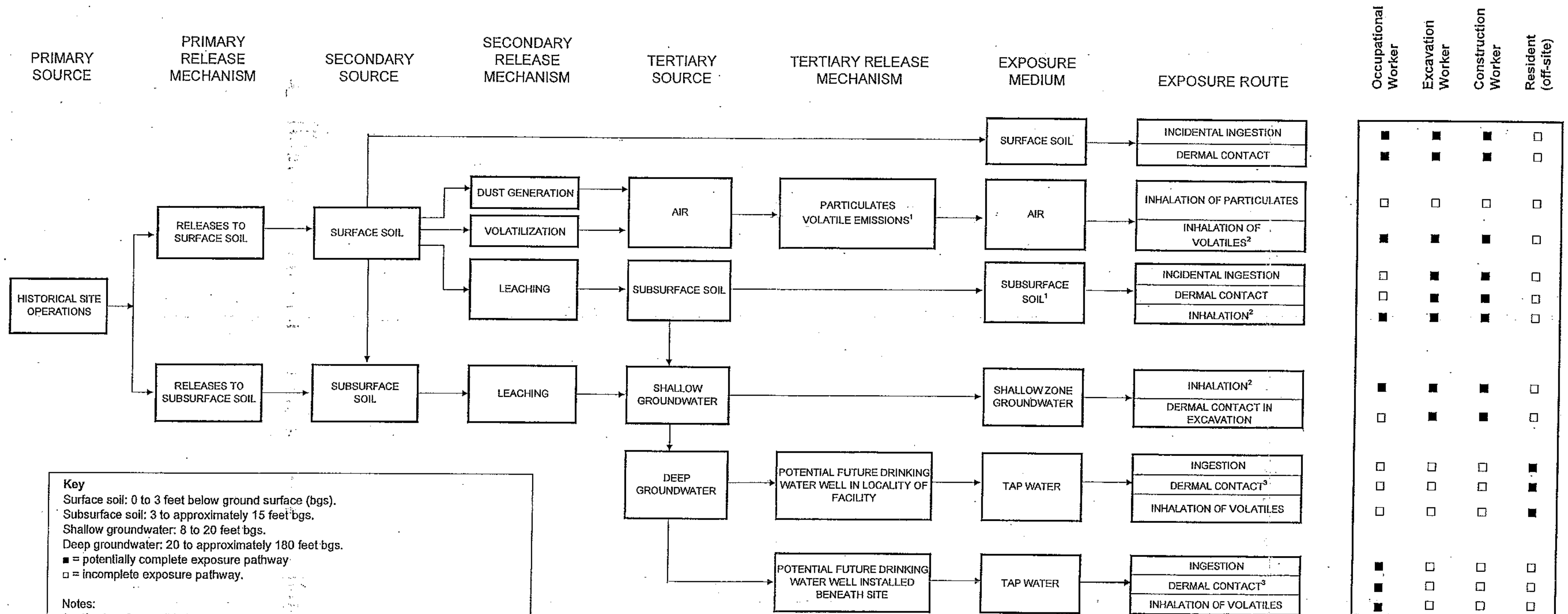
Figure 3-7

Figure 3-8

**Conceptual Site Model of Human Exposure Pathways**

Remedial Investigation

Milwaukie International Way




| Exposure Medium | Exposure Route | Occupational Worker | Excavation Worker | Construction Worker | Resident (off-site) |
|---|---|---|---|---|---|
| Surface Soil | Incidental Ingestion | ■ | ■ | ■ | □ |
| | Dermal Contact | ■ | ■ | ■ | □ |
| Air | Inhalation of Particulates | □ | □ | □ | □ |
| | Inhalation of Volatiles[2] | ■ | ■ | ■ | □ |
| Subsurface Soil[1] | Incidental Ingestion | □ | ■ | ■ | □ |
| | Dermal Contact | □ | ■ | ■ | □ |
| | Inhalation[2] | ■ | ■ | ■ | □ |
| Shallow Zone Groundwater | Inhalation[2] | ■ | ■ | ■ | □ |
| | Dermal Contact in Excavation | □ | ■ | ■ | □ |
| Tap Water (well in locality of facility) | Ingestion | □ | □ | □ | ■ |
| | Dermal Contact[3] | □ | □ | □ | ■ |
| | Inhalation of Volatiles | □ | □ | □ | ■ |
| Tap Water (well beneath site) | Ingestion | ■ | □ | □ | □ |
| | Dermal Contact[3] | ■ | □ | □ | □ |
| | Inhalation of Volatiles | ■ | □ | □ | □ |

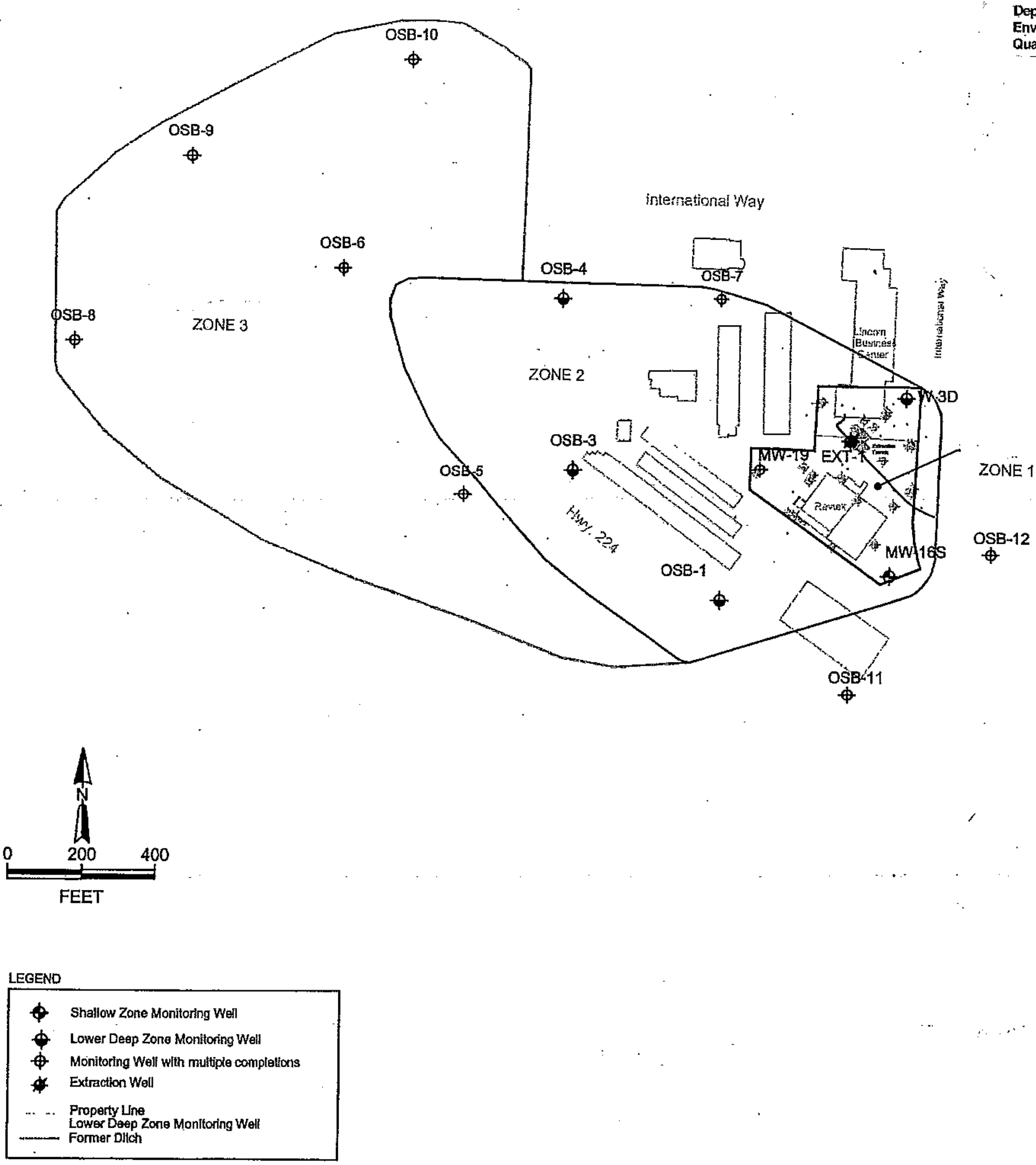
**Key**

Surface soil: 0 to 3 feet below ground surface (bgs).
Subsurface soil: 3 to approximately 15 feet bgs.
Shallow groundwater: 8 to 20 feet bgs.
Deep groundwater: 20 to approximately 180 feet bgs.
■ = potentially complete exposure pathway
□ = incomplete exposure pathway.

Notes:
1 = If subsurface soil is brought to the surface, human receptors could be exposed.
2 = Occupational workers could be exposed to volatile emissions in indoor and outdoor air. Excavation and construction workers could be exposed to volatiles in outdoor air.
3 = Although receptors coming into contact with groundwater used as tap water experience some exposure through dermal contact, DEQ takes only ingestion and inhalation of volatiles into account in the calculation of the related RBC. The ingestion and inhalation routes will be the "driver" uptake routes.

Because future site use is expected to remain the same as current use, exposure of site workers in each case will also be the same.

State of Oregon
Department of Environmental Quality

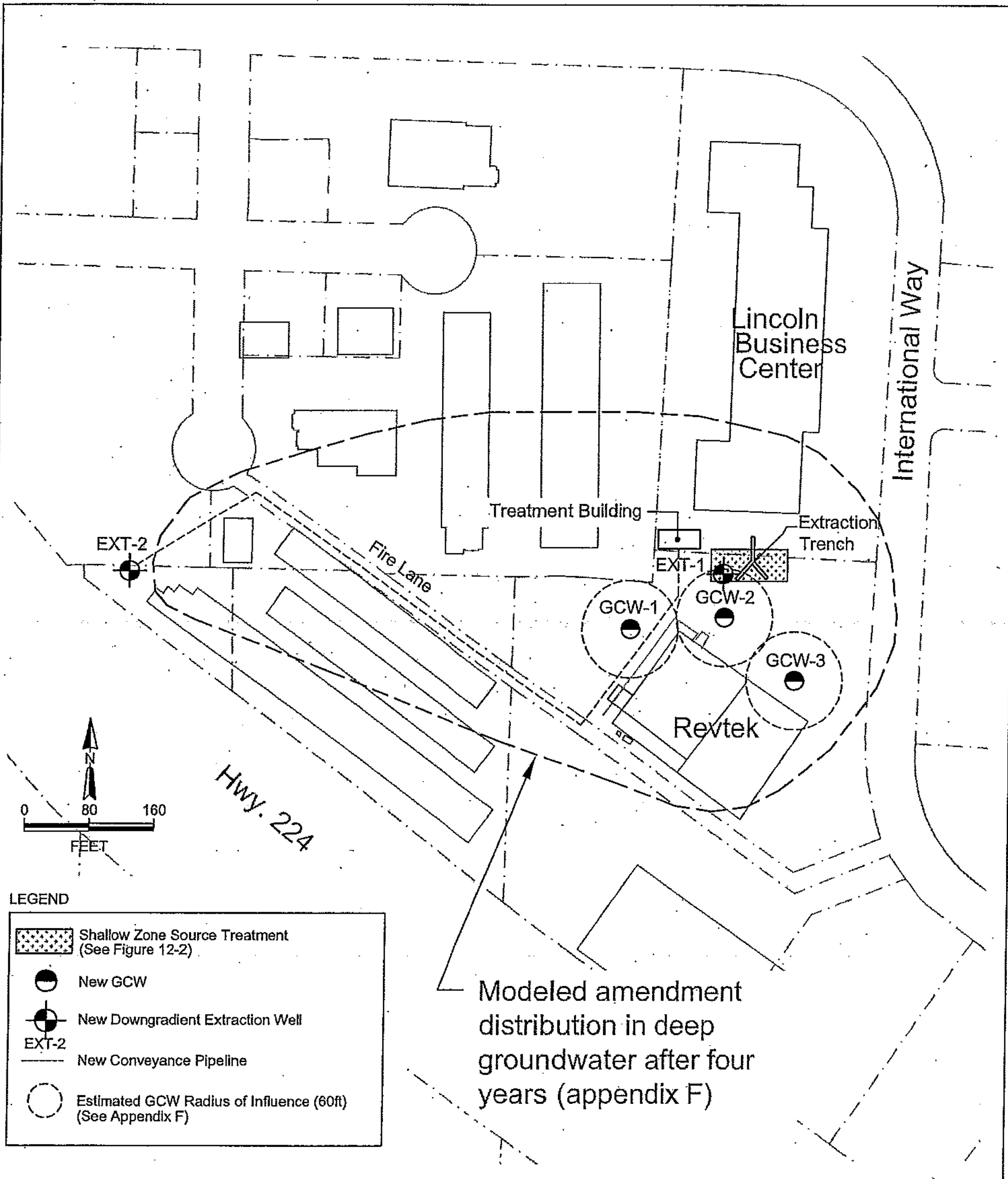



**Zones**

November 2006

Milwaukie International
Milwaukie, OR

Figure 5-1




**Proposed Treatment Alternative and Conveyance**

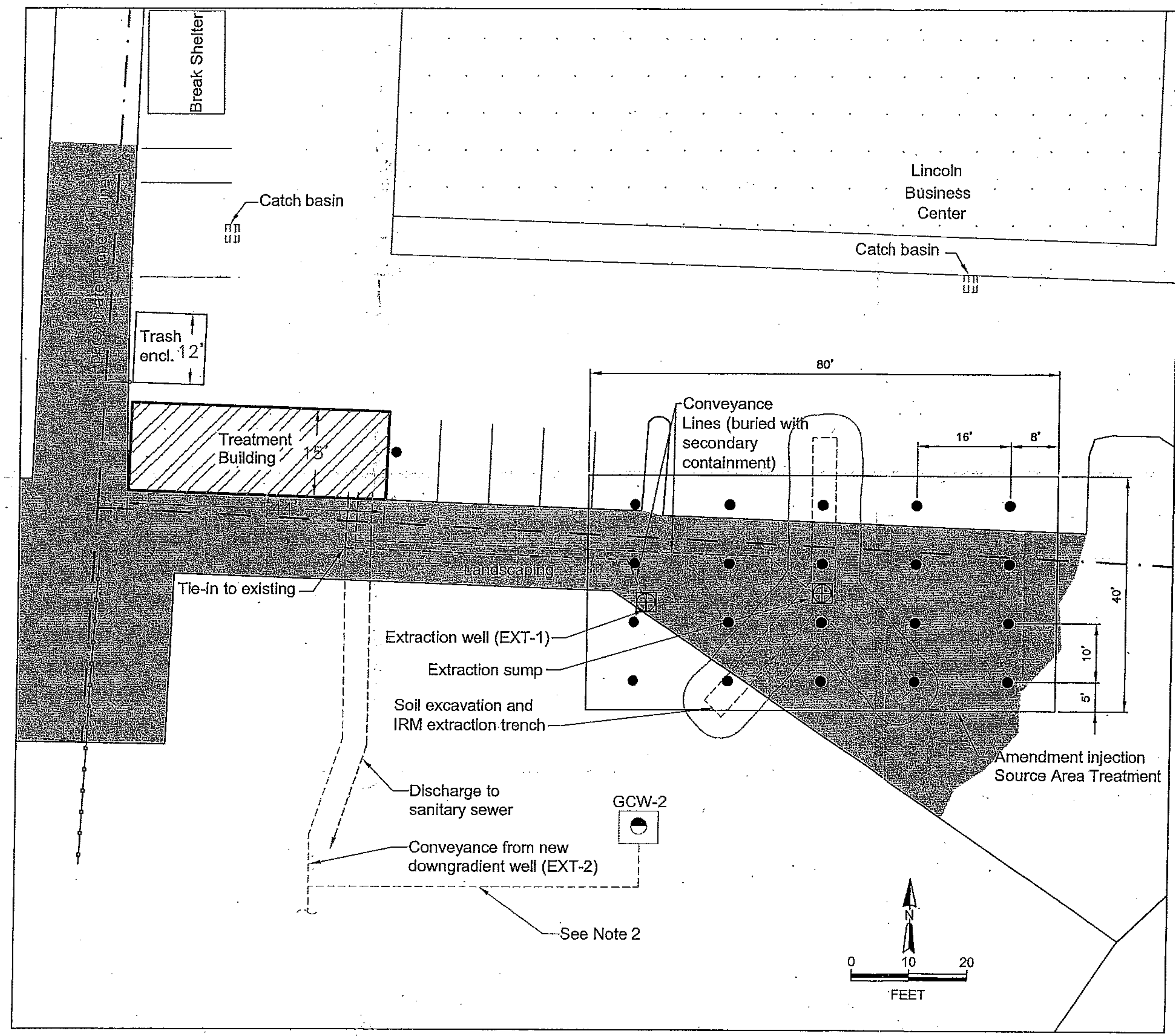
Feasibility Study

URS

August 2006
25695795

Milwaukie International
Milwaukie, OR

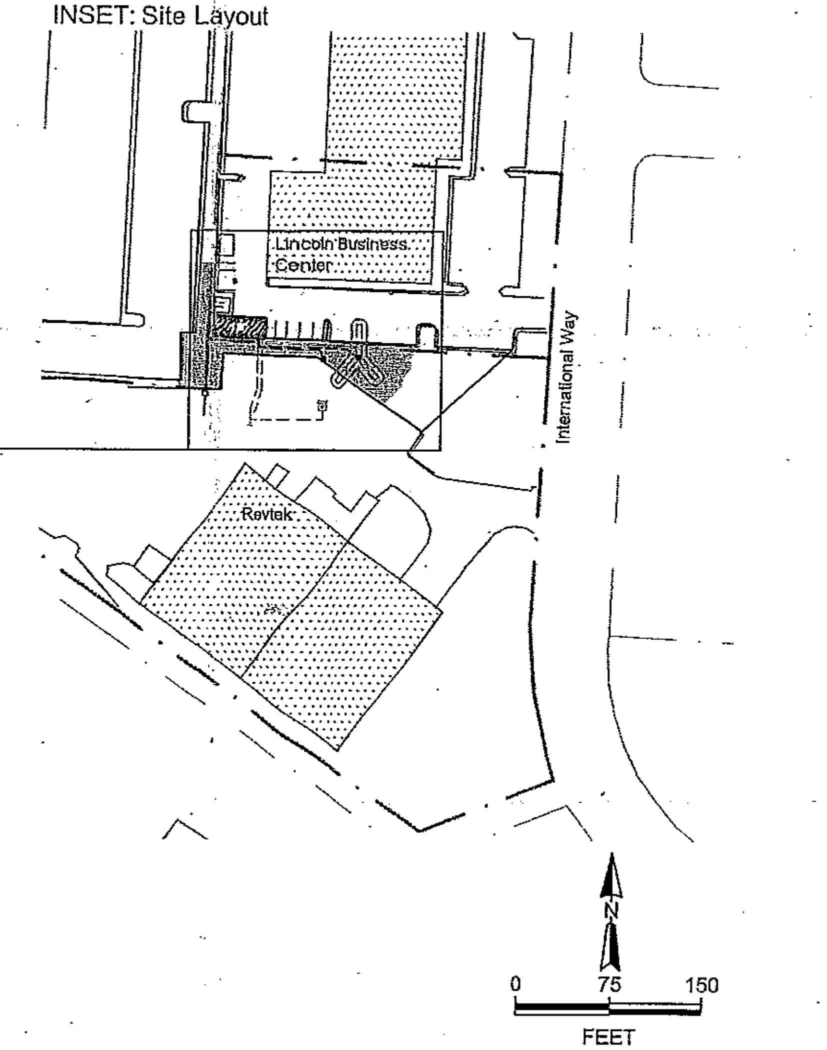
Figure 8-1




Notes:

1. Locations are approximate.
2. New EXT-2 conveyance system includes conduit for electrical and control. GCW well integration as shown, includes conduit for electrical - control and HDPE pipe for future extraction option.

INSET: Site Layout




**Existing Treatment System with Proposed Alternative**

URS

August 2006
25695795

Feasibility Study
Milwaukie International
Milwaukie, OR

Figure 8-2

# APPENDIX A

## ADMINISTRATIVE RECORD INDEX
## Staff Report
### Milwaukie International Way Site
### Milwaukie, Oregon

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The Administrative Record consists of the documents on which the recommended remedial action for the site is based. The primary documents used in evaluating remedial action alternatives for the Milwaukie International Way site are listed below. Additional background and supporting information can be found in the Milwaukie International Way project file located at DEQ Northwest Region Office, 2020 S.W. 4th Avenue, Portland, Oregon.

**Primary Site- Specific Documents**


Bridgewater, 2002. Preliminary Beneficial Water and Land Use Determination. September.

Bridgewater, 2004a. Well Survey Results – Milwaukie International Way. August 27.

Bridgewater, 2004b. Expanded Well Survey Results – Milwaukie International Way Site. Technical Memorandum. September 13.

D&L Excavating, 1991. Matrix Cleanup Report. Production Parts, Inc. Letter Report to Ray Peterson of DEQ from Lisa Riehl. December 20. (Appendix B of Golder Associates, Inc, 1992)

DEQ, 2006a. Internal DEQ Memorandum from H. Larsen to D. Bailey regarding travel time analysis. November.

DEQ, 2006b. Internal Memorandum from H. Larsen to D. Bailey regarding transport from OSB10 area to CW-7. November.

Exponent, 1998. Focused Source Investigation Data Report. December.

Exponent, 2002. Interim Remedial Measure Technology Screening and Preferred Alternative Selection. January.

Golder Associates, 1992. Preliminary Assessment of Manufacturing Parts, Inc dba Production Parts, Inc. June 30.

Integral, 2002. July 3, 2002 Revtek Building Air Sampling Results, International Way Site. Letter from D. Livermore of Integral to D. Bailey of DEQ. August.

Integral, 2005a. Regional TCE Contamination Sources in the Vicinity of City of Miwaukie Drinking Water Wells.

Integral, 2005b. April 2005 Sub-Slab Soil Gas Sampling Results, Revtek Building, Milwaukie International Way Site. Letter from D. Livermore to D. Bailey. September 2.

Integral, 2006. Addendum to Integral and MFA 2006. Revised J and E Modeling for Revtek Building. October 20.

Integral and Maul Foster and Alongi, Inc (MFA), 2006. Remedial Investigation Addendum: Evaluation of Vapor Intrusion Pathway. July 27.

Jacobs Engineering Group and Northwest Geotech, 1998. Final Data Summary Report. Milwaukie International Way Site Investigation, Phase I and Phase II, Milwaukie, Oregon. May 15.

Maul Foster and Alongi (MFA), 2001a. Letter regarding Milwaukie International Way site, results of air sampling in south part of Building 4 of the Lincoln Business Center to D. Bailey from A. St. John. July 27.

MFA, 2001b. Letter regarding air sampling results in southern portion of Lincoln Business Center building to D. Bailey from A. St. John. May 18.

MFA, 2004. Letter regarding sub-slab gas sampling in south part of Building 4 of Lincoln Business Center to D. Bailey from A. St. John. August 2.

MFA, 2005a. Letter regarding May 2005 sub-slab gas sampling results in south part of Building 4 of Lincoln Business Center to D. Bailey from A. St. John. June 22.

MFA, 2005b. Letter regarding Sub-Slab Sampling in South Part of Building 4 of Lincoln Business Center, to D. Bailey from M. Novak. August 2.

MFA, 2006. Letter regarding September 2005 sub-slab gas sampling results in south part of Building 4 of Lincoln Business Center to D. Bailey from A. St. John. January 26.

MFA and Exponent, 2000a. Source Area Investigation, Milwaukie International Way. August 2 and August 22.

MFA and Exponent, 2000b. Additional Geoprobe Investigation, Milwaukie International Way. January 19.

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