REMEDIAL INVESTIGATION/FEASIBILITY STUDY
ALCOA/EVERGREEN VANCOUVER SITE

Prepared for

Washington Department of Ecology
300 Desmond Drive SE
Lacey, Washington

On behalf of

Alcoa, Inc.
201 Isabella Street
Pittsburgh, Pennsylvania

Prepared by

Anchor Environmental, L.L.C.
1423 Third Avenue, Suite 300
Seattle, Washington 98101

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List of Acronyms and Abbreviations

µg	micrograms
ACPC	ACPC, Inc.
ADT	Advanced Disposal Technologies, Inc
AET	apparent effects threshold
Alcoa	Alcoa Inc.
Anchor	Anchor Environmental, L.L.C.
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
AUF	area use factor
BEI	Burlington Environmental Inc.
bgs	below ground surface
BHCR	baseline human cancer risk
BHCR	baseline human cancer risk
BMP	best management practice
BNSF	Burlington Northern Santa Fe
BPJ	Best Professional Judgment
BTEX	benzene, toluene, ethylbenzene, and xylene
CAP	Cleanup Action Plan
CAS	Columbia Analytical Services, Inc
CCCG	CCC Group
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	Contaminant of Concern
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CPU	Clark Public Utilities
CWA	Clean Water Act
cy	cubic yards
DMEF	Dredged Material Evaluation Framework
DNR	Department of Natural Resources
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement

ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
ESA	Environmental Site Assessment
Evergreen	Evergreen Aluminum LLC
FSDS	Field Sampling Data Sheet
g/L	grams per liter
GMA	Growth Management Act
GMP	Groundwater Monitoring Plan
gpm	gallons per minute
GRA	General Response Action
HCR	Human Cancer Risk
HDPE	high density polyethylene
HPA	Hydraulic Project Approval
HQ	hazard quotient
IAWP	Interim Action Work Plan
IDW	inverse distance weighting
K_d	distribution coefficient
LDC	Laboratory Data Consultants, Inc.
LDR	Land Disposal Restrictions
LNAPL	Light Non-Aqueous Phase Liquid
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MNR	monitored natural recovery
MRL	method reporting limit
msl	mean sea level
MTCA	Model Toxics Control Act
ng/L	nanograms per liter
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWP	Nationwide Permit
ORP	oxidation reduction potential

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
POC	point of compliance
POTW	public-owned treatment works
POV	Port of Vancouver
ppm	parts per million
PQL	practical quantitation limit
PUD	Public Utility District
QA/QC	quality assurance/quality control
RAI	reclaimed alumina insulation
RAL	remedial action level
RAO	remedial action objectives
RCRA	Resource Conservation and Recovery Act
REL	remediation level
RI/FS	Remedial Investigation/Feasibility Study
rkm	river kilometer
RM	river mile
SDG	sample delivery group
SE/E	Sweet-Edwards/EMCON, Inc
SEA	Sweet Edwards and Associates
SECOR	SECOR International Incorporated
SEPA	State Environmental Policy Act
SMS	Sediment Management Standards
SPL	spent potlining
SPLP	synthetic precipitation leaching procedure
SQS	sediment quality standards
SQV	sediment quality value
SVOC	semi-volatile organic compounds
SWAC	surface weighted average concentration
TAL	target analyte list
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TEF	toxicity equivalent factors

TMDL	total maximum daily load
TPH	total petroleum hydrocarbon
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
TVH	total volatile hydrocarbons
USA	Unconsolidated Sedimentary Aquifer
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Services
UST	underground storage tank
Vanexco	Vancouver Extrusion Company
VOC	volatile organic compounds
WDFW	Washington Department of Fish and Wildlife

1 INTRODUCTION

The Alcoa Inc. (Alcoa) and Evergreen Aluminum LLC (Evergreen) properties are collectively located at 5701 NW Lower River Road in Vancouver, Washington (herein referred to as the "Site"). This remedial investigation and feasibility study (RI/FS) report describes the site-wide historical investigations and remedial actions, current site-wide remedial investigation results and feasibility study for both the Alcoa and Evergreen properties that constitute the Site.

1.1 Property Ownership and Operation

The property was initially developed by Alcoa in the early 1940s when aluminum smelting operations began in Vancouver. The aluminum manufacturing facility at the Site was completed by Alcoa in 1940. During World War II, Alcoa filled and graded the eastern end of the smelter site with dredge sands from the Columbia River and constructed the smelter. From 1940 to 1970, Alcoa added a number of fabrication operations to the facility. By 1970, the facility contained an aluminum smelter and a series of fabrication plants to form the metal into finished goods such as wire, rod, and extruded channel. Alcoa operated the entire facility for approximately 45 years, until 1986.

The aluminum smelter and adjacent manufacturing facilities were closed by Alcoa in 1986. Individual land parcels associated with the aluminum manufacturing facility began to be remediated, closed, and sold by Alcoa. In 1985, the cable mill operation was sold to ACPC, Inc. (ACPC), who leased the property from Alcoa until 1997. In 1987, Alcoa sold the aluminum smelter to Vanalco, Inc., and retained title to the extrusion section of the property known as Vancouver Extrusion Company (Vanexco). Vanexco was operated by Alcoa until 1991 when it closed. Additionally, in 1991, Alcoa sold the property located between Evergreen Aluminum and the Alcoa property to Russell Towboat and Moorage Company. In 1994, a parcel of property known as the North Parcel was sold to the Clark County Public Utility District (PUD) for construction of a cogeneration plant. A cleanup was conducted on a parcel known as the Northeast Parcel and the property was sold to Clark County as a jail site in 1997. Glencore Washington LLC (now known as Evergreen Aluminum LLC [Evergreen]) purchased the smelter from Vanalco in 2002. Columbia Marine Lines (succeeded by Crowley Marine Services) leased property and operated a marine repair facility on the Alcoa property west of the aluminum smelter until 1984. Over the past few years, Alcoa has sold various parcels of land located to the east of the Site to the Port of

Vancouver (POV). Alcoa retains ownership of the river dock and loading area, the land east of the smelter (East Landfill, the North and North 2 Landfill areas, and the South Bank Area), and the western side of the smelter (Crowley Parcel). The rest of the center of the Site and the western stormwater lagoons are currently owned by Evergreen.

1.2 Site Description

The Site is located at 5701 NW Lower River Road on the northern shore of the Columbia River at river mile (RM) 103.3 in Clark County. It is approximately 3 miles northwest of downtown Vancouver, Washington, and approximately 3 miles due west of Interstate 5. The facility covers approximately 208 acres industrially zoned (of which Alcoa currently owns 97 acres and Evergreen owns 111 acres) and is bound on the north by NW Lower River Road, on the south by the Columbia River, on the east by property owned by the POV, and on the west by multiple industrial property owners. The Site and surrounding area are shown in Figure 1-1. In the general vicinity of the Site, the current land uses are mixed use industrial and agricultural.

Figure 1-2 provides the basic Site layout and the current property boundaries of Alcoa and Evergreen. The Site boundary includes the Evergreen and Alcoa properties, as well as property now owned by Clark County and CPU. These properties were previously owned and remediated by Alcoa.

1.2.1 Historical Site Use

The Site was developed in the late 1930s, with the completion of Alcoa's aluminum smelter in 1940. Since 1940, the aluminum smelter, which included potlines, an aluminum casting facility, greenmill, carbon bakes, dock and raw materials handling system, laboratory, and miscellaneous support facilities, operated with only intermittent interruptions until 2001, although the smelter's ownership changed twice, with Evergreen retaining current ownership. Alcoa expanded the smelter operations by adding a series of fabrication facilities. The fabrication facilities included the extrusion plant, the rod mill, and the cable plant. These facilities operated under Alcoa ownership or other company leadership until the mid-1990s. Alcoa retains current ownership of the property and the buildings that housed these facilities. Both Evergreen and Alcoa are in the process of demolishing their manufacturing facilities in preparation for the future sale of the properties.

1.2.2 Future Site Use

Alcoa and Evergreen intend to sell their properties to a buyer that will continue to use the property in an industrial capacity. Currently, Alcoa and Evergreen have each entered into prospective sales agreements with the POV. The POV intends to purchase both properties and develop the properties into Port facilities. The Port may conduct many different industrial use activities on the property. Current plans for the Port include the development of rail lines across the properties and development of a car unloading and storage facility.

1.3 Regulatory Setting

In order to effectively redevelop the property, the Site environmental concerns need to be addressed. This process involves developing a Site cleanup strategy with the Washington State Department of Ecology's (Ecology's) cooperation and oversight. Specifically, the project includes the review of historical Site data, identifying and filling data gaps, and developing this Site-specific RI/FS in accordance with Ecology's Model Toxics Control Act (MTCA; Ecology 2005) to minimize future environmental impacts. Alcoa and Evergreen will enter into Consent Decree negotiations with Ecology for the final cleanup of the combined Site. To facilitate the Consent Decree, on August 8, 2007, Evergreen executed an Ecology Enforcement Order (4931; Ecology 2007a). Evergreen and Alcoa submitted the Work Plan for Supplemental Well Installation to Ecology for review in August of 2007. In addition, Evergreen and Alcoa submitted the Work Plan, Site-Wide Groundwater Investigation in September of 2007. Evergreen also submitted the multiple Work Plans and Sampling Plans for the smelter site in September 2007.

1.4 Report Focus and Organization

This RI/FS Report describes the results of the historical data review, field investigations to fill data gaps, the Site conceptual model, identification of the contaminants of concern, groundwater flow modeling, fate and transport modeling, development of the Site cleanup levels for use in developing the cleanup strategy in the FS, presentation of site-wide remedial alternatives developed from an initial screening of technologies, and evaluation of each alternative to the applicable criteria. The report is organized as follows:

- Section 2 – Reviews the historical Site operations, environmental investigations, and remedial actions
- Section 3 – Identifies data gaps and describe associated field investigations
- Section 4 - Presents RI monitoring results
- Section 5 – Presents the results of the hydrogeological investigation
- Section 6 – Discusses the fate and transport of Site Contaminants of Concern (COCs) including the natural degradation and attenuation processes
- Section 7 – Describes the upland areas of concern (AOC)
- Section 8 – Presents the sediment risk evaluation
- Section 9 – Presents the Site-specific cleanup and remediation levels for sediment, groundwater, and soil
- Section 10 – Presents a summary of local, state, and federal applicable regulations
- Section 11 – Summarizes the remedial action objectives for each AOC
- Section 12 – Presents and screens cleanup technologies applicable to site conditions
- Section 13 – Develops remedial alternatives based on the selected cleanup technologies and evaluates the alternatives against the MTCA criteria for cleanup actions in accordance with WAC 173-340-360
- Section 14 – Presents the recommended remedial action for the Site

2 HISTORICAL INVESTIGATIONS AND REMEDIAL ACTIONS

Alcoa and Evergreen have conducted many historical Site investigations and remedial actions over the past 25 years. This section summarizes these historical investigations and remedial actions, both for upland and in-water (sediment) areas at the Site. Figure 2-1 provides the historical facility layout including investigation and remedial action locations. Remedial actions have occurred in the areas of the underground storage tanks (USTs), Transformer/Rectifier Yards, stormwater lagoons and sludge pond, Vanexco/Rod Mill Building, ACPC Facility, former Soluble Oil Areas and Hydraulic Oil Lagoons, former SPL Storage Area, and on-site landfills.

2.1 Upland Cleanup Studies and Source Control

This section focuses on the historical investigations and remedial actions that have occurred in the upland locations at the Site. These actions involve cleanup and source control for many of the Site's contaminants. A thorough review of the historical documentation from the Site has been conducted and is represented below.

2.1.1 Underground Storage Tank Cleanups

Alcoa maintained numerous USTs at the Site. These tanks stored a variety of fuels used in Site operations including gasoline, diesel, and fuel oils. The identification, capacity, contents, status, and sampling of all known tanks (current and former) are documented in Table 2-1.

Table 2-1
Underground Storage Tanks

Tank Identifier	Tank Capacity (gallons)	Tank Contents	Action	Date of Action	Sampling	Compounds Detected
1-34C[*]	15,000[a]	Number 1,2, or 4 Fuel Oil[b]	Decontaminated, inerted, and abandoned in place[c]	July 1987[c] October 1987[d]	Groundwater[e] Soil[f]	Diesel[f]
2-34C[*]	15,000[a]	Number 1,2, or 4 Fuel Oil[b]	Decontaminated, inerted, and abandoned in place[c]	July 1987[c] October 1987[d]	Groundwater[e] Soil[f]	Diesel[f]
3-34C[*]	15,000[a]	Number 1,2, or 4 Fuel Oil[b]	Decontaminated, inerted, and abandoned in place[c]	July 1987[c] October 1987[d]	Groundwater[e] Soil[f]	Diesel[f]
4-34C[*]	15,000[a]	Number 1,2 or 4 Fuel Oil[b]	Decontaminated, inerted, and abandoned in place[c]	July 1987[c] October 1987[d]	Groundwater[e] Soil[f]	Diesel[f]
5-34	2,000[a]	Diesel Fuel[b]	Removed[g]	June 1992[g]	Soil[g]	TVH, TPH, O&G
6-34	2,000[a]	Leaded Gasoline[b]	Removed[g]	July 1992[g]	Soil[g]	TVH, TPH, O&G

Tank Identifier	Tank Capacity (gallons)	Tank Contents	Action	Date of Action	Sampling	Compounds Detected
7-32	550[a] 500[h]	Leaded Gasoline[b]	Removed[c]	September 1988[c]	Soil[h,n]	TVH, BTX, O&G
8-30	550[a]	Unleaded Gasoline[b]	Removed[i]	November 1991[i]	Soil[i]	TVH, TPH, O&G, Gasoline
9-44	1,000[a], 2,000[h]	Diesel Fuel[b] Gasoline[h] (in past)	Removed[c]	September 1988[c]	Soil[h,n]	TVH, BTX, O&G
10-427	1,500[a]	Leaded Gasoline[b]	Removed[c]	June 1987[c]	Unknown	Unknown
11-410A	2,500[a]	Number 1,2, or 4 Fuel Oil[b]	Removed[c]	June 1987[c]	Unknown	Unknown
12-410A	2,500[a]	Number 1,2, or 4 Fuel Oil[b]	Removed[c]	June 1987[c]	Unknown	Unknown
13-45	10,000[a]	Leaded Gasoline[b]	Removed[c]	August 1987[c]	Unknown	Unknown
14-420	3,000[a]	Used Oil/Waste Oil[b]	Removed[j]	1987[j]	Soil[j]	ND[j]
Building 66 East Tank	6,000[k]	No. 6 fuel oil[k]	Removed[k]	September 2001[l]	Soil[k, l]	Heavy Oils
Building 66 West Tank	6,000[k]	No. 6 fuel oil[k]	Unknown	Unknown	Soil[k]	Unknown
Vanexco Gasoline Tank	1,000[m]	Unleaded Gasoline[m]	Removed[m]	November 1990[m]	Soil[m]	ND
Vanexco Diesel Tank	16,000[m]	Diesel[m]	Removed[m]	November 1990[m]	Soil[m]	Diesel, TRPH

Table footnotes and references:

* Located on the dike.

[a] Alcoa 1986a)

[b] (Alcoa 1986b)

[c] (Alcoa 1988)

[d] (Sweet-Edwards/EMCON 1991).

[e] (Sweet-Edwards/EMCON 1990)

[f] (Sweet-Edwards/EMCON 1987)

[g] (IAM/Environmental 1992)

[h] (Crosby and Overton 1988a)

[i] (Northwest Envirocon 1991)

[j] (Dames and Moore 1996)

[k] (ICF Kaiser Engineers 1996a)

[l] (IT Corporation 2001a)

[m] (Riedel Environmental Service 1991)

[n] (Crosby and Overton 1988b)

TVH – total volatile hydrocarbons

TPH – total petroleum hydrocarbon

O&G – oil and gas

ND – not detected

TRPH – total recoverable petroleum hydrocarbons

Additional information regarding the sampling conducted and detected compounds is available in Appendix A-1 or in the referenced documents. The locations of the aforementioned USTs are shown in Figure 2-2.

In 1987, the four USTs on the dike, 1-34C, 2-34C, 3-34C, and 4-34C, were emptied, decontaminated, and abandoned in place. As part of the process to abandon a UST in place, Ecology recommends filling the UST with a solid inert material such as sand slurry, weak cement slurry, or foam. Each of the Dike USTs were filled with gravel upon closure. On behalf of Alcoa, Sweet-Edwards/EMCON, Inc (SE/E) performed investigation and pilot testing services of the four diesel USTs located near the river dike. SE/E installed five monitoring wells, detected diesel light non-aqueous phase liquid (LNAPL) in the wells, and conducted pilot testing of free product recovery in the wells (Sweet-Edwards/EMCON 1989a and 1990). The presence of diesel products in the soil and groundwater in the vicinity of these USTs indicates that additional remediation activities may be necessary. Further investigation results are reported in Section 4. As part of the final remedial activities at the Site, these tanks, as well as any identified affected soil, will be excavated and disposed of off site.

Prior to the sale of the smelter facility to Vanalco, Alcoa owned and operated all of the USTs on the Site including USTs 5-34, 6-34, and 8-30 in the late 1980s (the Vanalco USTs). Vanalco assumed ownership of the Vanalco USTs in 1987 (Figure 2-2). Tanks 5-34 and 6-34 were each 2,000 gallons in capacity, contained diesel and leaded gasoline, respectively, and were located southwest of the former Potrooms (Figure 2-2). Tank 8-30 was a 550-gallon capacity unleaded gasoline tank located immediately east of Building 30 (Figure 2-2).

Prior to the Vanalco acquisition in 1987, five soil borings (B-1 through B-5) were installed in the vicinity of the Vanalco USTs. At that time, one monitoring well was also installed in the vicinity of each tank (Wells 1, 2, and 3) that were then sampled on a quarterly basis for between three to four quarters. Following Vanalco's acquisition, the Vanalco USTs were decommissioned by removal, at which time verification soil sampling of each tank excavation was conducted as documented in the IAM/Environmental, Inc. report titled *Report of Construction and Observation Services, Decommissioning of Underground*

Storage Tanks (August 13, 1992) (regarding tanks 5-34 and 6-34) and the Northwest Envirocon, Inc. report titled *UST Removal* (December 11, 1991) (tank 8-30) (Appendix A-1). The results indicate residual soil concentrations in each of these three areas are below MTCA Industrial Use cleanup levels. In addition, benzene, toluene, ethylbenzene, and xylene (BTEX) compounds where analyzed, were not-detected above laboratory method reporting limits (MRLs) in any monitoring well for a period of at least three quarters at each location. Accordingly, the investigation and remediation of these historical tank areas is considered complete.

In 1987, the following USTs were closed and removed: 10-427, 11-410A, 12-410A, and 13-45. It is unknown whether any sampling was conducted before or after the removal of these USTs. Additionally, although no documentation was found indicating that the Building 66 West Tank was closed or removed, a ground penetrating radar survey performed in 1996 was unable to identify a UST in the area, indicating the tank had been removed. From 1987 to 2001, USTs such as the Vanexco Gasoline Tank, Vanexco Diesel Tank, Building 66 East Tank, 7-32, 9-44, and 14-420 were closed and removed. Initial sampling conducted in the excavation pits of these USTs detected a variety of compounds including TVH, total petroleum hydrocarbons (TPH), oil and grease, and BTEX. When there was evidence of TPH impacts, additional soil was excavated from the impacted areas and sampling was conducted to confirm that the remaining soil achieved cleanup standards. Excavated soil exceeding cleanup levels was then temporarily placed on-site and subsequently disposed of at off-site locations. Additional remediation in the vicinity of the removed USTs is not required.

2.1.2 Transformer/Rectifier Yards

Site facilities historically contained two transformer rectifier stations designated as Rectifier Stations 1 and 2 (Figure 2-1). Of these two areas, Rectifier Station 2, servicing lines 4 and 5, were previously investigated and remediated in accordance with an approved U.S. Environmental Protection Agency (EPA) Self-Implementing On-Site Cleanup under 40 Code of Federal Regulations (CFR) 761.61 during 2002, as described below. EPA's cleanup goals for this remediation were consistent with Ecology's Method A Unrestricted Use cleanup levels for polychlorinated biphyenyls (PCBs) in soil for the Site.

In August 1991, Vanalco personnel reportedly observed some oil on a puddle of water within one of the rectifier stations and reported it to Ecology as a potential release of PCBs at the site. Subsequently, Vanalco retained Burlington Environmental Inc. (BEI) who collected 49 samples from visibly stained soils in close proximity to each of the transformers located within Rectifier Stations 1 and 2. These investigations detected concentrations of PCBs that varied from not-detect above laboratory MRL up to a maximum of 140 milligrams per kilogram (mg/kg); TPH (assumed to be mineral oil) was detected at concentrations ranging between 45 to 280,000 mg/kg.

In October and November 2002, Advanced Disposal Technologies, Inc. (ADT) conducted the Self-Implementing On-Site Cleanup of Rectifier Station 2, lines 4 and 5, documented in the report titled *Self Implementing On-Site Clean Up and PCB Removal Report* (Pacific Power 2002). After the removal, the results of the confirmation sampling indicated PCBs were non-detect above laboratory MRLs for 61 of 62 verification samples, with a single result reported at 0.228 mg/kg, less than the cleanup level of 1 mg/kg. The Self Implementing Cleanup was approved by EPA on February 6, 2003 (Appendix A-2). Again, EPA's cleanup goals for this remediation were consistent with Ecology's Method A Unrestricted Use cleanup levels for PCBs.

The remaining Transformer/Rectifier Yards and Site Electrical Systems at the smelter, which were not addressed under the initial remediation described above, were being addressed as a Self-Implementing On-Site Cleanup as approved by the U. S. Environmental Protection Agency (EPA) (EPA 2007) under TSCA (40 CFR Part 761). As such, sampling, analysis, and evaluation of these concerns to date have been conducted in accordance to, and comply with, 40 CFR Part 761. However, cleanup of this area will also comply with MTCA and the cleanup levels proposed in the RI/FS.

2.1.3 Stormwater Lagoons and Sludge Pond

The stormwater lagoons and sludge pond are located on the northern bank of the Columbia River on the western portion of the Site (Figure 2-1). Each of the stormwater settling lagoons is approximately 600 feet long, 150 feet wide, and 10 feet deep and is oriented parallel to the Columbia River (ENSR 1993). The sludge pond was located directly to the north of the stormwater lagoons.

Wastewater from non-contact cooling water, plant process water discharges, and Site stormwater runoff is directed into one of the two stormwater lagoons. Use of the stormwater lagoons is alternated depending on the relative capacity of the lagoons. Suspended material in the wastewater is allowed to settle and then the treated water exits the lagoon through a weir. The wastewater is then discharged to the Columbia River under National Pollution Discharge Elimination System (NPDES) Waste Discharge Permit WA 000029-9. In the past, sludge from the unused stormwater lagoon was pumped directly into the unlined sludge pond. In 1969, the stormwater lagoons were lined with a 10 mil PVC material; prior to 1969, the two stormwater lagoons were unlined (CH2M Hill 1992).

During the late 1980s, Alcoa began an investigation into closing the sludge pond. In February 1987, sampling of the material in the sludge pond indicated that it did not exceed toxicity criteria for metals as defined by both the EPA Extraction Procedure (EP) and the Toxicity Characteristic Leaching Procedure (TCLP) and thus was not considered a dangerous waste. Sampling results also indicated that fluoride was present in the sludge at concentrations of 2,400 mg/kg to 7,200 mg/kg (Hart Crowser 1987a). The majority of the fluoride is present in an insoluble form.

Prior to the closure of the sludge pond, Hart Crowser conducted a series of environmental investigations to determine the effects of the stormwater lagoons and sludge pond on the groundwater. From 1988 to 1992, Hart Crowser installed monitoring wells in the shallow (SP-3 and SP-7), intermediate (SP-1, SP-2, SP-4, SP-6, and SP-7), and deep (SP-1, SP-2, SP-3, SP-4, SP-5, SP-6, and SP-7) groundwater regimes in the vicinity of the stormwater lagoons and sludge pond. Each well was sampled periodically for metals, cyanide, fluoride, groundwater elevation, pH, temperature, and electrical conductivity. Groundwater quality monitoring indicated that contaminants from the sludge pond might have migrated into the intermediate groundwater regime prior to cleanup.

In 1992, CH2M Hill conducted soil sampling of the lagoon dikes and the bottom of the stormwater lagoons and reported that the 10 mil PVC stormwater lagoon lining had been breached in a number of places in the north lagoon (the south lagoon was in use at the time of the inspection). Initially, plans to move the stormwater lagoons to a different location were explored. Economics and operational logistics lead Alcoa and Vanalco to retain the stormwater lagoons in the historical locations. Several different alternatives for the replacement of the liner were developed. The final choice for the liner was a double HDPE liner (60 mil) with an intermediate synthetic drainage layer. Relining of the stormwater lagoons occurred in 1994. Additional information about the stormwater lagoon liner alternatives is available in Appendix A-3.

Closure of the sludge pond occurred around the same time in 1994 as the relining of the stormwater lagoons. Removal and off-site disposal of the impacted materials was determined to be the most conservative cleanup option for the sludge pond. A proposal submitted by RUST Remedial Services Inc. in June 1994 indicated that the sludge lagoon was approximately 4.68 acres in size and contained approximately 47,000 cy of aluminum hydroxide sludge (RUST 1994). As part of the remediation, the 6 inches of soil below the bottom of the unlined sludge pond would also be removed (RUST 1994). The volume of this soil was approximated to be 5,000 cy (RUST 1994) and was disposed of at an approved off-site facility. Sampling of the bottom of the excavation pit, sidewalls, and in the existing dikes around the stormwater lagoons and excavated sludge pond was conducted. The excavated sludge pond area was then filled with clean material, graded, covered, seeded, fertilized, and mulched. After remediation of the sludge pond and the relining of the stormwater lagoons, the property was sold to Vanalco.

A 5-year groundwater monitoring program for the stormwater lagoons and sludge pond was conducted from 1995 to 1999. Groundwater samples from the monitoring wells were collected and analyzed for free cyanide, fluoride, and a focused list of organic chemicals. In 1999, the test results were summarized and, with the exception of fluoride, no chemicals of concern were reported above detection limits. The fluoride results indicated that fluoride was below the MCL of 4 mg/L for wells located in the shallow and deep groundwater zones. The average concentration in the intermediate groundwater zone was below the MCL and ranged from 0.2 mg/L to 5.8 mg/L, exceeding the MCL at only one well (SP-4I). The monitoring program continued quarterly through 2002. Sampling of the intermediate wells in October 2002 indicated that fluoride concentrations from wells ranged from 2.2 to 4.2 mg/L. The average concentration was well below the MCL and groundwater monitoring in this area was terminated. The stormwater lagoons are still in operation today.

2.1.4 Scrap Yard Metal Recycling Area

Two separate characterization investigations of the Scrap Metal Recycling Area (Figure 2-1) were completed in 1995 and 1997, respectively, that included installation and sampling of a total of 12 test pits (HC TP-1 through HC TP-7 and VI TP-A through VI TP-E). In particular, HC TP-1 through HC TP-7 focused on the Scrap Metal Recycling and near vicinity areas including Building 69, adjacent fenceline, and pumphouse, whereas the subsequent test pits, VI TP-A through VI TP-E, focused on the area in near vicinity to HC TP-6 where elevated levels of leachable lead were previously detected.

Analytical testing of selected soil samples from 12 test pits (HC TP-1 through HC TP-7 and VI TP-A through VI TP-E; Hart Crowser 1995 and Vanalco 1997), and two recent area-wide fluoride samples collected are summarized below.

- **Subsurface:** The reported subsurface conditions within HC TP-1 through HC TP-7 were 1 to 2 feet of sandy gravel or gravelly sand (fill material) overlying a brown sand. Where encountered (excepting HC TP-1 and HC TP-5) fill material was observed to contain metal fines.
- **TPH**: In 17 of 23 test pit samples analyzed, TPH was detected at concentrations between 28 and 2,000 parts per million (ppm). TPH was principally detected in the eastern half of the Scrap Metal Recycling area, primarily at and in the vicinity of TP-6 and TP-7. Assuming a conservative MTCA Method A Soil Cleanup Level of 2,000 ppm for Industrial Properties, further investigation or cleanup relating to TPH does not appear to be warranted.
- **PCBs:** Total PCBs were detected in TP-6 and TP-7, the only two locations where samples were analyzed for this analyte, at concentrations of 1.52 and 0.34 ppm. Since the area of TP-6 is to remain un-capped, the permissible reference level for

PCB in soil defaults to the Method A Soil Cleanup Level of 1 ppm for Industrial Properties.

- **Cyanide:** Where detected, cyanide concentrations were below Standard Method B Formula Values for Unrestricted Land Use (direct contact). In general, more elevated concentrations of this parameter were detected in the eastern portion of the Scrap Metal Recycling area. Further investigation or cleanup relating to cyanide in this area does not appear to be warranted.
- **Fluoride**: Concentrations of fluoride were detected below MTCA Method B Standard Formula Values for Unrestricted Land Use of 4,800 ppm. However, more recent sampling conducted as part of area-wide fluoride evaluations detected fluoride in this area at concentrations of 19,700 ppm and 122,000 ppm in the eastern and western portions of this area, respectively. The source of elevated fluoride in the Scrap Metal Recycling area is not definitively known, but may have been related to storage of process collector bars (McLellan personal communication 2007).
- **Metals**: Of the nine metals analyzed (arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, and silver) concentrations of arsenic, cadmium, chromium, copper, and lead were detected above Clark County background levels (Ecology 2004), all in the eastern portion of the Scrap Metal Recycling area (vicinity of HC TP-6 and HC TP-7). However, only cadmium and chromium at TP-6 and TP-7 exceed MTCA Method A Soil Cleanup Levels for Industrial Land Use. Cadmium was only slightly above the MTCA Method A Soil Cleanup levels of 2 mg/kg, at 2.4 and 3.0 mg/kg. Cadmium was found in the two test pits at concentrations exceeding the MTCA Method A Cleanup Levels of 19 mg/kg, at 50 and 36 mg/kg. Metals analyzed where MTCA Method A Soil Cleanup Levels are not established include barium, copper, selenium, and silver, concentrations for which all fall below MTCA Method B Soil Cleanup Levels excepting copper, again in the eastern portion of the Scrap Metal Recycling area. The soil locations impacted with metals also have other contaminants at greater concentrations. It is likely that removal of soil in these areas will be driven by the constituents listed above and not metals.

> Analysis of soil samples from TP-6 and TP-7 indicate lead at TP-7 was leachable at a concentration of 20 milligrams per liter (mg/L) suggesting soil in this area could qualify as a characteristic hazardous waste (D008) upon removed. In addition, a conservative comparison indicates the leachable lead concentration of 20 μg/L from TP-7 exceeds the Method A Cleanup Level of 15 μg/L for groundwater.

The data suggest the Scrap Metal Recycling area is a potential area of concern (AOC) with respect to fluoride, PCBs, and variable exceedances of metals compared to conservative MTCA Method A Soil Cleanup Levels for Industrial Properties, where established. The elevated concentrations of these COPCs appear to be located principally within near-surface fill soil (sandy gravel) while lower concentrations are detected in the underlying sand.

2.1.5 Vanexco/Rod Mill Building

This section provides a summary of the remedial action performed at the Vanexco/Rod Mill complex. The complex consists of a portion of a large manufacturing building that housed an extrusion plant and rod mill. The rod mill section of the manufacturing facility was closed in 1990 for decommission and removal of machinery (Ecology 1995a and 1995b). During the closure and removal of equipment in the rod mill portion of the Vanexco/Rod Mill Building, PCB contamination was suspected and discovered in the concrete structures that extended below the floor surface and soil beneath the floor (Ecology 1995a and 1995b, ICF Kaiser Engineers Inc. 1996b).

Alcoa conducted an independent cleanup in 1992, under EPA and Ecology oversight. The cleanup objectives included the following measures (OHM Remediation Services Corp. 1992):

- Excavation of soils and concrete with PCBs at or above a concentration of 1.0 mg/kg
- Clean surfaces to a concentration of 10 micrograms (μg) per 100 square centimeters in a wipe test
- Demolition and removal of PCB-impacted concrete sumps and pits
- Coordination of the transportation and disposal of impacted soil and debris

- Backfilling and compaction of excavation pits
- Collection and treatment of impacted waters

The soil remediation successfully removed approximately 8,000 cy of material from the Rod Mill (Ecology 1995a and 1995b). The Vanexco remediation was completed during this same time period. During the Rod Mill excavation, cleanup operations were halted by a structural engineer after he determined that the excavation threatened columns that supported the building structure and roof creating an un-safe condition. The structural engineer determined that further excavation should cease, and the excavation should be filled with crushed rock to prevent the collapse of the roof (OHM Remediation Services Corp. 1992). Before the excavation was filled, samples were collected to characterize the surface of the excavation. Additional discussion and figures detailing sampling locations and PCB concentrations are included in Appendix A-4. While some of the soil samples achieved the site cleanup goal of 1 mg/kg, this sampling indicated PCB concentrations up to 2,000 ppm in soil samples from the excavated area and concentrations greater than 16,000 ppm in concrete pit chip samples from the southeastern portion of the Rod Mill excavation (OHM Remediation Services Corp. 1993). Subsequently in 1992, EPA granted Alcoa's request for an alternative cleanup level and approved the filling of the excavation, and continued groundwater monitoring (Ecology 1995b).

As part of the remediation program implemented in the Vanexco/Rod Mill Building area, additional chemical analyses were performed on Site surface water, the concrete floor and structures, soil, and groundwater. These investigations characterized the nature and extent of PCB-impacted media that remained in the Vanexco/Rod Mill Building area. In May 1995, Ecology published a Cleanup Action Plan (CAP), identifying the following cleanup remedy for this portion the Site (Ecology 1995b):

- The Site was identified as a routine site for MTCA Method A cleanup measures.
- Impacted soils on the Site were removed to the extent practicable (i.e., without threatening the structural integrity of the building) and disposed at an off-site hazardous waste landfill.
- Containment of remaining contaminants was accomplished by placing fill and engineered cap materials (i.e., floor slabs and foundations).

- The building surrounding the engineered cap is required to be maintained to ensure the integrity of the cap; current and future owners are required to maintain the integrity of the engineered cap and roof of the building over the cap, or provide drainage away from the cap.
- Long-term monitoring of Intermediate Zone groundwater was required at the Site, along with institutional controls, to ensure the protectiveness and integrity of the containment system.
- Institutional controls (deed restrictions) would not be removed from the Site until applicable cleanup standards are met.

Consistent with the CAP and Consent Decree requirements (Ecology 1995a and 1995b), cleanup actions in the Vanexco/Rod Mill Building area were completed in 1995. Impacted soils that were removed were disposed of off site in a TSCA hazardous waste landfill and impacted soils which could not be removed without jeopardizing the integrity of the building were covered with fill material. After backfilling, the foundation was restored with asphalt and/or concrete to serve as a final engineered cap over the impacted soils left at depth. As required by the Consent Decree, the building structure and roof has been maintained to provide drainage from the engineered cap. An independent environmental assessment performed in May of 1996 also confirmed the effectiveness of the excavation, fill, and capping actions in the Vanexco/Rod Mill Building area (Dames & Moore 1996).

Groundwater monitoring was required for PCBs in the Intermediate Zone for 5 years. This monitoring was subsequently completed in 2001. Sampling performed during the 5-year monitoring program did not detect PCBs (IT Corporation 2001b). Having fulfilled the long-term monitoring requirement of the Consent Decree, Ecology approved the cessation of monitoring. Per the 1995 Consent Decree, no further remedial action is required at the Vanexco/Rod Mill Building.

2.1.6 ACPC Facility

When the Alcoa Vancouver Works ceased operation in 1986, ACPC leased a collection of 16 buildings and a portion of the land on the Site. ACPC produced aluminum cable by drawing aluminum rod into wire and then combined strands of the wire into cable.

After the fabrication process, the cable was optionally coated with polyethylene or sandblasted with silica to remove the luster. The final step in the process was spooling the cable onto reels. Due to its proximity to the Vanexco/Rod Mill complex and the activities that occurred on-site, PCB contamination at the ACPC Facility was suspected.

In 1995, Geraghty and Miller conducted a Phase I Environmental Site Assessment (ESA) of the ACPC Facility. The ESA included a walk-through of all facilities and evaluation of on-site conditions. The following areas of interest were noted: UST, transformers containing PCB dielectric fluids, oil stains, aboveground storage tank (AST), the vapor degreaser, storm sewers, materials containing asbestos, coatings containing lead based paint, and detections of radon gas. A total of nine production wells and eight groundwater monitoring wells are located near the ACPC Facility were sampled during the ESA. Groundwater samples collected indicated the presence of fluoride and cyanide in select locations at concentrations below cleanup levels, but did not detect the presence of PCBs (Geraghty and Miller 1995). More detail may be found in Appendix A-5.

A Phase II ESA was conducted at the ACPC facility in August 1996 by ICF Kaiser Engineers. The areas of interest identified by the Phase I ESA were sampled. Soil samples indicated the presence of TPH, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total halogens, total PCBs, total lead, and fluoride at various locations. One building in particular, the Caterpillar shed, contained affected soil.

The Caterpillar shed was previously used as a repair shop for Caterpillar equipment. At the time of the Phase I ESA, 36 drums of grease were stored in the shed (Geraghty and Miller 1995). The floor of the shed was dirt and an oil drain pit emptied directly to the ground below. Samples collected during the Phase II investigation indicated concentrations of TPH up to 16,000 mg/kg and polycyclic aromatic hydrocarbon (PAH) of 292 mg/kg from the soil below the oil drain, and up to 40,000 mg/kg TPH and 9.8 mg/kg SVOCs from stained soils east of the shed (ICF Kaiser Engineers 1996b). Preliminary estimates indicated approximately 20 feet by 30 feet by 6 inches of soil would need to be removed in order to remediate the area (ICF Kaiser Engineers 1998).

Documentation indicates that the Caterpillar shed was demolished during in 1999. From September 1999 to January 2000, the wire draw oil system, consisting of two oil cellars and a variety of trenches, was partially removed and residual elements were cleaned. From January to February 2001, a soil and groundwater investigation was conducted to investigate whether wire draw oil had leaked into the soil below the system (IT Corporation 2001c). Soil borings were advanced, soil samples were collected, and temporary monitoring wells were installed in most of the borings. Extractable petroleum hydrocarbon (EPH) was detected in two soil samples and one groundwater sample (IT Corporation 2001c). Additional information is found in Appendix A-5. This investigation concluded that no further remediation was necessary because the small residual concentrations of contaminants would have minimal impacts.

During the 2000s, Alcoa has conducted a number of cleanup actions at the Site including: removal of the wood block flooring; partial scarification of the floor mastic that contains PCBs; removal of the majority of asbestos containing materials; removal/emptying of the remaining ASTs; backfill of the equipment pits and trenches with sand and rubble; removal of the majority of the hydraulic fluids from equipment; removal of the transformers, capacitors, and electrical equipment; and cleaning of the Vanexco trenches to remove PCBs. Additional work scheduled for completion in 2008 includes cleaning the storm system and final asbestos removals. As part of the purchase and sale agreement with the POV, Alcoa plans to demolish the ACPC buildings and remove all foundations to 3 feet below the existing ground surface. Visual inspection of the soil during excavation will be conducted to identify any additional potential impacts.

2.1.7 Former Soluble Oil Area and Hydraulic Oil Lagoons

During the fabrication of aluminum redraw rod, Alcoa used water soluble cooling oil. In approximately the 1970s and 1980s, Alcoa discharged this cooling oil to several basin-like areas on the eastern portion of the Site (Figure 2-1). At an unknown point in time, the water soluble cooling oil was incidentally mixed with hydraulic oil that contained PCBs as a fire retardant.

In the early 1980s, under direction from Alcoa, Robinson and Noble began an investigation into possible PCB impacts to soil and groundwater in the vicinity of the former waste oil disposal areas. In August 1984, four monitoring wells were installed and soil and groundwater samples were collected and analyzed for PCBs.

Subsequently, SE/E conducted a subsurface investigation focused on determining the extent and distribution of the PCBs in the soil and groundwater in the vicinity of the soluble oil lagoons during 1987 and 1988. This investigation identified two separate areas of impacted media. The first area, Area 1, contained elevated PCB concentrations and was also known as the Southeast Yard, or the Soluble Oil Area. Area 2, or the Hydraulic Oil Lagoons, contained elevated levels of hydraulic oil. These areas are discussed in detail in the following sections.

2.1.7.1 Area 1 (Soluble Oil Area)

An unknown amount of PCB-impacted water soluble oil was deposited in an equalization pond bordered on the north and south by spurs of the Burlington Northern Santa Fe (BNSF) railways, on the east by a berm, and on the west by a fence (Figure 2-1). Any excess water in the vicinity had the potential to drain out the southern end of the pond into the surrounding area via a series of ditches and culverts near the railroad tracks. Area 1 contained the equalization pond and the potentially impacted areas on both sides of the railroad tracks. Like much of the eastern portion of the Site, the native soil in this area was covered with dredge sands during the 1940s.

During the 1988 SE/E investigation, samples of soil, groundwater, and sludge material (found on the surface and at depth in the soil) were collected. Composite soil samples indicated PCB concentrations ranged from 1.9 ppm to 107 ppm whereas the sludge material contained PCB concentrations up to 1,600 mg/kg (Sweet-Edwards/EMCON 1988). This investigation also determined that PCB concentrations in the native soils, located at approximately 8.5 feet below ground surface (bgs), were negligible (Sweet-Edwards/EMCON 1988). Groundwater sampling of monitoring wells, production wells, and boreholes indicated PCB concentrations were greater in the shallow dredge sands than at depth.

In 1989, a supplemental soil and groundwater investigation was conducted in order to further define the horizontal and vertical extent of the PCB-impacted soil and provide background data for developing remedial alternatives (Sweet Edwards/EMCON 1989b). In general, in all media, PCB concentrations were found to diminish with depth and distance from the source.

In July 1989, Alcoa initially proposed to excavate all material with PCB concentrations greater than 25 ppm in accordance with 40 CFR 761.61(a)4(B) for low occupancy areas. This level was suggested by Alcoa because Ecology was in the process of developing PCB regulations under MTCA. After further discussions with Ecology and EPA, Alcoa chose to reduce the cleanup level to 15 ppm and remediate the area as a voluntary cleanup. By removing materials with PCB concentrations greater than 15 ppm, recognizing that residual PCB materials lacked mobility, and placing a clean cover over the excavated area, Alcoa believed the remediation would produce negligible environmental risk for the area.

On June 1, 1990, pre-excavation sampling was conducted to characterize the materials for disposal (Chemical Processors 1990a). Under direct supervision from Alcoa, Chemical Processors began remediating the area by excavating sludge material and incrementally excavating impacted soil from 0 to 4 feet bgs, 4 to 8 feet bgs, and 8 to 10 feet bgs.

By October 19, 1990, all material with PCB concentrations greater than 15 ppm had been excavated. The excavation depth varied by location from 4 feet to at least 10 feet. A total of approximately 4,750 cy of impacted soil had been excavated and was transported to an appropriate offsite landfill for disposal (Chemical Processors 1990b). After confirmation sampling verified that the desired cleanup levels had been met, the excavation was backfilled with onsite borrow material. According to the Remediation Plan, the excavations were backfilled with soil with PCB concentrations less than 15 mg/kg and the entire area was capped with a minimum 2-foot clean soil cap.

Additional information regarding the Area 1, Soluble Oil Area, can be found in Appendix A-6. As part of the final remedial activities at the Site, the soils contained within this area will be characterized in place and excavated and disposed of off site if determined not to be in compliance with the cleanup levels defined in this RI/FS.

2.1.7.2 Area 2 (Hydraulic Oil Lagoons)

PCB-impacted water soluble oil was also disposed of at a location south of the Vanexco parking lot (Figure 2-1). Historical aerial photographs, particularly one from 1972 (see Appendix A-6), clearly delineate the impacted area. Although elevated levels of PCBs were observed in this area, the contaminant of primary concern was hydraulic oil. The SE/E 1988 investigation further identified PCB impacts through the collection of soil, groundwater, and sludge samples. PCB concentrations ranged from non-detect to 4.5 mg/kg for composite soil samples and from 0.59 to 7.5 mg/kg for the sludge samples (Sweet-Edwards/EMCON 1988).

In October and November 1994, EMCON Northwest performed an environmental assessment of the area. Soil samples indicated TPH as hydraulic oil at concentrations up to 43,000 mg/kg and 14,100 mg/kg in the surface and subsurface, respectively, and soil PCB concentrations up to 4.5 mg/kg (EMCON Northwest 1994). Groundwater samples from test borings also indicated the presence of TPH as oil. In 1995, a focused remedial feasibility assessment was performed to determine the approximate volume and extent of impacted soils and to develop and evaluate possible remediation actions for the Site (EMCON 1995). Although soil samples collected during this investigation confirmed the presence of TPH (as noted above), groundwater samples from a down gradient monitoring well (MW-26) did not indicate the presence of any petroleum compounds.

As part of the 1995 EMCON investigation, four general remedial alternatives were developed: in-situ treatment, ex-situ treatment, off-site treatment, and off-site disposal. The treatment options considered included steam stripping, biological treatment, and thermal desorption. Each alternative was evaluated depending on the time required for completion, amount of handling of impacted soil (including possible transportation), cost effectiveness, permanence of the action, required permits, and ability to meet regulatory cleanup standards.

On-site ex-situ treatment of the impacted soils was selected as the preferred alternative because this alternative allowed for the protection of groundwater, could be implemented relatively quickly, and effectively reduced long-term impacts (because contaminants were degraded and thus concentrations were diminished). Initially, the MTCA cleanup action levels of 200 mg/kg TPH and 10 mg/kg PCBs were established; however, discussions with Ecology indicated that a cleanup level of 500 mg/kg TPH would also be permitted.

In January 1995, the CCC Group (CCCG) began excavation of the impacted soil at the northern former oil disposal area. Under the direction of Alcoa, all visually impacted soils were excavated. By February 16, 1996, over 12,000 cy of excavated material had been transported to the former Extrusion Building and divided into six stockpiles (CCC Group 1996a). Golder Associates conducted verification sampling of the excavation area and found it to be compliant with the established cleanup standards. The excavation was then backfilled using silty sand from the surrounding area.

In the former Extrusion Building, each stockpile of impacted soil was treated with nutrients and microbes specially selected for their ability to degrade oil and PCBs. During the bioremediation process, CCCG monitored the stockpiles for microbial activity, pH, moisture, and temperature. Samples were regularly collected and analyzed for TPH and PCBs to obtain estimates of degradation. The bioremediation process began in May 1995 and was completed in July 1996. During that time, 26 discrete samples were collected from six stockpiles and analyzed for TPH and PCBs. The bioremediation resulted in a decrease of the average PCB concentrations from 5.73 mg/kg to 0.37 mg/kg and a decrease in average TPH concentrations from 4,900 mg/kg to 464 mg/kg in the soil stockpiles. During the bioremediation process, supplementary samples were also analyzed for TCLP TPH, molybdenum, and aluminum. The molybdenum and TCLP TPH sample results were non-detect, while the aluminum was 6,275 mg/kg (CCC Group 1996b).

Additional verification sampling of the bioremediated soils was conducted by ICF Kaiser Engineers in September 1997. Sampling results confirmed that PCB soil concentrations met the MTCA Method A Soil Cleanup Levels for Residential areas (1 mg/kg) and that TPH had been successfully bioremediated below the Ecology established cleanup level of 500 mg/kg TPH, analyzed by WTPH-D Extended. After the completion of the project, the NWTPH methods were newly approved by Ecology. Bioremediated soils were additionally sampled and analyzed for TPH by NWTPH-G and NWTPH-Dx. The NWTPH-Dx indicated that heavy residual oil was still present at a maximum concentration of 390 mg/kg, above the 1997 MTCA Method A Soil Cleanup Levels for TPH-D of 200 mg/kg. A study was conducted that indicated that human health contact toxicity levels and soil to groundwater levels were acceptable based on the TPH concentrations. The study followed the *Interim Interpretative and Policy Statement Cleanup of Total Petroleum Hydrocarbons* (Ecology 1997). Additional information regarding the Area 2, Hydraulic Oil Lagoons, can be found in Appendix A-6.

2.1.8 Former SPL Storage Area

This section provides a summary of the remedial action performed at the former SPL Storage Area identified on Figure 2-1. Several reports, addendums, and technical memorandums associated with the remedial action at the SPL Storage Area have been completed. Information from these documents is included by reference in this report. A more detailed account of the remedial action at the SPL Storage Area is also provided in the Historical Review Report (Appendix A-7).

The SPL Storage Area is identified on Figure 2-1. Two dangerous wastes are associated aluminum production: spent potlining (SPL) and reclaimed alumina insulation (RAI) materials. SPL material consists primarily of carbon, fluoride, oxides and nitrides, aluminum, and sodium, with minor amounts of calcium, silica, iron, and cyanide. RAI material consists primarily of aluminum oxide.

From initial plant operations up until the early 1950s, SPL was stored on the southeast corner of the SPL Storage Area. SPL material was then temporarily hauled off site until

1973. From 1973 to 1981, a combination of SPL and RAI materials were stored in the same general southeast corner of the SPL Storage Area, forming three waste piles (Ecology 1992a). In 1978, two of the piles were covered with a layer of sand, a 12-mil impermeable liner, and up to an additional 2 feet of clean sand over the liner; the third pile was covered in the same manner in 1981 (Ecology 1992a). After 1981, SPL materials were shipped to off-site hazardous waste disposal areas (Ecology 1992a). In 1981, monitoring wells established near these waste piles identified the presence of cyanide and fluoride in the groundwater (Robinson, Noble, & Carr, Inc. 1981 and 1982). During the early 1980s Robinson, Noble & Carr, Inc. conducted an investigation to determine the nature and extent of contaminants contained within the former SPL piles (Robinson, Noble, & Carr, Inc. 1981 and 1982). Shallow monitoring wells MW-1 through MW-22 were installed near the SPL piles. The investigation focused on the Shallow, Intermediate, and Deep[1] hydrogeologic units and provided a preliminary evaluation of groundwater quality impacts from the SPL piles and a preliminary interpretation of groundwater flow patterns. In 1982, based on the groundwater analysis, Ecology determined that covering the waste piles with an impermeable liner and sand was sufficient to prevent further leaching of cyanide into the groundwater and cyanide levels should diminish (Robinson, Noble, & Carr, Inc. 1982).

In 1986, a preliminary assessment was performed when monitoring data indicated that cyanide levels were not decreasing, but increasing. During that investigation, Hart Crowser installed additional monitoring wells to supplement the wells previously installed by Robinson Noble. Hart Crowser subdivided the Deep unit identified by Robinson Noble into the Deep and Aquifer units. A total of 75 monitoring wells completed in all four hydrogeologic units were used in the RI investigation. The results from the investigation further defined the nature and extent of cyanide-bearing materials contained within the SPL piles and provided the necessary data to support the SPL feasibility study. The preliminary assessment documented cyanide and fluoride impacts on soils and groundwater at the SPL Storage Area.

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[1] The deep zone identified in the Robinson, Noble, & Carr, Inc. report is comprised of the Deep and Aquifer zones identified in subsequent studies and referred to in this RI report.

Alcoa subsequently submitted to Ecology the RI/FS for the SPL Storage Area (Hart Crowser 1987b and 1987c). In 1988, Ecology determined that the three waste piles qualified as hazardous waste and were to be removed from the Site. In 1990, Alcoa agreed to move the waste piles to an appropriate hazardous waste facility and remediate the SPL Storage Area. The Consent Decree for cleanup of the SPL Storage Area was completed in 1992 (Ecology 1992b).

Following completion of the RI, Ecology required Alcoa to establish a quarterly groundwater monitoring program, including monitoring wells and drinking water supply wells. The monitoring program commenced in 1988 and continued until 1992. As part of the remediation process at the SPL Storage Area, chemical analysis has been performed on the waste pile material, soil near the piles, surface water, and groundwater. Three major COPCs were identified during the analysis: cyanide, fluoride, and trichloroethene (TCE). Cyanide and fluoride were found in the waste pile material, soils, and groundwater. TCE was only found in groundwater. Priority pollutant analysis of groundwater identified low concentrations of several other organic chemicals and metals (detected, but not exceeding cleanup levels).

The RI/FS submitted to Ecology in July 1987 identified several alternatives for remedying any threat to human health and the environment caused by SPL and RAI waste materials at the SPL Storage Area. In February 1992, Ecology published a CAP, identifying the following cleanup remedy to be implemented at the SPL Storage Area (Ecology 1992a):

- Removal of approximately 47,500 cy of SPL and RAI materials at the SPL Storage Area
- Transport of these materials for permanent disposal at a Resource Conservation and Recovery Act (RCRA)-permitted hazardous waste disposal site
- Determine levels of fluoride and total cyanide in soils beneath the waste piles
- Cap the area of the surface of the SPL Storage Area where the three waste piles were located with PVC liners followed by a sand cover
- Grade the capped area and surrounding area ensuring that 4 to 6 inches of top soil are in place to support vegetation

- Hydroseed graded area and fence the area where the three waste piles were located
- Continue groundwater monitoring for a minimum of 5 years

The 1992 CAP considered an alternative consisting of source control with groundwater pumping with subsequent treatment but it was not selected as it was determined that treatment of fluoride at the site was impracticable given the low concentrations present in groundwater.

In 1992, remediation of the SPL Storage Area began. Initially, the sand and existing liners were removed from the three waste piles. The clean sand from above the liner was stockpiled separately from the sand below the liner, which was in contact with the SPL and RAI materials. The liner was disposed of off-site as hazardous waste.

Approximately 72,000 tons of material were removed from the SPL Storage Area and properly transported and disposed of off-site at an appropriate facility as hazardous waste (Chemical Waste Management 1992). In June 1992, composite soil samples were collected from the soil beneath the former waste piles. These samples indicated cyanide concentrations up to 491 mg/kg and fluoride concentrations up to 2,500 mg/kg (Chemical Waste Management 1992).

Following collection of the samples, the stockpiled impacted sand was spread over the location of the former waste piles. Additional clean sand was used to establish proper drainage. This sand layer was compacted and graded. A 50-mil high density polyethylene (HDPE) flexible membrane was installed (Chemical Waste Management 1992). In accordance with the CAP, a sand cover and top soil were placed over the HDPE liner, a fence and gates were installed around the perimeter of the cap, and the area was hydroseeded.

In 1996, EPA and Ecology determined that natural attenuation would effectively continue to remediate the SPL Storage Area and no further remediation actions were required on Alcoa's behalf at that time. On September 30, 1996, the Alcoa Vancouver SPL Storage Area was de-listed from the NPL.

The 1992 CD can be reopened if "new information becomes available regarding factors previously unknown to Ecology, including the nature or quantity of hazardous substances at the Site, and Ecology determines that these factors present a previously unknown threat to human health or the environment." The factors known are documented in long list of studies set forth in the CD. The CD can also be reopened if concentrations of total fluoride in groundwater at monitoring wells MW-18D, MW-19D, MW-20D, or MW-21D have increased one order of magnitude over average levels found in those wells from 1986-1990, or in the event of endangerment to human health or the environment.

As discussed below, none of circumstances that would trigger a reopener exist. The waste materials from the NPL Site were removed in the 1990s. The residual affected soil contained beneath the engineered cap is below the current Site-specific soil remediation level for fluoride and meets the current RAOs (discussed in later sections of this document). Fluoride concentrations are either the same or orders of magnitude below the 1986-1990 levels in groundwater (refer to Table 2-2), and fluoride in groundwater is not impacting the Columbia River.

Almost thirty years of groundwater monitoring data related to the NPL Site are available. Quarterly groundwater monitoring has taken place in the area of the former SPL piles since 1982. As part of the 2003 Agreed Order to cap the East Landfill, the Site-wide groundwater monitoring network was updated to ensure that all wells were in compliance with Ecology's modern well installation requirements. The wells designated to serve as conditional point of compliance wells for the NPL Site were among the wells that were abandoned and reinstalled. Table 2-2 summarizes the new nomenclature for wells located along the shoreline down-gradient from the NPL Site. The data show that concentrations of fluoride have markedly decreased as a result of source removal and control, and that concentrations in the deep zone are at or below cleanup levels. Only one well in the intermediate zone (MW-51-I at 8 milligrams per liter [mg/L]) exceeds the 4 mg/L cleanup level.

Table 2-2
Summary of Historical Groundwater Data Down-gradient from the 1992 Consent Decree Site

Old Well Designation	1986-1990 Average Fluoride Concentration (mg/L)	New Well Designation	2003-2007 Average Fluoride Concentration (mg/L)
MW-18-S	2.0	MW-49-S	3.3
MW-18-I	0.9	MW-18-I	0.5
MW-18-D	1.3	MW-49-D	0.5
MW-19-S	2.4	MW-50-S	0.7
MW-19-I	1.1	MW-19-I	0.9
MW-19-D	0.3	MW-50-D	0.4
MW-20-S	236.3	MW-51-S	DRY
MW-20-I	25.8	MW-51-I	8.0
MW-20-D	15.1	MW-51-D	1.0
MW-21-S[1]	15.0	-	-
MW-21-I[1]	2.1	-	-
MW-21-D[1]	13.4	-	-
MW-33-S[1]	6.2	-	-
MW-33-I	5.4	MW-46-I[2]	1.9

Notes:

1. Well cluster MW-21 was permanently abandoned per the 2003 Agreed Order.
2. Quarterly fluoride is not required by the 2003 Agreed Order in the MW-46 wells. The September 2007 data collected as part of the RI is presented.

Ongoing groundwater monitoring was performed quarterly near the waste piles since 1982 to assess cyanide and fluoride levels in the groundwater. The 1992 Consent Decree outlined specific requirements for groundwater monitoring at the SPL Storage Area until the levels of free cyanide and total fluoride in the Intermediate, Deep, and Aquifer Zones drop to or below 0.2 ppm and 4 ppm, respectively (Ecology 1992a). The quarterly monitoring program implemented by Hart Crowser continued until 2002. During that period, Hart Crowser prepared quarterly groundwater monitoring reports for submittal to Ecology (Hart Crowser 2001). In addition, to continue to assess the effectiveness of the remedial actions, a Site Wide Monitoring Plan was submitted to Ecology in 1999 (IT Corporation 1999) and a Groundwater Monitoring Plan was completed in 2001 (IT Corporation 2001b) incorporating revisions to the monitoring program based on the information gathered since 1999. The current groundwater monitoring program conducted by Anchor Environmental, L.L.C. (Anchor), described in Section 2.2., began in 2003.

2.1.9 On-Site Landfills

During the early 1940s, the eastern portion of the Alcoa Site was filled with dredge sands from the Columbia River. On top of the dredge sands, Alcoa established a series of landfills in which a variety of materials were deposited. The wastes deposited in each landfill varied somewhat by location and included one or more of the following materials: miscellaneous solid waste, construction debris, industrial waste, wire, cable, metal piping, alumina, scrap aluminum, carbon bake furnace brick, concrete, brick rubble, granular black material, carbon, plant floor sweepings, drums, pallets, conveyor belts, paper, plastic, and materials containing PAHs and PCBs. A series of investigations, outlined below, characterized the nature and extent of potential contamination in the Northeast Parcel, North Landfill, North 2 Landfill, South Bank Area, and East Landfill.

The remainder of this section provides a brief description of each of the landfill areas with regard to the identified COPCs, along with remedial actions that have been implemented to address these areas. For additional information consult Appendix A-8.

2.1.9.1 Northeast Parcel

The Northeast Parcel is located on the eastern edge of the Site and is north of the East Landfill (Figure 2-1) and is bordered on the north and west by BNSF railways. In the mid 1990s, sampling conducted as part of the TCE RI identified PCB, PAH, metal, and hydrocarbon-bearing materials in North Landfill, North 2 Landfill, and Northeast Parcel. During 1996 and 1997, ICF Kaiser Engineers conducted three investigations of the Northeast Parcel to determine the horizontal limits and the approximate volume of impacted material. The first investigation occurred in February 1996 and indicated that while construction debris extended to depths greater than 7 feet, impacted materials were generally confined to the first 3 feet bgs. The majority of soil samples collected in the Northeast Parcel did not indicate the presence of contaminants. However, composite soil samples collected from the north central part of the Northeast Parcel indicated the presence of PAHs, cyanide, and metals.

A second site investigation occurred in August 1996 and concentrated on the north central portion of the site. Soil samples analyzed from this area contained concentrations of PCBs and carcinogenic PAHs (cPAHs) of up to 161 mg/kg and 562 mg/kg, respectively. These concentrations exceeded the MTCA Method A unrestricted use soil cleanup levels for PCBs (1.0 mg/kg) and cPAHs (0.1 mg/kg). Additional sampling indicated that groundwater had not been impacted and therefore no cleanup standard for groundwater was developed. In February 1997, a third investigation of the Northeast Parcel was conducted by ICF Kaiser Engineers to define the nature and extent of PCB-impacted soil and to provide analytical data to determine disposal requirements for excavated material.

Based on the contaminant levels and approximate volume of impacted material, four remedial alternatives were developed for the Northeast Parcel. All alternatives (except no action) included the excavation of impacted soil and the backfilling of excavated areas with clean material. The alternatives differed as to whether the excavated soil would be disposed of off-site at an appropriate landfill or retained on-site and either stored or bioremediated.

The recommended alternative included excavation of impacted soil and transport to the East Landfill for final disposal or storage for 2 years. Excavated materials that were designated as dangerous waste would be disposed at an off-site facility permitted to receive such materials. Other alternatives were determined to be infeasible given the contaminant concentrations, time frame, and economic considerations. The recommended remedial action also complied with cleanup standards and applicable state and federal regulations, protected human health and the environment, and provided for compliance monitoring.

In 1997, under Ecology Agreed Order DE97 TCI032, the Northeast Parcel was remediated in accordance with MTCA Method A unrestricted use soil cleanup levels. Approximately 5,800 tons of PCB-impacted soil were excavated (Ecology 2003a). The excavated material was segregated into dangerous (472 tons) and non-dangerous (5,330 tons) waste and disposed of at appropriate off-site facilities (ICF Kaiser 1997a). An additional 17,000 cubic yards (cy) of PAH-impacted soil were excavated and moved to a designated area within the East Landfill (ICF Kaiser 1997a). Sampling of the bottom and sidewalls of the excavation determined that the cleanup standards had been met. Clean fill was backfilled into the excavation and the area was compacted, graded for proper surface water drainage, and vegetated. In the East Landfill, the excavated material was also graded to establish proper surface runoff. Six to 12 inches of clean soil (1,800 cy) was placed over the impacted soil and was maintained as a cover (ICF Kaiser 1997a). The cover was sloped to establish drainage, surveyed, and then vegetated. In 2004, the material from the Northeast Parcel was permanently isolated beneath engineered cap installed over the East Landfill. Section 2.1.8.4 provides further discussion of this subject.

2.1.9.2 North and North 2 Landfills

The North and North 2 Landfills are located in the southeast section of the Site. Both landfills are northwest of the East Landfill area and are bordered by the BNSF railway tracks (Figure 2-1). The North 2 Landfill is directly north of the North Landfill. As discussed in Section 2.1.8.4, soil and groundwater sampling was conducted in the vicinity of the Northeast Parcel, East, North, and North 2 Landfill areas during three Hart Crowser investigations from 1991 to 1993 as part of the TCE RI. This work included test pit soil sampling in the North and North 2 landfill areas (Hart Crowser 1992). Although the primary purpose of the RI was to determine the sources of TCE, the sampling also indicated the presence of other contaminants besides TCE in the North and North 2 Landfills.

During 1988 and 1989, Alcoa retained SE/E to conduct a groundwater and soil investigation in the area now termed the North 2 Landfill and the low area on the north side of the North 2 Landfill (Sweet-Edwards/EMCON 1989b). The purpose of the investigation was to determine if PCBs were present in soil and shallow groundwater. Several previously installed monitoring wells were decommissioned due to inadequate annular seals. The investigation found that the Site drinking water supply wells were not impacted by PCBs.

A supplemental study of the landfill sites was also conducted in 1994 (Hart Crowser 1994a). In the mid 1990s two additional soil investigations were conducted by ICF

Kaiser Engineers (1996c and 1997b). These investigations determined that TCE, cPAH, and vinyl chloride were present in the soils of the North Landfill and that PCBs, PAHs, target analyte list (TAL) metals, and vinyl chloride were present in the soils of the North 2 Landfill. Additionally, although the water table was not encountered during these investigations, chlorinated solvents including TCE and PAHs were present in overlying unsaturated groundwater.

The remediation plan for the North and North 2 Landfills was developed in conjunction with the remediation plan for the East Landfill. Eight remedial alternatives including a variety of containment, treatment, excavation, and disposal options were considered. Appendix A-8 includes a more in-depth discussion of the remedial alternatives. As noted above, because the East, North, and North 2 Landfills are located in the same vicinity and the volume of impacted material from the North and North 2 Landfills was relatively small, the recommended remedy included consolidation of impacted material on-site in the East Landfill and construction of an engineered cap to isolate the impacted material.

In April 2004, remediation of the North and North 2 Landfills began. The MTCA industrial site soil cleanup levels for PCBs (10 mg/kg), cPAHs (20 mg/kg), and TCE (0.03 mg/kg) were used. Selected monitoring wells were sealed, vegetation was cleared, and debris was removed. Both landfills were excavated to a layer of brown, in-situ, non-contaminated sand. Immunoassay field screening and verification grab samples conducted by CH2M Hill during excavation were used to define the excavation limits and determine the disposal method of the impacted material. Materials with PCB concentrations above 50 mg/kg were classified as dangerous waste according to Toxic Substances Control Act (TSCA) regulations. These wastes were segregated and disposed of at an off-site permitted facility. Excavated material containing PCBs, cPAHs, and TCE at concentrations above the MTCA Method A industrial site soil cleanup levels but below the TSCA limits was transferred and deposited in the East Landfill. Additional excavation was conducted as determined by the contaminant concentrations of the grab samples. By May 19, 2004, immunoassay screening and grab sampling verified the removal of all PCB, cPAH, and TCE impacted soil in excess of the cleanup standards. In total, approximately 38,000 cy of material was excavated from the North and North 2 Landfills.

On April 29, 2004, grading of the materials deposited in the East Landfill was completed. A 3- to 6-inch-thick layer of sand was spread over the impacted material. Final containment of the materials was achieved by the placement of an engineered cap.

The excavation pits remaining in the North and North 2 Landfills were re-graded, hydroseeded, fertilized, and mulched. These pits will be used for the disposal of impacted Columbia River sediment and a soil cap, or equivalent, will be placed over the entire area. Section 2.2 discusses the groundwater monitoring activities that have been performed since completion of the source control activities. No further remedial action is planned in this area.

2.1.9.3 South Bank Area

The South Bank Area is located on the northern bank of the Columbia River and borders the western edge of the East Landfill (Figure 2-1). The bank consists of loose sands overlying layers of landfill rubble, fine to coarse sands, and native silts and clays. The Clark County Public Utilities (CPU) NPDES non-contact cooling water outfall is centrally located in the South Bank Area.

Shortly after the 1997 construction of a non-contact cooling water discharge pipeline and outfall to the Columbia River, CPU collected sediment from the outfall area in accordance with its NPDES permit requirements. These sediment samples indicated the presence of locally elevated concentrations of PCBs in the immediate vicinity of the outfall (see Section 2.4 for a detailed discussion of the sediment data). Subsequently, Alcoa began a soil and groundwater investigation to determine if the PCBs detected in these sediments were potentially attributable to releases from the East Landfill or from a different source.

In November 1998, ICF Kaiser Engineers collected soil samples from nine borings installed at the bottom of the bank and six borings at the top of the bank. Samples contained PCB concentrations up to 5,182 mg/kg and TPH-Dx concentrations up to 506 mg/kg. These elevated concentrations initiated further investigation to determine the horizontal and vertical limits of the PCB-impacted media and provide a basis for exploring remediation options.

Consequently, in June 1999, a second round of soil and groundwater sampling commenced at the South Bank Area. 114 soil samples were taken from 22 soil borings (IT Group 1999). Concentrations of PCBs and TPH in the soil samples ranged from non-detect to 752 ppm and from non-detect to 731 ppm, respectively (IT Group 1999). Soil sampling also indicated the presence of TPH and PCBs at depths from 2 to 14 feet below ground surface (Ecology 2003a). However, groundwater samples collected from monitoring wells in the vicinity did not detect PCBs (Ecology 2003a). The test borings were used to characterize the nature and extent of PCB-impacted soil and revealed that approximately 2,500 cy of PCB-impacted soil were located in the South Bank Area (Ecology 2003a). The sampling also identified a local "hot-spot" of sediment PCBs near the CPU NPDES outfall and revealed that the East Landfill area was not a significant source of PCBs to the South Bank Area or Columbia River sediments.

Subsequent soil borings identified eight areas of potential PCB concern within the South Bank Area. On October 8, 2003, remediation of these areas was initiated to achieve MTCA Method A industrial site soil cleanup levels. In each area, vegetation was cleared, debris was removed, and safety fences were installed. As excavation occurred, immunoassay field screening for PCBs and PAHs was used to refine the excavation limits and determine whether impacted material exceeded PCB concentrations of 50 mg/kg. Material exceeding this PCB level was classified as TSCA waste and was segregated and disposed of independently at an approved off-site facility. A total of approximately 1,270 cy of impacted material was excavated from the South Bank Area (Bergmann 2006). After the excavation activities, additional grab samples were collected by CH2M Hill to verify that cleanup standards had been met and that all impacted material had been removed. The locations and concentrations of the verification samples are shown in Appendix A-8. Impacted material below the TSCA limit was excavated and transported to a temporary location in the northeast corner of the East Landfill. This impacted soil was isolated as part of the East Landfill engineered cap.

2.1.9.4 East Landfill

The East Landfill is located in the southeast corner of the Site and is bordered on the south by the Columbia River (Figure 2-1). During the 1987 SPL Storage Area RI conducted by Hart Crowser (Subsection 2.1.7), TCE was detected in a groundwater sample collected from a plant water supply well. Further testing detected TCE in other plant supply wells and monitoring wells. Subsequently, in 1990 Ecology issued an Agreed Order (DE90-I053; Ecology 1990) to conduct an RI with the purpose of determining the sources of TCE. Hart Crowser prepared a Remedial Investigation work plan to assess the extent of TCE in soil and groundwater, based on laboratory analysis of soil from test pits and groundwater samples from wells. As part of the TCE RI, Hart Crowser conducted three investigations on behalf of Alcoa from 1991 to 1993. These investigations characterized the horizontal and vertical extent of TCE-impacted media through the installation of additional monitoring wells, excavation of test pits, advancement of borings, and collection of groundwater and soil samples in the North, North 2, Northeast Parcel, and East Landfills. The groundwater and soil sampling indicated the presence of other contaminants besides TCE in each of these areas, as described below. An additional supplemental study of the landfill sites was also conducted in 1994 (Hart Crowser 1994a).

Soil samples collected from the East Landfill indicated the presence of COPCs including lead, cyanide, fluoride, PCBs, TPH, VOCs (primarily TCE), and SVOCs (mainly PAHs, including cPAHs). Groundwater samples also identified VOCs (primarily TCE) and SVOCs. Concentrations of TCE and cPAHs exceeded MTCA Method A industrial site soil cleanup levels and the MTCA Method A groundwater cleanup levels within the footprint of the landfill.

The RI concluded that the East Landfill contained approximately 150,000 cy of waste materials and that an estimated 57,000 cy of this material likely exceeded the then current MTCA industrial site soil cleanup levels for TCE (0.03 mg/kg), cPAHs (20 mg/kg), and PCBs (10 mg/kg) (Ecology 2003a). In 1994, Alcoa completed a FS to develop and examine remediation options for the East and North Landfills (Hart Crowser 1994b). The remediation alternatives included a variety of containment, excavation, disposal, and long term monitoring actions, and are presented in full in Appendix A-8. Because the East, North, and North 2 Landfills are located in the same vicinity and the volume of impacted material from the North and North 2 Landfills was relatively small, the recommended remedy included consolidation and containment of impacted materials on-site in the East Landfill by constructing an engineered cap to isolate the impacted material. The recommended alternative protects human health and the environment through effective containment and management of impacted materials and landfill areas. The recommended remedy effectively addresses risks associated with potential contaminant releases to groundwater and surface waters, and direct contact with impacted materials.

In 1997, prior to the consolidation of the materials from the North, North 2, and East Landfills, approximately 17,000 cy of PAH-impacted material from the Northeast Parcel remediation was placed in the East Landfill under Ecology Agreed Order DE TC-I032 (Ecology 2003a; Section 2.1.8.1 contains additional information on the Northeast Parcel). In 2003, Ecology issued AO DE 03 TCPIS-5737 directing remedial action. The 2003 remedial action consisted of consolidating the waste from the three landfill areas (East Landfill, North Landfill and North 2 Landfill) and the South Bank into the East Landfill; capping the East Landfill with a RCRA Subpart C dangerous waste double lined cover; executing stabilization and protection measures on the river bank, conducting ground water and engineered cap monitoring, and preserving the North and North 2 Landfill areas for disposal of sediments from the future river remedial action.

During October 2003, a pre-cast concrete revetment structure was constructed to stabilize the shoreline adjacent to the East Landfill. In April 2004, under Ecology Agreed Order DE 03 TCPIS-5737, remediation of the East Landfill began. Alcoa excavated and moved impacted materials from the South Bank Area, North, and North 2 Landfills to the East Landfill. An engineered cap designed in accordance with RCRA requirements was placed over the East Landfill, thus isolating the impacted materials from the Northeast Parcel, South Bank Area, North, North 2, and East Landfills. The multi-layer impermeable cap consisted of a geosynthetic clay layer covered with a 60-mil thick textured HDPE geomembrane, a synthetic drainage net, an 18-inch layer of compacted fill soil, a 6-inch layer of soil, and vegetation (Bergmann 2006). During construction of the engineered cap at the East Landfill, erosion along the base of the shoreline revetment was observed. A riprap toe was designed and constructed (October 2006) to prevent additional erosion.

The East Landfill remedial action was considered to be an interim action because the upland source control work and elimination of exposure to landfill waste materials could be completed more quickly than the sediment cleanup could be developed and implemented, but at the same time the North and North 2 Landfills were recognized as the intended disposal site for dredged sediments. Performing the encapsulation of the East Landfill waste above Site-groundwater and isolating the waste from infiltration under the Agreed Order prior to final Site-wide closure, accelerated the degradation of TCE-impacted groundwater. Monitoring data was also required to verify that source control activities were effective and that natural attenuation of residual TCE in groundwater would occur.

Since completion of the source control activities, concentrations of TCE in groundwater beneath the East Landfill have significantly reduced and is monitored via 16 monitoring wells maintained as part of the East Landfill monitoring program (Bergmann 2006). Ongoing monitoring of these wells is discussed further in Section 2.2.

2.2 Ongoing Groundwater Monitoring

In 2003, Alcoa entered into Agreed Order DE 03 TCPIS-5737 with Ecology. This Agreed Order required the implementation of a groundwater monitoring plan that was developed for the Site (IT Corporation 2001b). This plan required the abandonment of 75 monitoring wells, the installation of 22 new monitoring wells, and quarterly monitoring of the newly created 41 well network. This network of wells also satisfies the requirements of the 1992 Consent Decree for the monitoring of the SPL Storage Area. The well decommissioning and installation work was completed between August and November 2003, and is detailed within Anchor 2004.

In November 2003, Anchor conducted the first round of sample collection from the wells in the Alcoa well network per the requirements of the Groundwater Monitoring Plan (GMP). The GMP lists specific testing requirements that were selected for each well location based on previously identified AOCs, which includes testing for PAHs, PCBs, VOCs, free cyanide, fluoride, total organic carbon, and/or total organic halides. Table 2-3 provides the specific testing requirements at each well, and the required testing frequencies. A monitoring report which includes tabular reporting of testing results, time-series concentration plots, and event-specific procedures is prepared upon completion of each quarter's sampling event. The data collected to date under the GMP from 2003 to May 2007 is found in the Quarterly Report in Appendix A-9. These data continue to show compliance with the requirements of the 1992 Consent Decree for the SPL Storage Area (as discussed in Section 2.1.8) and also demonstrate that concentrations of PAHs and PCBs in groundwater are below non-Site-specific, MTCA Method A cleanup levels. The remainder of this section discusses the reductions of VOCs in Site-groundwater observed since the remedial actions completed in 2004.

Review of the TCE and vinyl chloride data collected between 2003 and May 2007 is presented in Figure 2-4. The TCE and vinyl chloride concentrations in groundwater are decreasing across the Site, verifying the positive results of the remedial actions for source removal and control, as described in Sections 2.1.9. The two western monitoring wells, MW-47-A and MW-48-A, were located to monitor the effects of total source removal activities conducted at North and North 2 Landfills. Data from both wells show a continual decrease in TCE since 2003 and have been observed below the Washington State primary maximum contaminant level (MCL) since mid-2004. The TCE degradation product, vinyl chloride, also had an overall decrease in concentration in the groundwater since 2003, but a slight increase during the middle of the monitoring period was observed, due to the degradation of TCE.

At the East Landfill, TCE concentrations in groundwater in the intermediate zone have dropped by approximately 85% since 2001, and several wells are now in compliance with groundwater cleanup levels. Maximum concentrations of TCE have dropped from 4,200 micrograms per liter (µg/L) to 620 µg/L in the intermediate zone and from 2,400 µg/L to 7.2 µg/L in the deep zone. Review of the monitoring data for TCE at the remaining monitoring wells, MW 35-I, MW 35-D, MW 94-1-I, MW 94-1-D, MW 94-1-A, MW 94-2-I, and MW 94-2-D, reveals significant decreases in TCE concentrations in the groundwater at each well. The most significant decrease in the past 4 years was in MW 94-1-I, with a reduction of over 500 µg/L. It should be noted that, prior to the source removal and control described in Section 2.1.9, TCE was detected in MW 94-1-I at 4,200 µg/L indicating a decrease in TCE concentrations of approximately 3,600 µg/L since the construction of the East Landfill engineered cap. Review of the monitoring data for vinyl chloride in the same wells reveals a general downward trend in concentration; however, as vinyl chloride is a degradation product of TCE, some increases during the monitoring time period have occurred. Vinyl chloride concentrations will continue to fluctuate as the degradation process continues.

The five years of groundwater monitoring data collected since the completion of the East Landfill source control measures demonstrate:

- that the East landfill waste is no longer a source of contamination to groundwater,
- that through natural attenuation the concentrations and mass of TCE in groundwater have been dramatically reduced, and
- that the remaining TCE dissolved in groundwater is degrading naturally.

Table 2-3
Groundwater Monitoring Well List and Monitoring Schedule[1]

		Analytical Frequency			
Well Identification	**Zone**	**CN/FL**	**TOX/TOC**	**PAHs/PCBs**	**VOCs**
SPL Storage Area					
MW-52	S	Annual	-	-	-
MW-8	I	Annual	-	-	-
MW-8	D	Annual	-	-	-
MW-8	A	Annual	-	-	-
MW-30	S	Annual	-	-	-
MW-30	I	Annual	-	-	-
MW-30	D	Annual	-	-	-
MW-49	S	Annual	Quarterly	-	-
MW-18	I	Annual	Quarterly	-	-
MW-49	D	Annual	Quarterly	-	-
MW-18	A	Annual	Quarterly	-	-
MW-50	S	Annual	Quarterly	-	-
MW-19	I	Annual	Quarterly	-	-
MW-50	D	Annual	Quarterly	-	-
MW-50	A	Annual	Quarterly	-	-
MW-51	S	Annual	Quarterly	-	-
MW-51	I	Annual	Quarterly	-	-
MW-51	D	Annual	Quarterly	-	-
MW-51	A	Annual	Quarterly	-	-
North and North 2 Landfill Area					
MW-47	I	-	-	Annual	Quarterly
MW-47	D	-	-	Annual	Quarterly
MW-47	A	-	-	Annual	Quarterly
MW-48	I	-	-	Annual	Quarterly
MW-48	D	-	-	Annual	Quarterly
MW-48	A	-	-	Annual	Quarterly
East Landfill Area					
MW-35	S	-	-	Annual	Quarterly
MW-35	I	-	-	Annual	Quarterly
MW-35	D	-	-	Annual	Quarterly
MW-35	A	-	-	Annual	Quarterly
MW-41	S	-	-	Annual	Quarterly
MW-41	I	-	-	Annual	Quarterly
MW-41	D	-	-	Annual	Quarterly
MW-46	I	-	-	Annual	Quarterly
MW-46	D	-	-	Annual	Quarterly
MW-46	A	-	-	Annual	Quarterly
MW-94-1	I	-	-	Annual	Quarterly
MW-94-1	D	-	-	Annual	Quarterly
MW-94-1	A	-	-	Annual	Quarterly
MW-94-2	I	-	-	Annual	Quarterly
MW-94-2	D	-	-	Annual	Quarterly
MW-94-2	A	-	-	Annual	Quarterly
TOTALS	**41**	**19**	**12**	**22**	**22**

Notes:

"Annual" event scheduled for second month of fourth quarter each year

"Quarterly" event scheduled for second month of each quarter each year

[1] based on *Groundwater Monitoring Plan, Alcoa Inc., Former Vancouver Operations,* IT Corporation, July 2001

CN/FL = cyanide and fluoride

TOX/TOC = total organic halides/total organic carbon

PAHs/PCBs = polycyclic aromatic hydrocarbons/polychlorinated biphenyls

VOCs = volatile organic compounds

S = Shallow D = Deep

I = Intermediate A = Aquifer

2.3 Crowley Parcel

The Crowley Parcel is located on the northern bank of the Columbia River to the west of the former Alcoa smelter facility (Figure 2-1). Prior to 1976, Pacific Inland Navigation operated the area as a barge maintenance and cleaning facility. In 1976, Crowley Marine Lines (also known as Columbia Marine Lines and Puget Sound Tug and Barge Company) acquired the operations.

From 1964 to 1983, water and waste materials from the barge maintenance and cleaning operation were deposited in a series of three excavated pits (Ecology 1985). These excavation pits, termed the barge waste disposal area, were approximately 300 to 400 feet north of the Columbia River (GeoEngineers 1983). Historical aerial photographs indicate that the southern pit operated from 1964 to approximately 1966-1968, the western pit operated from 1966-1668 to 1969-1971, and the eastern pit operated from 1969-1971 to 1983 (SLR 2007; GeoEngineers 1985; GeoEngineers 1983). Each pit was backfilled reasonably soon after closure. Prior to backfilling the eastern pit, in January 1984, all liquids were removed (GeoEngineers 1985).

Over the course of operations, over 2 million gallons of waste materials were deposited in the barge waste disposal area (Crowley Marine Lines 1984). These waste materials consisted of barge slops, bilge slops, and water from gas freeing operations. Because the waste materials contained dilute petroleum hydrocarbon fuel products, the COPCs for the Crowley Parcel included PAHs, TPH-G, TPH-oil, TPH-D, and BTEX (SECOR 1996). Contamination from the barge waste disposal area impacted the soil and groundwater at the rest of the facility.

In 1983, the first of three hydrogeologic studies was conducted to obtain an evaluation of subsurface soil and groundwater conditions. In August 1984, Columbia Marine Lines informed Ecology of the closure and past uses of the former barge waste disposal area. Monitoring wells MW-1 through MW-21 were installed near the waste disposal site in 1985 by Crowley Marine Services Corp (GeoEngineers 1986).

Subsequently, in 1985, the second hydrogeologic investigation was conducted to further define the extent and characteristics of the contamination in the vicinity of the former barge waste disposal area. Free hydrocarbons or LNAPL petroleum hydrocarbons were observed on the water surface of the wells near the disposal site.

In April 1985, as part of the second hydrogeologic investigation, GeoEngineers recommended installation of a floating hydrocarbon recovery system. This system was installed in July 1985 and consisted of a hydrocarbon recovery well, trench, submersible pump, and wick-type hydrocarbon recovery unit. As needed, free hydrocarbons were also collected from the water surfaces of the monitoring wells using a vacuum truck.

In response to the notification of the past practices at the barge waste disposal area, Ecology issued an Agreed Order (No. DE 85-591) in August 1985. The Agreed Order stipulated that an effective hydrocarbon recovery system be installed (previously completed) and the horizontal and vertical extent of the contamination be determined. Additionally, under the Agreed Order, an oil-water separator was installed in the hydrocarbon recovery system and the third phase of the hydrogeologic study was completed (1986).

Over the course of the three phase hydrogeologic evaluation, monitoring wells CMW-1 through CMW-21 were installed near the waste disposal site. With the addition of the hydrocarbon recovery system, the amount of LNAPL in each of the monitoring wells appeared to decrease over time. The hydrocarbon recovery system was operated until 1995 when observations indicated that it could not recover additional free hydrocarbons.

On behalf of Crowley Marine Services, SECOR International Incorporated (SECOR) conducted site investigations to support development of a cleanup action plan. This work included aquifer testing and groundwater quality testing to evaluate potential groundwater cleanup alternatives. The FS recommended in-situ cleanup using enhanced natural bioremediation (SECOR 1996).

SECOR subsequently conducted additional subsurface investigation at the site in 1999. The work scope included GeoProbe soil borings to collect soil samples, installation of temporary well points for groundwater and hydrologic monitoring, and laboratory testing. The work provided additional definition of the nature and extent of diesel in soil and groundwater (SECOR 1999).

In February 2000, SECOR conducted pilot tests of a dual phase vacuum extraction and bioventing system, an in-situ bioremediation technique. Testing indicated that this method increased oxygen in the soil and expedited the decomposition of petroleum hydrocarbons by indigenous microorganisms. Additionally, the pilot test provided important parameters for designing a full scale system.

During the summer of 2000, SECOR evaluated in-situ bioventing and the excavation and treatment of impacted soils as remedial actions for the site. Based on encouraging pilot test results, dual phase extraction process was chosen to be implemented. The dual phase extraction system was operated from November 2000 through February 2003 and from December 2004 through December 2005. Approximately 200 pounds of liquid phase hydrocarbons and 1,100 pounds of vapor phase hydrocarbons were extracted by this system (Columbia Marine Lines 2007).

Subsequently, infrequent groundwater and soil sampling were conducted until 2007. The most recent round of sampling was conducted in August 2007 by SLR International Corporation. Groundwater samples were collected from monitoring and extraction wells and sampled for TPH, BTEX, SVOCs, PAHs, and VOCs. Soil samples were collected from a series of Geoprobe borings and also sampled for TPH, BTEX, PAHs, VOCs, and SVOCs.

The 2007 sampling event indicated that TPH-Gx, TPH-Dx diesel, TPH-Dx heavy oil, PAHs and VOCs continue to be COPCs for both the soil and groundwater. In particular, elevated levels of TPH-Dx diesel will need to be addressed. Future remediation activities are anticipated at the Site. Additional information regarding the Crowley Parcel can be found in Appendix B.

2.4 Sediment Investigations

As discussed in Section 2.1.8.3, in late February 1997, CPU initiated construction of a submerged 12-inch-diameter outfall pipeline that discharges into the Columbia River at RM 103.3 (Figure 2-1). Installation of the outfall pipe required the excavation of subsurface soils and shallow nearshore sediments to the west of the Alcoa East Landfill. Upon completion of the outfall pipeline installation in May 1997, CPU collected three baseline sediment samples in the vicinity of the outfall discharge (Vlastelicia 1997). Each sample was analyzed for the full suite of Sediment Management Standards (SMS; Chapter 173-240 WAC) chemicals (Ecology 1995c). Total PCBs were the only chemical parameter to exceed chemical screening criteria based on marine sediment quality standards (SQS), with concentrations ranging from 3 to 6 mg/kg (dry weight basis). In contrast, sediment investigations conducted in the area prior to the construction of the outfall pipeline did not identify elevated concentrations of PCBs in sediments (Tetra Tech 1993: USACE 1999).

At the request of the Washington State Department of Natural Resources (DNR) and Ecology, soil and groundwater investigations were conducted in 1998 and 1999 at the southern bank of the East Landfill to determine whether the elevated PCB concentrations in sediments adjacent to the CPU outfall were a result of an ongoing source. The results of these upland investigations are summarized in Section 2.1.8.3 above, and identified an area of elevated PCB concentrations in soils west of the landfill and a "hot-spot" near the CPU outfall. These data revealed that disturbance of these upland landfill soils during construction of the outfall line was the source of PCBs detected in Columbia River sediments.

The remainder of this section summarizes scope and results of the in-water sampling performed to characterize the nature and extent of the PCB release caused by the installation of the CPU outfall. The section also discusses work performed by others, such as the U.S. Army Corps of Engineers (USACE) river-wide clam characterization efforts, and the results of an Ecology-guided ecological risk assessment. Supporting documentation, including copies of original data reports, has been provided in Appendix C.

2.4.1 Sediment Sampling

At Ecology's request, Phase 1 sediment sampling was conducted in November and December 1999 by Windward Environmental (Windward 2000) to characterize the nature and extent of PCBs in sediments upstream, downstream, and in the immediate vicinity of the CPU outfall. A total of 34 stations were sampled and analyzed for total PCBs, total organic carbon, percent solids, and apparent grain size (Figure 2-5, 2-6, and 2-7). Results for PCBs are shown in Table 2-4. Two transects were positioned upstream of the CPU outfall to assess baseline sediment concentrations, two transects were positioned immediately upstream of the CPU outfall, and three transects were positioned downstream of the CPU outfall. PCB concentrations upstream of the CPU outfall were at or near the detection limit, whereas PCB concentrations immediately downstream of the CPU outfall were greater than 0.35 mg/kg. The highest concentrations of PCBs were located closest to the CPU outfall pipeline between the shoreline and the river shipping channel. Total PCB concentrations up to 28 mg/kg were detected immediately adjacent to the CPU outfall. A data report was submitted to Ecology in March 2000 (Windward 2000) and is provided in Appendix C.

Phase 2 of the sediment sampling program was implemented to further refine the nature and extent of PCBs in surface and subsurface sediments adjacent to the CPU outfall. Phase 2 sediment sampling was conducted during two separate events. During the first event on August 15, 2000, 30 surface sediment samples were collected from 12 transect lines extending from the shoreline toward the Columbia River shipping channel (Figure 2-5, 2-6, and 2-7). The transects were located on either side of the CPU outfall, beginning 700 feet upstream and continuing approximately 800 feet downstream of the outfall. A second sampling event was conducted from November 12 to 18, 2000, to collect additional surface sediment samples and subsurface samples. Surface sediment samples were collected from 26 additional stations downstream of the stations sampled during the first event and along transects located 900 to 2,500 feet downstream of the CPU outfall. Subsurface sediment samples were collected from 24 subtidal and three intertidal stations. One to two cores were collected from each of the 14 transects located 200 to 700 feet downstream of the CPU outfall (Figure 2-5, 2-6, and 2-7).

The Phase 1 and 2 sampling data revealed that the highest PCBs concentrations in surface sediments at the Site, up to 25 mg/kg, were located immediately adjacent to the CPU outfall. Elevated surface sediment PCB concentrations (to 9.2 mg/kg) were detected near the shoreline at transects up to 1,200 feet downstream of the CPU outfall. Sediment samples collected from transects further downstream had much lower PCB concentrations that were similar to PCB concentrations 300 to 700 feet upstream of the CPU outfall. The PCB results for surface sediments are presented in Table 2-5.

In areas removed from the CPU outfall, PCB concentrations in subsurface sediments were generally much lower than the corresponding concentrations in surface sediments. However, subsurface PCB concentrations in a sediment core collected immediately adjacent to the CPU outfall were as high as 300 mg/kg, compared to 25 mg/kg measured during Phase 1 at the nearby surface sediment station. PCB concentrations in subsurface sediments from areas outside the immediate vicinity of the CPU outfall were less than 0.50 mg/kg; most were less than 0.10 mg/kg. These results are consistent with the conceptual site model of PCB releases associated with the 1997 CPU outfall construction, and specifically from the mixing of impacted riverbank soils with nearshore sediment during this construction event.

Six subsurface sediment samples were collected on the beach at low tide at transects located 300, 500, and 700 feet upstream of the CPU outfall. These intertidal stations are located downgradient from the East Landfill. PCB concentrations in all samples were less than 0.10 mg/kg. The PCB results for subsurface sediments are shown in Table 2-6. These results suggest that the PCBs detected in nearshore sediments upstream of the CPU outfall are not derived from the East Landfill. Overall, the highest concentrations of PCBs in surface sediments measured in both the Phase 1 and Phase 2 sampling events were located in a limited area surrounding the CPU outfall. A data report was submitted to Ecology in March 2001 (Windward 2001) and is provided in Appendix C.

The conceptual site model of PCB releases to sediments downstream (and to a limited degree, upstream) of the CPU outfall is that localized migration of the PCBs has occurred in the vicinity of the CPU outfall beginning with the construction event due to nearshore hydrodynamic processes in the Columbia River. The sediment RI data also reveal that the only source of contaminant releases to sediments at the Site is related to the 1997 excavation around the CPU outfall pipe. As discussed in Section 2.1.8.3, this source is now controlled.

As part of a river-wide characterization effort, the USACE conducted sampling in June 2001 of the Federal channel and adjacent bed of the Columbia River. This study further confirmed the limits of PCB-impacted sediment defined by the 1999 and 2000 investigations. A total of 25 samples (24 surface grab samples and 1 core) were collected from the north side of the federal navigation channel and the adjacent nearshore area at Columbia River RM 103. In the six grab samples collected nearest to shore, PCB Aroclor 1248 was detected at levels that exceeded the 0.13 mg/kg screening level in the Dredged Material Evaluation Framework (DMEF) for total PCBs. All samples with PCB detections above the DMEF screening levels were located outside of the federal channel. A complete report for the June 2001 USACE sampling is provided in Appendix C.

Table 2-4
Surface Sediment Sampling Results from 2000 Windward Investigation

Sample Number	Aroclor 1016		Aroclor 1242		Aroclor 1248		Aroclor 1254		Aroclor 1260		Aroclor 1221		Aroclor 1232		Total PCBs	
-300 feet transect																
ES-SS-10-30	18	U	18	U	**360**		18	U	18	U	36	U	18	U	**360**	
ES-SS-10-34	18	U	18	U	**340**		18	U	18	U	35	U	18	U	**340**	
ES-SS-06-17	28	U	28	U	**1,500**		28	U	28	U	35	U	28	U	**1,500**	
ES-SS-06-18	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.5	U	2.7	U	5.5	U
ES-SS-06-19	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.5	U	2.7	U	5.5	U
ES-SS-06-20	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.5	U	2.7	U	5.5	U
-150 feet transect																
ES-SS-10-31	74	U	74	U	**1,500**		74	U	74	U	150	U	74	U	**1,500**	
ES-SS-10-35	180	U	180	U	**4,300**		180	U	180	U	360	U	180	U	**4,300**	
ES-SS-06-09	2.7	U	2.7	U	**5.7**		2.7	U	2.7	U	5.4	U	2.7	U	**5.7**	
ES-SS-06-10	2.8	U	2.8	U	**3.0**		2.8	U	2.8	U	5.6	U	2.8	U	**3.0**	
ES-SS-06-11	2.8	U	2.8	U	**2.3**	**J**	2.8	U	2.8	U	5.6	U	2.8	U	**2.3**	**J**
ES-SS-06-12	2.8	U	2.8	U	**3.4**		2.8	U	2.8	U	5.5	U	2.8	U	**3.4**	
ES-SS-06-29	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.5	U	2.8	U	5.5	U
-50 feet transect																
ES-SS-10-32	1,900	U	1,900	U	**25,000**		1,900	U	1,900	U	3,700	U	1,900	U	**25,000**	
ES-SS-10-33	180	U	180	U	**2,400**		180	U	180	U	370	U	180	U	**2,400**	
ES-SS-06-01	55	U	55	U	**880**		55	U	55	U	110	U	55	U	**880**	
ES-SS-06-02	2.8	U	2.8	U	**3.7**		2.8	U	2.8	U	5.6	U	2.8	U	**3.7**	
ES-SS-06-03	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.5	U	2.8	U	5.5	U
ES-SS-06-04	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.5	U	2.8	U	5.5	U
+50 feet transect																
ES-SS-10-05	370	U	370	U	**5,000**		370	U	370	U	740	U	370	U	**5,000**	
ES-SS-10-06	1,000	U	1,000	U	**28,000**		1,000	U	1,000	U	2,100	U	1,000	U	**28,000**	
ES-SS-10-07	1,000	U	1,000	U	**9,000**		1,000	U	1,000	U	2,000	U	1,000	U	**9,000**	
ES-SS-10-08	18	U	18	U	**12**	**J**	18	U	18	U	35	U	18	U	**12**	**J**
+150 feet transect																
ES-SS-10-13	170	U	170	U	**2,100**		170	U	170	U	350	U	170	U	**2,100**	
ES-SS-10-14	70	U	70	U	**1,300**		70	U	70	U	140	U	70	U	**1,300**	
ES-SS-10-15	39	U	39	U	**720**		39	U	39	U	79	U	39	U	**720**	
ES-SS-10-16	11	U	11	U	**150**		11	U	11	U	22	U	11	U	**150**	
+1,000 feet transect																
ES-SS-10-21	2.8	U	2.8	U	**26**		2.8	U	2.8	U	5.5	U	2.8	U	**26**	
ES-SS-10-22	2.8	U	2.8	U	**27**		2.8	U	2.8	U	5.6	U	2.8	U	**27**	
ES-SS-10-23	2.8	U	2.8	U	**15**		2.8	U	2.8	U	5.6	U	2.8	U	**15**	
ES-SS-10-24	2.8	U	2.8	U	**21**		2.8	U	2.8	U	5.6	U	2.8	U	**21**	
+2,000 feet transect																
ES-SS-06-25	2.7	U	2.7	U	**10**		2.7	U	2.7	U	5.5	U	2.7	U	**10**	
ES-SS-06-26	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.6	U	2.8	U	5.6	U
ES-SS-06-27	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.5	U	2.8	U	5.5	U
ES-SS-06-28	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.7	U	2.8	U	5.7	U

Notes:

Total PCBs were calculated by summing all detected Aroclors. For samples with no reported detections, the highest reporting limit is given instead.

Detected values are shown in bold.

All units are in µg/kg dry weight.

J = detected at a concentration below reporting limit

PCBs = polychlorinated biphenyls

U = not detected above the laboratory reporting limit indicated

Table 2-5
Surface Sediment Sampling Results from 2001 Windward Investigation

Sample Designation	Aroclor 1016		Aroclor 1242		Aroclor 1248		Aroclor 1254		Aroclor 1260		Aroclor 1221		Aroclor 1232		Total PCBs	
+700 ft transect																
WW-SS-10-01	42	U	42	U	**510**		42	U	42	U	84000	U	42	U	**510**	
WW-SS-10-02	2.9	U	2.9	U	**6.7**		2.9	U	2.9	U	5.7	U	2.9	U	**6.7**	
WW-SS-10-03	2.7	U	2.7	U	**1.4**	J1	2.7	U	2.7	U	5.5	U	2.7	U	**1.4**	**J1**
WW-SS-10-04	2.8	U	2.8	U	**3**		2.8	U	2.8	U	5.6	U	2.8	U	**3**	
+500 ft transect																
WW-SS-10-05	2.8	U	2.8	U	**40**		2.8	U	2.8	U	5.7	U	2.8	U	**40**	
WW-SS-10-06	2.8	U	2.8	U	**4.9**		2.8	U	**3.3**		5.6	U	2.8	U	**8.2**	
WW-SS-10-07	2.8	U	2.8	U	**4.4**		2.8	U	2.8	U	5.6	U	2.8	U	**4.4**	
WW-SS-10-08	2.9	U	2.9	U	**1.8**	J1	2.9	U	2.9	U	5.7	U	2.9	U	**1.8**	**J1**
+300 ft transect																
WW-SS-10-09	2.7	U	2.7	U	**260**		2.7	U	2.7	U	5.4	U	2.7	U	**260**	
WW-SS-10-10	2.8	U	2.8	U	**16**		2.8	U	2.8	U	5.7	U	2.8	U	**16**	
WW-SS-10-11	2.8	U	2.8	U	**5.5**		2.8	U	2.8	U	5.5	U	2.8	U	**5.5**	
WW-SS-10-12	2.7	U	2.7	U	**18**		2.7	U	2.7	U	5.4	U	2.7	U	**18**	
+50 ft transect																
WW-SS-10-17	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.5	U	2.7	U	5.5	U
-150 ft transect																
WW-SS-10-20	2.8	U	2.8	U	**1,300**		2.8	U	2.8	U	5.6	U	2.8	U	**1,300**	
-300 ft transect																
WW-SS-10-24	2.8	U	2.8	U	**10**		2.8	U	2.8	U	5.6	U	2.8	U	**10**	
-500 ft transect																
WW-SS-10-25	62	U	62	U	**350**		62	U	62	U	120	U	62	U	**350**	
WW-SS-10-26	41	U	41	U	**1,200**		41	U	41	U	82	U	41	U	**1,200**	
WW-SS-10-27	2.8	U	2.8	U	**1,400**		2.8	U	2.8	U	5.6	U	2.8	U	**1,400**	
WW-SS-10-28	2.8	U	2.8	U	**100**		2.8	U	2.8	U	5.5	U	2.8	U	**100**	
-600 ft transect																
WW-SS-10-29	2.8	U	2.8	U	**650**		2.8	U	2.8	U	5.6	U	2.8	U	**650**	
WW-SS-10-30	2.8	U	2.8	U	**310**		2.8	U	2.8	U	5.6	U	2.8	U	**310**	
WW-SS-10-31	2.7	U	2.7	U	**69**		2.7	U	2.7	U	5.5	U	2.7	U	**69**	
WW-SS-10-32	2.7	U	2.7	U	**930**		2.7	U	2.7	U	5.4	U	2.7	U	**930**	
-700 ft transect																
WW-SS-10-34	540	U	540	U	**8,100**		540	U	**1,100**		1100	U	540	U	**9,200**	
WW-SS-10-35	14	U	14	U	**300**	J3	14	U	**25**	J3	28	U	14	U	**325**	**J3**
WW-SS-10-35-dup	27	U	27	U	**500**	J3	27	U	**110**	J3	55	U	27	U	**610**	**J3**
WW-SS-10-36	27	U	27	U	**340**		27	U	**61**		54	U	27	U	**401**	
-800 ft transect																
WW-SS-10-37	57	U	57	U	**780**		57	U	**100**		110	U	57	U	**880**	
WW-SS-10-38	56	U	56	U	**1,700**		56	U	**180**		110	U	56	U	**1,880**	
WW-SS-10-39	11	U	11	U	**430**		11	U	**30**		23	U	11	U	**460**	
WW-SS-10-40	2.8	U	2.8	U	**74**		2.8	U	**6.4**		5.6	U	2.8	U	**80.4**	
WW-SS-10-40-dup	2.8	U	2.8	U	**100**		2.8	U	**8.8**		5.7	U	2.8	U	**108.8**	
-900 ft transect																
WW-SS-41-10	44	U	44	U	**1,400**		44	U	**200**		88	U	44	U	**1,600**	
WW-SS-42-10	2.8	U	2.8	U	**340**		2.8	U	**32**		5.7	U	2.8	U	**372**	
WW-SS-43-10	2.8	U	2.8	U	**44**		2.8	U	**11**		5.5	U	2.8	U	**55**	
WW-SS-44-10	2.7	U	2.7	U	**170**		2.7	U	**15**		5.5	U	2.7	U	**185**	
-1,000 ft transect																
WW-SS-45-10	43	U	43	U	**2,100**		43	U	**340**		86	U	43	U	**2,440**	

Table 2-5
Surface Sediment Sampling Results from 2001 Windward Investigation

Sample Designation	Aroclor 1016		Aroclor 1242		Aroclor 1248		Aroclor 1254		Aroclor 1260		Aroclor 1221		Aroclor 1232		Total PCBs	
WW-SS-46-10	2.8	U	2.8	U	**1,700**		2.8	U	**98**		5.6	U	2.8	U	**1,798**	
WW-SS-47-10	2.8	U	2.8	U	**820**		2.8	U	**44**		5.6	U	2.8	U	**864**	
WW-SS-48-10	14	U	14	U	**320**		14	U	76	U	28	U	14	U	**320**	
-1,100 ft transect																
WW-SS-49-10	44	U	44	U	**5,900**		44	U	**480**		88	U	44	U	**6,380**	
WW-SS-50-10	43	U	43	U	**1,500**		43	U	**200**		86	U	43	U	**1,700**	
WW-SS-51-10	2.7	U	2.7	U	**220**		2.7	U	**18**		5.4	U	2.7	U	**238**	
WW-SS-52-10	2.7	U	2.7	U	**200**		2.7	U	**19**		5.5	U	2.7	U	**219**	
-1,200 ft transect																
WW-SS-53-10	43	U	43	U	**2,000**		43	U	**280**		86	U	43	U	**2,280**	
WW-SS-54-10	42	U	42	U	**720**		42	U	**82**		83	U	42	U	**802**	
WW-SS-55-10	2.8	U	2.8	U	**350**		2.8	U	**22**		5.6	U	2.8	U	**377**	
WW-SS-56-10	2.8	U	2.8	U	**220**		2.8	U	**11**		5.7	U	2.8	U	**231**	
-1,450 ft transect																
WW-SS-57-10	40	U	40	U	**510**		40	U	**49**		81	U	40	U	**559**	
WW-SS-58-10	2.7	U	2.7	U	**14**		2.7	U	2.7	U	5.4	U	2.7	U	**14**	
WW-SS-59-10	2.7	U	2.7	U	**110**		2.7	U	**24**		5.5	U	2.7	U	**134**	
-2,000 ft transect																
WW-SS-60-10	2.7	U	2.7	U	**130**		2.7	U	**14**		5.5	U	2.7	U	**144**	
WW-SS-60-10-dup	2.8	U	2.8	U	**170**		2.8	U	**20**		5.5	U	2.8	U	**190**	
WW-SS-61-10	2.8	U	2.8	U	**290**		2.8	U	**32**		5.6	U	2.8	U	**322**	
WW-SS-62-10	2.7	U	2.7	U	**77**		100	U	**23**		5.4	U	2.7	U	**100**	
-2,500 ft transect																
WW-SS-63-10	2.8	U	2.8	U	**100**		2.8	U	**13**		5.7	U	2.8	U	**113**	
WW-SS-64-10	2.8	U	2.8	U	**7**		2.8	U	**3.1**		5.5	U	2.8	U	**10.1**	
WW-SS-65-10	2.8	U	2.8	U	**51**		**54**		22		5.7	U	2.8	U	**127**	
WW-SS-66-10	2.8	U	2.8	U	**21**		2.8	U	**3.3**		5.6	U	2.8	U	**24**	

Notes:

Total PCBs were calculated by summing all detected Aroclors. For samples with no reported detections, the highest reporting limit is given instead.

Detected values are shown in bold.

All units are in μg/kg dry weight.

J1 = estimated value less than the calculated reporting limit

J3 = estimated value due to precision outside of DQOs

PCBs = polychlorinated biphenyls

U = not detected above the laboratory reporting limit indicated

Table 2-6
Subsurface Sediment Sampling Results from 2001 Windward Investigation

	Aroclor		**Aroclor**		**Aroclor**		**Aroclor**		**Aroclor**		**Aroclor**		**Aroclor**		**Total**	
Sample Designation	**1016**		**1242**		**1248**		**1254**		**1260**		**1221**		**1232**		**PCBs**	
+700 ft transect																
WW-SB-700-01	2.7	U	2.7	U	**55**		2.7	U	**8.2**		5.5	U	2.7	U	**63.2**	
WW-SB-700-02	2.7	U	2.7	U	**70**		2.7	U	**6.6**		5.4	U	2.7	U	**76.6**	
+500 ft transect																
WW-SB-500-01	2.8	U	2.8	U	**3.8**		2.8	U	2.8	U	5.6	U	2.8	U	**3.8**	
WW-SB-500-03	2.8	U	2.8	U	**19**		2.8	U	**1.8**	**J1**	5.7	U	2.8	U	**20.8**	
+300 ft transect																
WW-SB-300-01	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.6	U	2.8	U	5.6	U
WW-SB-300-03	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.5	U	2.7	U	5.5	U
+50 ft transect																
WW-SB-13-01	2.9	U	2.9	U	**920**		2.9	U	**75**		230	U	2.9	U	**995**	
WW-SB-13-02	2.8	U	2.8	U	**25**		2.8	U	2.8	U	27	U	2.8	U	**25**	
WW-SB-14-01	2.7	U	2.7	U	**66**		2.7	U	**5**		5.5	U	2.7	U	**71**	
WW-SB-14-02	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.6	U	2.8	U	5.6	U
WW-SB-15-01	2.8	U	2.8	U	**29**		2.8	U	2.8	U	5.5	U	2.8	U	**29**	
WW-SB-15-02	2.8	U	2.8	U	**110**		2.8	U	**7.9**		25	U	2.8	U	**117.9**	
WW-SB-15-03	2.8	U	2.8	U	**300**		2.8	U	**9.8**		30	U	2.8	U	**309.8**	
WW-SB-15-04	2.8	U	2.8	U	**78**		2.8	U	**5.1**		15	U	2.8	U	**83.1**	
WW-SB-15-06	2.7	U	2.7	U	**47**		2.7	U	**3.2**		5.4	U	2.7	U	**50.2**	
WW-SB-16-01	40	U	40	U	**1,400**		40	U	**74**		350	U	40	U	**1,474**	
WW-SB-16-02	41	U	41	U	**1,000**		41	U	**75**		390	U	41	U	**1,075**	
-50 ft transect																
WW-SB-18-01	2.8	U	2.8	U	**3,400**		2.8	U	**93**		5.5	U	2.8	U	**3,493**	
WW-SB-18-02	2.7	U	2.7	U	**260**		2.7	U	**14**		5.4	U	2.7	U	**274**	
WW-SB-18-03	2.8	U	2.8	U	**26**		2.8	U	**1.9**	**J1**	5.6	U	2.8	U	**27.9**	
WW-SB-18-06	2.8	U	2.8	U	**170**		2.8	U	**21**		5.5	U	2.8	U	**191**	
WW-SB-19-01	1200	U	1200	U	**290,000**		1200	U	**9,400**		25000	U	1200	U	**299,400**	
WW-SB-19-02	1200	U	1200	U	**42,000**		1200	U	**1,700**		11000	U	1200	U	**43,700**	
WW-SB-19-03	41	U	41	U	**2,100**		41	U	**150**		720	U	41	U	**2,250**	
-150 ft transect																
WW-SB-20-01	2.8	U	2.8	U	**31**		2.8	U	2.8	U	5.5	U	2.8	U	**31**	
WW-SB-20-02	2.8	U	2.8	U	**22**		2.8	U	2.8	U	5.6	U	2.8	U	**22**	
WW-SB-21-01	2.8	U	2.8	U	**380**		2.8	U	**27**		5.7	U	2.8	U	**407**	
WW-SB-21-02	2.7	U	2.7	U	**31**		2.7	U	2.7	U	5.5	U	2.7	U	**31**	
WW-SB-21-03	2.8	U	2.8	U	**140**		2.8	U	**9.4**		5.6	U	2.8	U	**149.4**	
WW-SB-21-04	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.5	U	2.7	U	5.5	U
-300 ft transect																
WW-SB-23-01	2.7	U	2.7	U	**57**		2.7	U	2.7	U	5.5	U	2.7	U	**57**	
WW-SB-23-02	2.8	U	2.8	U	**28**		2.8	U	2.8	U	5.6	U	2.8	U	**28**	
WW-SB-24-01	2.8	U	2.8	U	**320**		2.8	U	**16**		5.5	U	2.8	U	**336**	
WW-SB-24-01-dup	2.8	U	2.8	U	**340**		2.8	U	**24**		5.5	U	2.8	U	**364**	
-500 ft transect																
WW-SB-26-01	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.5	U	2.8	U	5.5	U
WW-SB-26-03	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.4	U	2.7	U	5.4	U
WW-SB-27-01	2.8	U	2.8	U	**22**		2.8	U	2.8	U	5.5	U	2.8	U	**22**	
-600 ft transect																
WW-SB-30-01	2.8	U	2.8	U	**100**		2.8	U	2.8	U	5.5	U	2.8	U	**100**	
-800 ft transect																
WW-SB-38-01	2.7	U	2.7	U	**4.1**	**J3**	2.7	U	2.7	U	5.4	U	2.7	U	**4.1**	**J3**

Table 2-6
Subsurface Sediment Sampling Results from 2001 Windward Investigation

Sample Designation	Aroclor 1016		Aroclor 1242		Aroclor 1248		Aroclor 1254		Aroclor 1260		Aroclor 1221		Aroclor 1232		Total PCBs	
WW-SB-38-01-dup	2.8	U	2.8	U	**6.8**	**J3**	2.8	U	2.8	U	5.6	U	2.8	U	**6.8**	**J3**
WW-SB-38-02	2.8	U	2.8	U	**3.6**		2.8	U	2.8	U	5.5	U	2.8	U	**3.6**	
WW-SB-39-01	2.7	U	2.7	U	**2**	**J1**	2.7	U	2.7	U	5.5	U	2.7	U	**2**	**J1**
-1,000 ft transect																
WW-SB-46-01	2.7	U	2.7	U	**14**		2.7	U	2.7	U	5.5	U	2.7	U	**14**	
WW-SB-46-03	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U	5.4	U	2.7	U	5.4	U
WW-SB-47-01	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.5	U	2.8	U	5.5	U
WW-SB-47-02	2.7	U	2.7	U	**4.6**		2.7	U	2.7	U	5.5	U	2.7	U	**4.6**	
-1,100 ft transect																
WW-SB-52-01	2.7	U	2.7	U	**200**		2.7	U	2.7	U	5.4	U	2.7	U	**200**	
-2,000 ft transect																
WW-SB-61-01	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U	5.6	U	2.8	U	5.6	U

Notes:

Total PCBs were calculated by summing all detected Aroclors. For samples with no reported detections, the highest reporting limit is given instead.

Detected values are shown in bold.

All units are in µg/kg dry weight.

J1 = estimated value less than the calculated reporting limit

J3 = estimated value due to precision outside of DQOs

PCBs = polychlorinated biphenyls

U = not detected above the laboratory reporting limit indicated

2.4.2 USACE Tissue Sampling

In 2005, the USACE collected composite samples of the bivalve *Corbicula fluminea* (Asian clam) from nearshore areas throughout the Lower Columbia River, including seven locations immediately upstream of the site (RM 104 to 108), and one location immediately downstream of the submerged CPU outfall (RM 103; see Figure 2-8). The composite samples were analyzed for PCB congeners and Aroclors using EPA method SW846 1668A and 8082.

The Asian clam tissue and surface sediment data for upstream and Site areas are summarized in Tables 2-7 and 2-8, respectively. Overall, sediment and tissue data were well-correlated with the previous modeling efforts, as discussed further in Section 8.2. The data collected proximate to the Site indicated equilibrium conditions between these media, for average surface sediment organic carbon levels in the site area of approximately 0.7 percent, and lipid contents in Asian clam of roughly 2 percent.

Measured concentrations of PCBs in both Asian clam tissue (Table 2-7) and surface sediments (Table 2-8; expressed as the 0 to 10 centimeters weighted average concentration [SWAC]) in the 16-acre site investigation area are currently elevated roughly 30- to 60-fold above area background concentrations (Table 2-4). Consistent with statistical procedures set forth in MTCA (specifically, the MTCASTAT 97 Background Module; assuming a lognormal data distribution), existing upper 90th percentile background concentrations of PCBs in surface sediments (Table 2-8) and Asian clam tissue (Table 2-7) are calculated at approximately 0.033 mg/kg dry weight and 0.061 mg/kg wet weight, respectively. The corresponding measured Site concentrations are 1.13 mg/kg dry weight and 3.5 mg/kg wet weight, respectively.

Table 2-7
Summary of Asian Clam Tissue Concentrations

Sampling Station	River Mile	Total PCBs (µg/kg wet wt)
Upstream		
SG-24	108	28
SG-20	108	24
SG-19	108	23
SG-22	107	49
SG-21	105	52
SG-15	104	41
SG-14	104	47
Upper 90th percentile (MTCASTAT)		**61**
Site Area		
SG-13	103	**3,500**

Table 2-8
Summary of Surface Sediment Concentrations

Sampling Station	River Mile	Total PCBs (µg/kg dry wt)
Upstream		
ES-SS-10-25	104	10
ES-SS-10-26	104	5.6
ES-SS-10-27	104	5.5
ES-SS-10-21	104	26
ES-SS-10-22	104	27
ES-SS-10-23	104	15
ES-SS-10-24	104	21
WW-SS-10-02	104	6.7
WW-SS-10-03	104	1.4
WW-SS-10-04	104	3.0
Upper 90th-percentile (MTCASTAT)		**33**
Site Area		
SWAC	103	**1,130**

3 REMEDIAL INVESTIGATION FIELDWORK

Alcoa and Evergreen submitted multiple work plans describing RI activities to be conducted at the Site. Work plans that have been submitted include:

- Work Plan for Supplemental Monitoring Well Installation (Evergreen 2007a)
- Work Plan, Site-Wide Groundwater Investigation (Anchor 2007)
- Area-Specific Characterization and Sampling and Analysis Plan: Fuel Oil Distribution System (Evergreen 2007b)
- Area-Specific Site Characterization and Sampling and Analysis Plan (Hahn 2007)
- Confirmation Sampling and Analysis Plan (Evergreen 2008)

This group of work plans will be referred to as the Work Plans in this RI/FS Report. The Work Plans identified several data gaps necessary to complete the comprehensive Site-wide investigation of COPCs at the Site. As a result, additional groundwater monitoring wells were installed and groundwater sampling, soil sampling, and surface water sampling was performed. This section discusses the field work conducted to complete the objectives of the Work Plans.

3.1 Preliminary Screening Levels

As discussed in previous sections, the Site COPCs include PCBs, PAHs, TPH, VOCs (such as TCE, vinyl chloride, cis-1,2 dichloroethene, and 1,1 dichloroethene), fluoride, cyanide, and other metals. Various federal and state laws were reviewed to determine the applicable or relevant and appropriate requirements (ARARs) for this RI. These ARARs contain numeric screening levels that are used in evaluating the potential for affects to human health or the environment of a specific contaminant.

The potentially applicable federal laws that were considered include:

- Clean Water Act (CWA; including the National Toxics Rule and NPDES requirements)
- Safe Drinking Water Act (including Drinking Water Standards and Health Advisories)
- Clean Air Act
- RCRA
- TSCA

Potentially applicable state laws include:

- MTCA (WAC 173-340)
- Water Pollution Control Act (including Surface Water Quality Standards [WAC 173-201A], Groundwater Quality Standards [WAC 173-200], and SMS [WAC 173-204])
- Water Resources Act of 1971
- Drinking Water Act (including Drinking Water Regulations)
- Air Pollution Control Act
- Hazardous Waste Management Act (including Dangerous Waste Regulations)

Upon review of these ARARs, and knowledge of future industrial site uses, the MCL and the MTCA Method A groundwater cleanup levels were referenced as appropriate screening levels for groundwater. For metals, these values are generally evaluated on a total (not dissolved) basis. Because the site is proximate to a major surface water body, the Colombia River, freshwater water quality criteria were also considered. Of the Site COPCs, free cyanide, PCBs, and select metals are the only contaminants with chronic criteria for the protection of aquatic life published under Chapter 173-201A WAC. For TCE and vinyl chloride, the national recommended criteria (under the CWA) for protection of human health for direct consumption of water and aquatic organisms were considered. Surface water criteria are evaluated on a dissolved basis and are considered a secondary screening level for this preliminary analysis.

For soil, MTCA Method A Industrial Use cleanup levels were referenced as initial screening criteria. These values can be conservative because they consider risks associated with contaminant migration from soil to groundwater, in addition to direct contact and ingestion. When Method A cleanup levels were not available, Method C values were derived appropriately for carcinogenic and non-carcinogenic contaminants under an industrial land use scenario. The only deviation from this approach was taken with respect to PCBs. The Method A Unrestricted Use cleanup level of 1 mg/kg will be used to evaluate new source areas requiring potential remediation, such that a soil cap would not be required. Screening levels are presented in Table 3-1.

Table 3-1
Preliminary Screening Levels

COPC	Selected Groundwater Screening Level (µg/L)	Selected Soil Screening Level (mg/kg)	Selection Basis (Groundwater/Soil)
Arsenic	5 (150)	20	Method A Groundwater (CWA) / Method A Soil
Benzene	5	0.03	Method A Groundwater / Method A Soil
Benzo[a]pyrene	0.1	2	Method A Groundwater / Method A Soil
Cadmium	5 (0.25)	2	Method A Groundwater (CWA) / Method A Soil
Chromium (total)	50	NA	Method A Groundwater / No Soil Value
Copper	1,300 (3.5)	130,000	Method A Groundwater (201A) / Method C Soil Non-Carcinogen
Cyanide, free	200 (5.2)	70,000	State MCL (201A) / Method C Soil Non-Carcinogen
1,1-Dichloroethylene	7	220	State MCL / Method C Soil Carcinogen
cis-1,2- Dichloroethene	70	35,000	State MCL / Method C Soil Non-Carcinogen
trans-1,2- Dichloroethene	100	70,000	State MCL / Method C Soil Non-Carcinogen
Ethylbenzene	700	6	Method A Groundwater / Method A Soil
Fluoride	4,000	210,000	State MCL / Method C Soil Non-Carcinogen
Lead	15 (0.54)	1,000	Method A Groundwater (201A) / Method A Soil
Mercury	2 (0.012)	2	Method A Groundwater (201A) / Method A Soil
Total PCBs	0.1 (0.014)	10 (1)	Method A Groundwater (201A) / Method A Soil
Toluene	1,000	7	Method A Groundwater / Method A Soil
TPH, diesel range organics	500	2,000	Method A Groundwater / Method A Soil
TPH, heavy oils	500	2,000	Method A Groundwater / Method A Soil
TPH, mineral oil	500	4,000	Method A Groundwater / Method A Soil
TPH: GRO, benzene present	800	30	Method A Groundwater / Method A Soil
TPH: GRO, no detectable benzene*	1,000	100	Method A Groundwater / Method A Soil
1,1,1-Trichloroethane	200	2	Method A Groundwater / Method A Soil
1,1,2-Trichloroethane	5	2,300	State MCL / Method C Soil Carcinogen
Trichloroethylene	5 (2.5)	0.03	Method A Groundwater (CWA) / Method A Soil
Vinyl chloride	0.2 (0.025)	88	Method A Groundwater (CWA) / Method C Soil Carcinogen
Xylenes	1,000	9	Method A Groundwater / Method A Soil

Notes: PCB unrestricted use soil value is 1 mg/kg
CWA = Clean Water Act; note, the values for TCE and vinyl chloride are recommended criteria
Benzo(a)pyrene (total cPAH based on toxicity equivalent factors [TEF] to benzo(a)pyrene, per MTCA)
201A = WAC 173-201A Surface Water Quality Criteria

3.2 Data Gaps and RI Work Plans Purpose

The Work Plans were developed to address data gaps identified during the review of historical data, historical remediation, and future remediation activities. The Work Plans address the upland portion of the Site. The groundwater data gaps identified were 1) the installation for additional monitoring wells in the center of the Site; 2) the completion of a Site-wide comprehensive groundwater analytical monitoring program; and 3) the completion of a Site-wide comprehensive hydrogeologic monitoring program. Two well clusters, totaling eight wells, were installed in the center of the Site. A comprehensive Site-wide groundwater sampling and hydrogeologic investigation event was conducted, to complement the existing historical data and collect data from the new wells.

The soil investigation data gaps identified were related to areas of the Site that had not been previously investigated. In areas near previously existing buildings, soil sampling was conducted to characterize the soil after the demolition of the buildings and, in some situations, after the superficial surface remediation of areas near the buildings. Due to the dynamic nature of the demolition activities, additional work plans may be developed, in conjunction with Ecology oversight, to address immediate and newly discovered issues. The remediation resulting from these investigations will include conducting remedial activities under the presumptive remedy, removing soil to the cleanup levels developed within Section 9 of this RI/FS Report and disposing of the impacted soil in the appropriate off-site landfill.

Section 2.4 discussed the extensive characterization performed by Windward (2000 and 2001). Based on discussions with Ecology, no remaining RI/FS data gaps have been identified in sediment areas of the Site. We also do not anticipate any data gaps to be identified during remedial design.

3.3 Hydrogeologic Field Investigation

This section describes hydrogeologic field investigation activities. These field activities include the following: monitoring well installation, monitoring well development, and measurement of groundwater and surface water elevations. Unless noted, all hydrogeologic field investigation activities were completed in accordance with the *Work Plan for Supplemental Monitoring Well Installation* (Evergreen 2007a) and the *Work Plan, Site-Wide*

Groundwater Investigation (Anchor 2007). A discussion of the evaluation and interpretation of the data collected during these field activities is presented in Section 5.

It should be noted that this section focuses on hydrogeologic field investigation activities conducted during 2007. Previous investigation activities were completed by Alcoa, Sweet Edwards and Associates (SEA), ICF Kaiser, and Hart Crowser. Pertinent sections of these historical evaluations have been discussed in Section 2 and will be further discussed in Section 5.

3.3.1 Monitoring Well Installation

Eight monitoring wells were installed at the Site from September 7 to 14, 2007. Four wells in one cluster were installed on the northern side of the Evergreen property (EVGR-01 S, I, D, and A). The remaining four wells were installed in one well cluster south of the former carbon bake scrubber lagoons and the current carbon plant emission control system (EVGR-02 S, I, D, and A). These well locations are illustrated on Figure 3-1.

All of the monitoring wells were installed by Boart Longyear Company, using a rotosonic drilling rig. Materials encountered during drilling were logged under the direction of a licensed geologist, and Evergreen personnel supervised the construction of the monitoring wells. Materials encountered during drilling included silts, sandy-silts, silty-sands, sands, and gravels. Monitoring wells are constructed of 2-inch schedule-40 PVC threaded casing. The 5-foot screened interval in each of the wells is constructed of 0.020-inch slotted PVC and a sump/end cap 3 inches in length. The sand-pack within the screened interval was constructed using #10-20 Colorado silica sand, and bentonite pellets were used to construct the seal just above the sand-pack. AquaGuard™ bentonite grout was used to fill the remaining annular space from the top of the sand-pack seal to the ground surface. Monitoring wells were completed with aboveground lockable steel security casings, each surrounded by protective steel posts set in concrete. Copies of the boring logs and well construction details for these eight monitoring wells are included in Appendix D. A summary of well construction data is in Table 3-2.

The newly installed monitoring wells were surveyed relative to the vertical datum NGVD 1929[47] (Based on Benchmark 'Vancouver CBL'). The survey is based on horizontal datum NAD 1983[98] using the U.S. State Plane 1983 Washington South 4602 local coordinate system. During development of preliminary groundwater elevation contour maps, it was recognized that survey data for several of the older monitoring wells had not been currently surveyed. As it is critical to the development of a groundwater flow pathway to have accurate survey data, the majority of the monitoring wells at the Site were surveyed under this project and the new survey data were used in this report as shown in Table 3-2.

Table 3-2
Well Construction Data

Monitoring Well Identification	Ground Surface Elevation[1] (feet NGVD 1929)	Monitoring Point Elevation[1] (feet NGVD 1929)	Top of Screen Elevation[1] (feet NGVD 1929)	Bottom of Screen Elevation[1] (feet NGVD 1929)
Intermediate Zone Wells				
MW-18I	24.2	26.17	-1.97	-6.97
MW-30I	31.3	33.70	1.22	-3.78
MW-35I	44.1	43.88	7.96	2.96
MW-46I	35.0	34.89	7.15	2.15
MW-47I	30.9	32.94	5.52	0.52
MW-51I	23.5	25.52	3.35	-1.65
MW-94-2I	30.6	30.12	0.50	-4.50
EVGR-1I	28.5	31.49	4.98	-0.02
EVGR-2I	28.9	32.32	3.39	-1.61
SP-4I	30.5	29.97	10.50	5.50
SP-2I	20.7	22.77	9.20	5.20
Deep Zone Wells				
MW-49D	24.2	26.20	-21.00	-26.00
MW-30D	31.3	33.91	-7.64	-12.64
MW-35D	44.1	44.44	-13.32	-18.32
MW-46D	35.0	34.95	-19.94	-24.94
MW-47D	30.9	33.62	-11.94	-16.94
MW-51D	23.5	24.97	-16.60	-21.60
MW-94-2D	30.6	30.19	-22.95	-27.95
EVGR-1D	28.4	31.37	-15.12	-20.12
EVGR-2D	29.0	32.46	-15.52	-20.52
SP-4D	30.5	29.66	-15.00	-20.50
SP-2D	20.7	22.10	-20.80	-26.80
Aquifer Zone Wells				
MW-8-A	32.3	34.69	-74.7	-79.7
MW-18-A	24.2	26.39	-94.1	-99.1
MW-50-A	23.8	25.90	-90.3	-95.3
MW-35-A	44.1	44.12	-68.9	-73.9
MW-46-A	35.0	34.98	-85.5	-90.5
MW-47-A	30.9	33.20	-68.2	-73.2
MW-48-A	28.2	31.75	-77.5	-82.5
MW-51-A	23.5	25.47	-93.6	-98.6
MW-94-2-A	36.1	35.96	-76.4	-81.4
EVGR-1A	28.5	31.44	-72.49	-77.49
EVGR-2A	29.0	32.26	-100.56	-105.56

Notes:

feet NGVD 1929 = feet relative to the North American Vertical Datum of 1929

[1] elevation based on Clark County 1990 Datum (USACE NGVD 1929) and survey completed in November 200

3.3.2 Monitoring Well Development

Monitoring wells EVGR-01 S,I,D,A and EVGR-02 S,I,D,A were developed during the period from September 17 to 19, 2007, prior to collection of groundwater elevation data and groundwater samples. These eight monitoring wells were developed to optimize hydraulic communication between the screened intervals and the surrounding formations. Well development was completed with the use of a surge block, bailer, and an actuator-driven inertial pump system. During development, field parameters were monitored to evaluate the adequacy of development. These field parameters included temperature, specific conductance, pH, and sediment content as measured with an Imhoff cone. Well development records for each well are included on the well construction logs in Appendix D.

3.3.3 Water Level Measurement

On September 17 to 26, 2007 depths to water were measured at all monitoring wells as they were being sampled as part of the Site-wide groundwater monitoring program. The depths to water in these selected wells were also measured on October 9, 2007 and again on October 11, 2007. Depth to water was measured to the nearest 0.01 foot using an electric water level indicator. Groundwater elevations at monitoring wells were calculated by subtracting the measured depth to water from surveyed measuring point elevations. Table 3-3 presents the depth-to-water and water level elevations measured during these three monitoring periods, and field records are included in Appendix E.

On October 5 to 11, 2007 33 continuous recording pressure transducers were installed in order to simultaneously monitor groundwater elevations at multiple monitoring wells. The *IN-SITU*™ transducer and logging systems were configured to allow direct data communication to the surface, as well as constant venting to ambient barometric pressure. This vented configuration precludes the need to apply barometric pressure corrections. The pressure transducers were installed into selected Intermediate, Deep, and Aquifer Zone monitoring wells. The wells were selected based on relative screened-interval elevations and spatial distribution across the site. The well construction details are listed in Table 3-2. Each transducer was then referenced to a real-time measurement of depth to water. The transducer clock times were synchronized with the clock on a single laptop that would be used throughout the monitoring period. Measurements were scheduled to be automatically recorded at each quarter hour (i.e. 04:00, 04:15, 04:30, etc.).

The Columbia River water level elevation data were also collected from October 5 to 11, 2007. The real-time river elevations were monitored on 15 minute intervals using the pressure transducer-datalogging system and protocol described in the preceding paragraph. All surface water elevation data are presented relative to NGVD 1929, and were based on the depth to water from a surveyed benchmark on the Alcoa dock.

Appendix F presents the real-time water level elevations measured in each of the Intermediate, Deep, and Aquifer Zone wells respectively, and in the Columbia River during the monitoring period.

Table 3-3
Hydrology Measurements
Site-wide Groundwater Monitoring Event

Monitoring Well Identification	Monitoring Point Elevation (feet[5])	September 17-26, 2007			October 9, 2007			October 11, 2007		
		Measurement Date and Time	Depth to Water from Monitoring Point[1] (feet)	Water Level Elevation (feet[5])	Measurement Time	Depth to Water from Monitoring Point[1] (feet)	Water Level Elevation (feet[5])	Measurement Time	Depth to Water from Monitoring Point[1] (feet)	Water Level Elevation (feet[5])
Alcoa Property Monitoring Wells										
MW-8I	34.84	9/21/07 9:50	Dry	--	15:50	28.30	6.54	13:36	Dry	--
MW-8D	34.75	9/21/07 10:40	31.32	3.43	15:46	30.27	4.48	13:39	30.07	4.68
MW-8A	34.69	9/21/07 12:00	31.52	3.17	15:40	30.71	3.98	13:42	30.54	4.15
MW-52S[6]	35.03	9/21/07 10:15	Dry	--	15:43	Dry	--	9:20	Dry	--
MW-18I	26.17	9/24/07 15:25	21.67	4.50	15:14	21.03	5.14	14:01	20.75	5.42
MW-18A	26.39	9/24/07 16:10	23.04	3.35	15:18	22.70	3.69	14:05	22.35	4.04
MW-49S	26.22	9/24/07 15:20	Dry	--	15:07	19.43	6.79	9:40	Dry	--
MW-49D	26.20	9/25/07 9:35	22.55	3.65	15:09	22.11	4.09	14:08	22.27	3.93
MW-19I	23.47	9/24/07 13:50	21.08	2.39	14:49	20.39	3.08	14:18	20.34	3.13
MW-50S	25.84	9/24/07 13:54	17.30	8.54	14:57	17.01	8.83	14:21	17.02	8.82
MW-50D	25.95	9/24/07 14:40	23.40	2.55	14:54	22.11	3.84	14:16	22.29	3.66
MW-50A	25.90	9/24/07 13:00	22.78	3.12	15:02	22.04	3.86	14:14	21.80	4.10
MW-30S	34.02	9/24/07 9:15	12.92	21.10	13:59	12.96	21.06	15:00	12.95	21.07
MW-30I	33.70	9/24/07 9:24	27.90	5.80	13:53	27.87	5.83	15:06	27.57	6.13
MW-30D	33.91	9/24/07 9:36	29.42	4.49	13:56	29.41	4.50	15:03	29.01	4.90
MW-35S	43.79	9/18/07 12:15	Dry	--	16:27	Dry	--	9:10	Dry	--
MW-35I	43.88	9/18/07 11:30	34.97	8.91	16:30	35.22	8.66	9:50	35.20	8.68
MW-35D	44.44	9/18/07 10:55	40.04	4.40	16:34	39.17	5.27	9:55	38.86	5.58
MW-35A	44.12	9/18/07 10:15	40.60	3.52	16:37	39.97	4.15	10:02	39.68	4.44
MW-41S	35.40	9/17/07 16:00	Dry	--	17:25	Dry	--	9:00	Dry	--
MW-41I	35.43	9/17/07 15:50	Dry	--	17:30	27.98	7.45	12:00	27.88	7.55
MW-41D	35.06	9/18/07 8:50	30.19	4.87	17:35	29.58	5.48	12:15	29.53	5.53
MW-46I	34.89	9/19/07 12:30	26.91	7.98	16:45	27.72	7.17	10:10	27.26	7.63
MW-46D	34.95	9/19/07 13:30	31.80	3.15	16:48	29.38	5.57	10:15	30.31	4.64
MW-46A	34.98	9/19/07 15:30	33.42	1.56	16:52	30.64	4.34	10:24	30.64	4.34
MW-47I	32.94	9/20/07 10:26	25.75	7.19	16:00	26.23	6.71	11:20	26.16	6.78
MW-47D	33.62	9/20/07 11:05	30.00	3.62	16:09	29.02	4.60	11:30	28.72	4.90
MW-47A	33.20	9/20/07 11:45	29.94	3.26	16:05	29.16	4.04	11:45	28.86	4.34
MW-48I	31.17	9/20/07 14:50	26.91	4.26	16:15	26.40	4.77	13:15	25.84	5.33
MW-48D	31.25	9/20/07 13:45	27.67	3.58	16:20	26.45	4.80	13:12	26.99	4.26
MW-48A	31.75	9/20/07 12:35	28.41	3.34	16:24	27.65	4.10	13:10	27.56	4.19
MW-51S	25.72	9/25/07 10:55	Dry	--	14:15	Dry	--	9:30	Dry	--
MW-51I	25.52	9/25/07 10:15	21.20	4.32	14:22	20.98	4.54	14:28	20.48	5.04

Table 3-3
Hydrology Measurements
Site-wide Groundwater Monitoring Event

		September 17-26, 2007			October 9, 2007			October 11, 2007		
Monitoring Well Identification	**Monitoring Point Elevation (feet[5])**	**Measurement Date and Time**	**Depth to Water from Monitoring Point[1] (feet)**	**Water Level Elevation (feet[5])**	**Measurement Time**	**Depth to Water from Monitoring Point[1] (feet)**	**Water Level Elevation (feet[5])**	**Measurement Time**	**Depth to Water from Monitoring Point[1] (feet)**	**Water Level Elevation (feet[5])**
MW-51D	24.97	9/25/07 11:03	21.98	2.99	14:30	21.60	3.37	14:30	21.49	3.48
MW-51A	25.47	9/25/07 11:45	22.85	2.62	14:35	21.64	3.83	14:35	21.38	4.09
MW-94-1I	37.32	9/18/07 14:05	32.51	4.81	16:59	32.58	4.74	12:40	32.25	5.07
MW-94-1D	36.84	9/18/07 12:30	33.54	3.30	17:05	31.45	5.39	12:45	32.94	3.90
MW-94-1A	36.83	9/18/07 13:18	33.32	3.51	17:10	32.72	4.11	12:50	32.62	4.21
MW-94-2I	30.12	9/19/07 10:30	26.78	3.34	17:15	25.01	5.11	10:40	25.29	4.83
MW-94-2D	30.19	9/18/07 15:35	27.11	3.08	17:19	24.70	5.49	10:47	25.48	4.71
MW-94-2A	35.96	9/18/07 14:40	32.55	3.41	17:22	31.68	4.28	11:00	31.59	4.37
Alcoa Property Water Supply Wells										
PW-4	NA[1]	--	--	--	--	--	--	--	--	--
PW-19	NA[1]	--	--	--	--	--	--	--	--	--
PW-20	NA[1]	--	--	--	--	--	--	--	--	--
PW-21	NA[1]	--	--	--	--	--	--	--	--	--
PW-22	NA[1]	--	--	--	--	--	--	--	--	--
Evergreen Property and UST Monitoring Wells										
EVGR-01S	31.41	9/25/07 10:56	18.81	12.60	13:15	19.23	12.18	15:32	Dry	--
EVGR-01I	31.49	9/25/07 10:55	27.44	4.05	13:20	27.17	4.32	15:35	26.90	4.59
EVGR-01D	31.37	9/25/07 10:52	27.51	3.86	13:25	27.22	4.15	15:40	26.92	4.45
EVGR-01A	31.44	9/25/07 10:39	28.00	3.44	13:30	27.71	3.73	15:43	27.25	4.19
EVGR-02S	32.48	9/25/07 14:25	13.85	18.63	13:45	13.85	18.63	14:45	13.91	18.57
EVGR-02I	32.32	9/25/07 13:30	13.80	18.52	13:42	13.94	18.38	14:50	14.01	18.31
EVGR-02D	32.46	9/25/07 13:18	28.85	3.61	13:47	28.30	4.16	14:53	27.87	4.59
EVGR-02A	32.26	9/25/07 13:05	29.40	2.86	13:51	28.59	3.67	14:56	28.15	4.11
T3-3	28.28	9/24/07 11:26	9.50	18.78	13:35	9.32	18.96	15:10	9.33	18.95
T3-4	32.59	9/24/07 10:51	17.37	15.22	13:38	Dry	--	15:20	Dry	--
T3-5	34.31	9/24/07 10:48	18.95	15.36	13:41	Dry	--	15:30	Dry	--
Crowley Marine Monitoring Wells										
CMW-10	NA	Unable to locate			Unable to locate			Unable to locate		
CMW-12	NA	Unable to locate			Unable to locate			Unable to locate		
CMW-13	NA	Unable to locate			Unable to locate			Unable to locate		
CMW-14	NA	Unable to locate			Unable to locate			Unable to locate		
CMW-15	NA	9/24/07 9:23	8.85	--	13:12	8.51	--	15:45	8.60	--
CMW-16	31.29	9/21/07 15:20	11.67	19.62	13:05	11.74	19.55	15:47	11.75	19.54

Table 3-3
Hydrology Measurements
Site-wide Groundwater Monitoring Event

		September 17-26, 2007			October 9, 2007			October 11, 2007		
Monitoring Well Identification	Monitoring Point Elevation (feet[5])	Measurement Date and Time	Depth to Water from Monitoring Point[1] (feet)	Water Level Elevation (feet[5])	Measurement Time	Depth to Water from Monitoring Point[1] (feet)	Water Level Elevation (feet[5])	Measurement Time	Depth to Water from Monitoring Point[1] (feet)	Water Level Elevation (feet[5])
CMW-17	34.11	9/21/07 14:35	17.63	16.48	12:39	18.02	16.09	15:53	18.07	16.04
Stormwater Lagoons and Sludge Pond Wells										
SP-1I	NA	Unable to locate			Unable to locate			Unable to locate		
SP-1D	NA	Unable to locate			Unable to locate			Unable to locate		
SP-2I	22.77	9/19/07 12:20	12.00	10.77	12:48	12.35	10.42	16:08	12.36	10.41
SP-2D	22.10	9/19/07 12:27	18.99	3.11	12:51	18.13	3.97	16:11	17.92	4.18
SP-3S	36.64	9/19/07 12:36	19.54	17.10	12:41	19.54	17.10	15:57	19.55	17.09
SP-3D	35.84	9/19/07 12:40	32.77	3.07	12:45	32.50	3.34	15:55	31.80	4.04
SP-4I	29.97	9/24/07 14:28	17.25	12.72	12:53	17.55	12.42	16:20	17.57	12.40
SP-4D	29.66	9/25/07 8:57	25.62	4.04	12:57	25.92	3.74	16:15	25.54	4.12
SP-5D	NA	Could not access			Could not access			Could not access		
SP-6I	27.47	9/20/07 13:52	9.75	17.72	12:15	9.85	17.62	15:51	9.86	17.61
SP-7S	34.27	9/19/07 13:41	15.97	18.30	12:23	16.16	18.11	15:59	16.20	18.07
SP-7I	34.43	9/19/07 13:36	20.20	14.23	12:30	20.32	14.11	16:01	20.29	14.14
SP-7D	34.72	9/20/07 13:32	31.62	3.10	12:35	31.13	3.59	16:03	30.59	4.13
Columbia River										
Columbia River	28.28	9/25/07 10:50	25.01	3.27	14:05	25.13	3.15	13:57	24.90	3.38

Notes:

Dry = well was Dry

NA = data not available

[1] no monitoring point avalable, no access for water level measuremen

[2] monitoring well survey data provided by W&H Pacific (survey completed 10-12-04

[4] water level could not be measured--water level below top of pum

[5] Coordinate system based on US State Plane 1983 Washington South 4602. Vertical datum NGVD 1929[47]. Survey data: November 5, 2007

[6] New Top of Casing Elevation data not provided. Datum shown is Clark County Datum 1990/USACE NVGD 1929--based on KPFF survey 11/25/0

3.4 Field Sampling

Field sampling was conducted at Alcoa Vancouver based upon the *Work Plan, Site-Wide Groundwater Investigation*, (Anchor 2007) and the *Work Plan for Supplemental Monitoring Well Installation* (Evergreen 2007a). Surface water and groundwater samples were collected from the Columbia River, selected monitoring wells, and industrial supply wells on September 17 to 26, 2007. All water samples were tested for a standard list of analyses including total cyanide, free cyanide, fluoride, and a comprehensive list of analytes needed for geochemical modeling. Monitoring wells in strategic locations were also sampled for priority pollutants and/or other potential Site COPCs. Table 3-4 lists the analytes tested in the samples collected from each well and from the Columbia River.

Table 3-4
Groundwater and Surface Water Sample Locations and Analytes Tested

Station ID	Comment	Total Cyanide	Free Cyanide[1]	Fluoride	TOX	VOCs	SVOCs	Pesticides	PCBs	LL-PAHs	TPH-Dx, Gx	TOC	Sulfide	Sulfate as S	Density	Ca, Mg, Na, K	Silica	Chloride	Alkalinity	Ammonia	Nitrate +Nitrite	Total Phosphate as P	Ortho-phosphate as P	pH, Conductivity, D.O., ORP, Temperature	Fe3+	Fe2+	Priority Pollutant Total Metals	Priority Pollutant Dissolved Metals	Title 22 Metals (Fe, Mn, Al)	Dis. Pb
Alcoa Property Monitoring Wells																														
MW-8A		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-8I	Dry																													
MW-8D		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-18I		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-18A		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-19I		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-30S		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-30I		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-30D		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-35S	Dry																													
MW-35I		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-35D		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-35A		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-41S		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-41I	Dry																													
MW-41D		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-46I		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-46D		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-46A		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-47I		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-47D		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-47A		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-48I		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-48D		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-48A		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-49S	Dry																													
MW-49D		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-50S		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-50D		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-50A		1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-51S	Dry																													
MW-51I		1	1	1	1	1	NS[2]	NS[2]	NS[2]	NS[2]		1	1	1	1	NS[2]	1	1	1	1	1	1	1	F	C	F	1	NS[2]	NS[2]	
MW-51D		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
MW-51A		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
MW-52S	Dry																													
MW-94-1I		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-94-1D		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-94-1A		1	1	1		1			1	1			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
MW-94-2I		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
MW-94-2D		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
MW-94-2A		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
Alcoa Property Water Supply Wells																														
PW-4	No power supply--pump not functional/no sample collected																													
PW-19		1	1	1		1							1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
PW-20		1	1	1		1							1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
PW-21	No power supply--pump not functional/no sample collected																													
PW-22	Sample port clogged--no sample could be collected																													

Table 3-4
Groundwater and Surface Water Sample Locations and Analytes Tested

Station ID	Comment	Total Cyanide	Free Cyanide[1]	Fluoride	TOX	VOCs	SVOCs	Pesticides	PCBs	LL-PAHs	TPH-Dx, Gx	TOC	Sulfide	Sulfate as S	Density	Ca, Mg, Na, K	Silica	Chloride	Alkalinity	Ammonia	Nitrate +Nitrite	Total Phosphate as P	Ortho-phosphate as P	pH, Conductivity, D.O., ORP, Temperature	Fe3+	Fe2+	Priority Pollutant Total Metals	Priority Pollutant Dissolved Metals	Title 22 Metals (Fe, Mn, Al)	Dis. Pb
Evergreen Property and UST Monitoring Wells																														
EVGR-01S	Dry																													
EVGR-01I		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
EVGR-01D		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
EVGR-01A		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
EVGR-02S		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
EVGR-02I		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
EVGR-02D		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
EVGR-02A		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
T3-3		1	1	1		1[3]				1[3]	1[3]		1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	1[3]
T3-4	Dry																													
T3-5	Dry																													
Crowley Site Monitoring Wells																														
CMW-10	Could not locate																													
CMW-12	Could not locate																													
CMW-13	Could not locate																													
CMW-14	Could not locate																													
CMW-15		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
CMW-16		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
CMW-17		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
Stormwater Lagoons and Sludge Pond Wells																														
SP-1I	Could not locate																													
SP-1D	Could not locate																													
SP-2I		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
SP-2D		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	F	C	F	1	1	1	
SP-3S	Dry																													
SP-3D		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
SP-4I		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
SP-4D		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
SP-5D	Confined space--no access to well/not sampled																													
SP-6I		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	
SP-7S		1	1	1		1[3]				1[3]			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	1[3]
SP-7I		1	1	1		1[3]				1[3]			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	1[3]
SP-7D		1	1	1		1[3]				1[3]			1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	1[3]
Columbia River																														
Alcoa Dock		1	1	1									1	1	1	1	1	1	1	1	1	1	1	F	C	F			1	

Notes:

[1] Microdiffusion method

[2] NS - low sample volume some analytes not sampled

[3] additional testing requested based on field observations

Al = aluminum
Ca = calcium
C = calculated from total Fe measured in the laboratory and Fe++ measured in the field
Dis Pb = dissolved lead
F = measured in the field
Fe = iron
K = potassium
Mg = magnesium
Mn = mangenese
Na = sodium
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
SVOCs = semi-volatile organic compounds
TOC = total organic carbon
TOX = total organic halides
VOCs = volatile organic compounds

3.4.1 Groundwater Sampling

The selected well locations are shown on Figure 3-1. Samples could not be collected from 20 wells listed in the Work Plan including 10 monitoring wells that were dry, six monitoring wells that could not be located, one monitoring well that was located in a confined space, and three supply wells that did not have operational pumps.

Wells were purged and samples were collected using one of three pumping systems: peristaltic pump, inertial pump (Waterra™), or bladder pump. The sample line, pump tubing, and/or check valves were dedicated to each specific well to prevent cross contamination and reduce the need for equipment rinseate blanks and extensive decontamination efforts. Field parameters (pH, conductivity, temperature, dissolved oxygen, and oxidation-reduction potential [ORP]) were measured and recorded throughout the purging process, per the Work Plan. Water levels and field parameters were recorded on Field Sampling Data Sheets (FSDS) for each location sampled. The FSDS documents are provided in Appendix E. Of the wells selected for sampling within the Work Plan, 41 are part of the ongoing Alcoa quarterly groundwater monitoring program. These wells are equipped with dedicated pumping systems and were purged and sampled using low-flow/minimal drawdown methodology (USEPA 1996). The remaining monitoring wells were purged of three well volumes or until the well purged dry. Samples were collected after field parameters had stabilized to within 10 percent of the readings measured in the preceding casing volume. Wells that purged dry were allowed to recover to at least 60 percent of the initial water column height before samples were collected.

Samples were preserved to less than 4 degrees Celsius, carefully packaged in ice chests, and transported by laboratory courier to Columbia Analytical Services (CAS) laboratory located in Kelso, Washington. Samples were managed under chain-of-custody protocol and custody documentation was completed for each sample batch released to the laboratory courier. The laboratory data reports with completed chain-of-custody forms are included in Appendix G.

3.4.2 Surface Water Sampling

A single surface water sample was collected from the Columbia River from the channel-ward edge of the Alcoa dock structure. The sample was collected using a new disposable bailer equipped with double check valves. The bailer was attached to unused nylon twine and lowered to approximately 2 feet below the Columbia River's surface. The bailer was retrieved to the dock platform and the sample water was dispensed into the laboratory-provided sample containers. The sample was tested for the analyses listed in Table 3-4.

3.4.3 Soil Sampling

Evergreen and Alcoa are in the process of demolishing their former production facilities, while conducting remedial cleanup under a presumptive remedy of soil and debris removal to industrial use standards, followed by disposal of removed materials at permitted off-site facilities. Alcoa and Evergreen have conducted soil sampling to characterize COPCs near buildings and other structures on the property. Potential AOCs include the former Carbon Storage building, soil east of Carbon Storage, the Carbon Bakes within the Carbon Plant, and soils adjacent to the Vanexco/Rod Mill (Figure 2-1). If other potential AOCs are identified as facility demolition activities proceed, they will be addressed with Ecology. COPCs preliminarily evaluated in each of these areas are summarized in Table 3-5.

Table 3-5
Soil Sampling Locations and Contaminants of Potential Concern

Area	COPC Analyzed
Carbon Storage Building	PAHs, Lead
East of Carbon Storage Building	PAHs
Carbon Plant Bakes	PAHs, Fluoride
Electrical Yards at Vanexco/Rod Mill	PCBs
Historical Road at Vanexco/Rod Mill	PCBs
Various locations	Fluoride

Note: PCBs = polychlorinated biphenyls
PAH = polycyclic aromatic hydrocarbons

3.4.3.1 Carbon Storage Building

The Carbon Storage sampling was conducted to delineate the lateral and vertical extent of carbon impacts. The impacts in the vicinity of the Carbon Storage building appeared to be visually widespread and relatively uniform. A series of test pits were excavated for the collection of surface and near-surface soil samples. A discrete soil sample was collected from both the upper-interval (from land surface to 6 inches bgs) and from a lower-interval (from 6 inches to 12 inches bgs). If dark colored soil, suggesting carbon, was present at a depth deeper than the 1-foot interval, additional deeper soil samples were collected from that location for possible laboratory analysis. The locations of investigative test pits (TP) are included on Figure 3-2.

Directly east of the carbon storage building is a large area that had been used by ACPC as a finished product lay down area (East Carbon Storage). This area has potentially been impacted coke and pitch materials from the rail line, which goes into the Carbon Storage Building and from the tracking of coke and pitch on the eastern side of the Carbon Storage Building. Test pits were excavated on the northern edge of the rail line, which enters the Carbon Storage Building. Samples were collected from the two test pits to characterize the soils in the area around the rail ballast for PAHs. The sample locations are on Figure 3-2, identified as ATP-1 and ATP-2.

A series of 11 test pits were placed to the east of the Carbon Storage Building to visually inspect the soils in this area. In addition to the visual inspection, six samples were collected from these test pits at a depth of 0 to 6 inches. These samples were analyzed for PAHs and the sample locations are on Figure 3-2, identified as ATP-3 and ATP-13.

3.4.3.2 Carbon Plant Bakes

The Carbon Bakes are located within the Carbon Plant. Sampling and analysis was conducted to determine the presence of COPCs and assess their vertical extent and magnitude. Carbon and fluoride impacts relating to the carbon bake process, if present, were expected to be relatively uniform due to the long history of carbon management in these areas, consistency in application of the bake process, and similarity of Bake Pit underdrain system construction. Fluoride sampling is discussed in Section 3.4.2.6. Evergreen records indicated the bottom of each Carbon Bake underdrain system was at an approximate depth of 18.5 feet mean sea level (msl; 13 feet bgs) and consisted of a network of 20 terra cotta tile underdrains spaced approximately 20 feet apart and perpendicular to the axis of each Bake Pit floor (Figure 3-2). The configuration of the underdrain system, where encountered in investigative test pits, was similar to that on record.

Samples were collected from 21 shallow test pits in what were considered to be worst-case areas. The test pits were excavated along the down-gradient confluence of the underdrain system adjacent each of the Carbon Bake Pit concrete pads (Bakes No. 2 and 3) and through the central portion of each Bake Pit floor at selected locations. The samples were analyzed for PAHs. The locations of investigative test pits are included on Figure 3-2.

3.4.3.3 Vanexco/Rod Mill Electrical Yards

Soil sampling was conducted in three electrical yards around the exterior of the Vanexco/Rod Mill facility. Twelve soil samples were collected from these electrical yards. Historical information did not indicate the presence of PCB-impacted media in these yards; however, sampling had not previously been performed. The samples were collected in locations where soils/rock were stained or in locations along the transformer rails, whichever was the worse-case scenario. These samples were analyzed for PCBs and the sample locations are on Figure 3-2, identified as S-1 to S-12.

3.4.3.4 Vanexco/Rod Mill Historical Road

Historical aerial photographs showed that there was a parking lot and road in the area. This area is now covered by asphalt. It was noted during the Vanexco/Rod Mill Investigation in the early 1990s that a road constructed with PCB-bearing materials was located in this area. The asphalt was removed from this area and the historical parking lot/road area was located. Three samples of a road/parking lot type of material from the southwestern area of Vanexco were collected. The samples were analyzed for PCBs and the sample locations are on Figure 3-2, identified as ATP-14, 15, and 16.

3.4.3.5 Fluoride-bearing Materials

Soil samples were collected in specific areas around the Site. The samples were collected in areas where fluoride containing materials had been present on the soil. Ten samples were collected of the fluoride-bearing materials. Fourteen samples of soil were collected under the fluoride-bearing materials (when these materials were still present). Under the concrete of the carbon bakes, 33 samples were collected from locations adjacent to carbon bake emission collection activities. The purpose for collecting the fluoride samples was to develop a site-wide soil distribution coefficient (K_d) for fluoride. The samples were analyzed for total fluoride and leachate was extracted and tested using the synthetic precipitation leaching procedure (SPLP). The sample locations are shown on Figure 3-2.

4 REMEDIAL INVESTIGATION RESULTS

This section presents the results of the field investigations for the groundwater, surface water, and soil sampling that was performed. There are no new sediment data to report. The data validation process and exceptions are discussed in this section. The monitoring data has been compiled, reviewed, and validated in accordance with the quality assurance and quality control (QA/QC) parameters described in the Work Plans.

4.1 Groundwater Quality

The groundwater samples were collected in three sampling events. The primary sampling event occurred in September 2007, while two smaller sampling events occurred in May and December of 2007. Samples collected at that time, as identified in the Work Plan, *Site-Wide Groundwater Investigation Work Plan*, will be used to determine COPC concentrations in the groundwater during low rainfall and low river conditions. Sampling of the newly installed monitoring wells was also conducted for the first time. Samples were collected from each zone at each well cluster, unless the wells were dry. Tables 4-1, 4-2, and 4-3 present the data collected during the sampling events. The laboratory data packets are in Appendix G. Each well was sampled for numerous anions and cations. This data is not evaluated here, but was collected for use in the geochemical modeling discussed in Section 6.

Table 4-1
Groundwater and Surface Water Sampling Results - Conventionals and Metals
September and December 2007

	Location ID	Screening Level Values	Col River		CMW-15		CMW-16		CMW-17		SP-2-D		SP-2-I		SP-3-D		SP-4-D		SP-4-S		SP-6-I		SP-7-D		SP-7-D		SP-7-I	
	Sample ID		Col River-092607		CMW-15-092407		CMW-16-092107		CMW-17-092107		SP-2D-092007		SP-2I-091907		SP-3D-092007		SP-4D-092507		SP-4S-092407		SP-6I-092107		SP-57D-092107		SP-7D-092107		SP-7I-092007	
	Sample Date		9/26/2007		9/24/2007		9/21/2007		9/21/2007		9/20/2007		9/19/2007		9/20/2007		9/25/2007		9/24/2007		9/21/2007		9/21/2007		9/21/2007		9/20/2007	
	Sample Time		14:00		09:50		16:00		15:00		11:45		16:15		15:15		09:45		15:20		11:45		10:30		10:25		16:50	
	Sample Matrix		WG		WG		WG		WG		WG		WG		WG		WG		WG		WG		WG-DUP		WG		WG	
Conventionals																												
Alkalinity, Total as CaCO3	mg/L		**68**		**204**		**88**		**49**		**306**		**424**		**248**		**235**		**416**		**172**		**236**		**230**		**696**	
Ammonia	mg/L		**0.03**	**J**	**0.42**		**3.19**		**0.22**		**1.8**		**0.2**		**2.07**		**1.26**		**0.63**		**2.4**		**2.7**		**2.71**		**2.3**	
Conductivity	uS		**326**		**522**		**396**		**123**		**880**		**1027**		**761**		**546**		**802**		**595**		--		**828**		**1,772**	
Density	g/ml		**1**		**1.02**		--		--		--		**1.02**		--		**1.01**		**1.02**		--		--		--		--	
Density	none		--		--		--		--		--		--		--		--		--		--		--		--		--	
Dissolved oxygen	mg/L		**8.12**		**0.4**		**1.16**		**7.86**		**2.09**		**5.36**		**4.61**		**3.04**		**0.41**		**2.02**		--		**1.86**		**15**	
Free Cyanide	µg/L	5.2	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	10	U	5	U	5	U
Nitrate + Nitrite	mg/L		**0.11**		0.05	U	**0.19**		**0.031**	J	**0.11**		**0.025**	J	**0.12**		**0.26**		0.05	U	**0.11**		**0.13**		**0.13**		**0.06**	
ortho-Phosphate	mg/L		--		--		--		--		**0.02**		**0.08**		**0.03**		--		--		**0.01**		**0.02**		**0.02**		**0.05**	
Orthophosphate as Phosphorus	mg/L		**0.01**		**0.05**		--		--		--		--		--		**0.06**		**0.11**		--		--		--		--	
Oxidation-Reduction Potential	mV		**67.7**		**-13.2**		**-45.7**		**17.6**		**-86.3**		**24.4**		**-98.5**		**-26.5**		**90.8**		**-127**		--		**-74**		**-97.4**	
pH	None		**7.21**		**6.77**		**6.72**		**6.75**		**7.18**		**7.12**		**6.87**		**6.49**		**6.56**		**7.24**		--		**6.68**		**7.12**	
Phosphorus	mg/L		**0.03**		**0.1**		**0.9**		**0.36**		**0.47**		**0.1**		--		**1.1**		**0.25**		**2.94**		**2.37**		**2.26**		**0.2**	
Silicon (Dissolved)	µg/L		**3,630**		**16,300**		**28,400**	J	**22,200**	J	**27,500**	J	**22,200**		**36,300**	J	**35,800**		**14,000**		**29,600**	J	**37,400**		**37,500**	J	**29,100**	J
Specific gravity	none		--		--		**1.02**		**1**		**1.01**		--		**1.02**		--		--		**0.95**		**1**		**0.98**		**0.99**	
Sulfate	mg/L		**11.9**		**51.6**		**0.3**		**1.6**		**0.135**	J	**2**		**0.036**	J	**19.6**		**6.5**		**0.055**	J	**0.028**	J	**0.3**		**0.045**	J
Sulfide	mg/L		0.05	U	0.05	U	**0.06**	J	0.05	UJ	0.05	UJ	0.05	U	0.05	UJ	0.05	U	0.05	U	0.05	UJ	0.05	U	0.05	U	0.05	UJ
Temperature	deg C		**22.1**		**15.83**		**17.05**		**16.54**		**17.79**		**15.44**		**14.51**		**14.46**		**15.72**		**14.85**		--		**15.9**		**16.07**	
Total Chloride	mg/L		**9.2**		**3.9**		**1.7**		**1.3**		**14.7**		**1.9**		**12.6**		**7.6**		**1.9**		**1.9**		**16.5**		**16.5**		**8.2**	
Total Cyanide	mg/L		**0.02**		**0.005**	J	0.003	U	0.003	U	**0.004**	J	**0.02**		0.003	U	**0.01**		**0.005**	J	0.003	U	0.01	U	0.003	U	0.003	U
Total Fluoride	mg/L	4	**0.127**	**J**	**0.5**		**1**		**0.9**		**0.5**		**0.3**		**0.5**		**0.3**		**5.2**		**2.7**		**0.4**		**0.4**		**0.7**	
Total Organic Carbon	mg/L		--		--		--		--		**4.1**		**14.7**		--		--		--		--		--		--		--	
Total Organic Halides (TOX)	µg/L		--		--		--		--		**5**	J	**9**	J	--		--		--		--		--		--		--	
Volume	Gal		**0**		**4.5**		**2.5**		**4**		**15**		**2.5**		**15**		**15**		**3**		**6.5**		--		**12**		**13**	
Metals (Dissolved)																												
Aluminum	µg/L		50	U	50	U	**60**		50	U	**163**		**48**	J	50	U	50	U	50	U	50	U	**74**		**159**		50	U
Antimony	µg/L		--		--		--		--		**0.05**	J	0.06	U	--		--		--		--		--		--		--	
Arsenic	µg/L	150	--		--		--		--		**14.9**		**0.66**		--		--		--		--		--		--		--	
Beryllium	µg/L		5	U	--		--		--		--		--		--		--		--		--		--		--		--	
Cadmium	µg/L	0.25	5	U	--		--		--		--		--		--		--		--		--		--		--		--	
Calcium metal	µg/L		**16,800**		**59,800**		**12,200**		**8,720**		**62,000**		**90,100**		**46,500**		**48,600**		**76,100**		**36,400**		**42,500**		**42,500**		**105,000**	
Chromium	µg/L		5	U	--		--		--		--		--		--		--		--		--		--		--		--	
Copper	µg/L	3.5	10	U	--		--		--		--		--		--		--		--		--		--		--		--	
Iron	µg/L		**9.7**	**J**	**5,090**		**20,200**		**3,150**		**18,400**		**25**	J	**36,900**		**24,400**		**581**		**20,700**		**42,300**		**42,300**		**28,300**	
Iron 2+	µg/L		**0**		**2,200**		**2,100**		**3,500**		**2,500**		**0**		**2,500**		**2,500**		**2,100**		**5,000**		--		**6,500**		**2,250**	
Iron 3+	µg/L		**9.7**		**2,890**		**18,100**		**-350**		**15,900**		**25**		**34,400**		**21,900**		**-1519**		**15,700**		**42,300**		**35,800**		**26,050**	
Lead	µg/L	0.54	--		--		--		--		**0.121**		**0.037**		--		--		--		--		**0.038**		**0.06**		**0.071**	
Magnesium	µg/L		**5,100**		**19,100**		**9,280**		**3,360**		**24,500**		**37,300**		**21,800**		**26,500**		**34,800**		**10,400**		**19,600**		**19,600**		**57,500**	
Manganese	µg/L		**1.9**	**J**	**3,130**		**606**		**167**		**3770**		**8,070**		**2,450**		**1,830**		**3,430**		**4,210**		**1,810**		**1,810**		**2,380**	
Mercury	µg/L	0.012	--		--		--		--		0.2	UJ	0.2	UJ	--		--		--		--		--		--		--	
Nickel	µg/L		20	U	--		--		--		--		--		--		--		--		--		--		--		--	
Potassium	µg/L		**1,130**	**J**	**4,510**		**2,760**		**1,010**	J	**4,870**		**7,860**		**2,240**		**3,700**		**2,810**		**2,630**		**1,910**	J	**1,620**	J	**2,840**	
Silver	µg/L		10	U	--		--		--		--		--		--		--		--		--		--		--		--	
Sodium	µg/L		**8,810**		**7,230**		**5,280**		**5,080**		**8,870**		**22,500**		**7,370**		**9,600**		**43,200**		**13,900**		**9,330**		**9,370**		**78,300**	
Metals (Total)																												
Antimony	µg/L		--		--		--		--		**0.15**	J	0.06	U	--		--		--		--		--		--		--	
Arsenic	µg/L	5	--		--		--		--		**17**		**0.68**		--		--		--		--		--		--		--	
Beryllium	µg/L		--		--		--		--		**2.3**	J	5	U	--		--		--		--		--		--		--	
Cadmium	µg/L	5	--		--		--		--		10	U	5	U	--		--		--		--		--		--		--	
Chromium	µg/L	50	--		--		--		--		**41.5**		5	U	--		--		--		--		--		--		--	
Copper	µg/L	1,300	--		--		--		--		**68.2**		10	U	--		--		--		--		--		--		--	
Lead	µg/L	15	--		--		--		--		**19.2**		**0.248**		--		--		--		--		--		--		--	
Mercury	µg/L	2	--		--		--		--		**0.04**	J	0.2	UJ	--		--		--		--		--		--		--	
Nickel	µg/L		--		--		--		--		40	U	20	U	--		--		--		--		--		--		--	
Silver	µg/L		--		--		--		--		20	UJ	10	U	--		--		--		--		--		--		--	

Notes:

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample
WG-FB = groundwater field blank

Table 4-1
Groundwater and Surface Water Sampling Results - Conventionals and Metals
September and December 2007

	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	SP-7-S SP-7S-092007 9/20/2007 16:30 WG		T3-3 T3-3-092407 9/24/2007 13:00 WG		EVGR-01A EVGR-01A-092507 9/25/2007 11:30 WG		EVGR-01D EVGR-01D-092507 9/25/2007 11:50 WG		EVGR-01I EVGR-01I-092507 9/25/2007 12:25 WG		EVGR-02A EVGR-02A-092507 9/25/2007 14:15 WG		EVGR-02D EVGR-02D-092507 9/25/2007 14:20 WG		EVGR-02I EVGR-02I-092507 9/25/2007 15:00 WG		EVGR-02S EVGR-02S-092507 9/25/2007 15:00 WG		MW-18-A MW-18A-092407 9/24/2007 16:40 WG		MW-18-I MW-18I-092407 9/24/2007 16:00 WG		MW-19-I MW-19I-092407 9/24/2007 14:30 WG		MW-30-D MW-30D-092407 9/24/2007 12:30 WG	
Conventionals																												
Alkalinity, Total as CaCO3	mg/L		**130**		**116**		**188**		**160**		**121**		**234**		**376**		**366**		**55**		**151**		**452**		**363**		**350**	
Ammonia	mg/L		**2.25**		**0.64**		**0.028**	J	**0.29**		0.043	J	**1.29**		**2.39**		**0.7**		**0.049**	J	**0.56**		**5.07**		**2.96**		**0.12**	
Conductivity	uS		**540**		**329**		**0.363**		**477**		**242**		**0.51**		**1,228**		**927**		**0.139**		**475**		**803**		**687**		**616**	
Density	g/ml		--		**1.01**		**1**		**0.99**		**1.01**		**0.99**		**1.01**		**1**		**1.02**		**0.99**		**1.02**		**1.02**		**1**	
Density	none		--		--		--		--		--		--		--		--		--		--		--		--		--	
Dissolved oxygen	mg/L		**10.1**		**0.53**		**2.2**		**0.91**		**5.09**		**8.41**		**0.89**		**11.81**		**7.73**		**0.63**		**1.39**		**0.69**		**4.63**	
Free Cyanide	µg/L	5.2	5	U	**6**	J	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Nitrate + Nitrite	mg/L		**0.13**		**0.029**	J	**0.035**	J	**0.008**	J	0.05	U	**0.018**	J	**0.05**	J	0.05	U	0.05	U	**0.16**		0.05	U	**0.035**	J	0.05	U
ortho-Phosphate	mg/L		**0.03**		--		--		--		--		--		--		--		--		--		--		--		--	
Orthophosphate as Phosphorus	mg/L		--		**0.03**		**0.25**		**0.05**		**0.09**		**0.05**		**0.07**		**0.12**		**0.11**		**0.04**		**0.1**		**0.04**		**0.2**	
Oxidation-Reduction Potential	mV		**-40.8**		**7.1**		**-514**		**-98.8**		**61**		**-68**		**-86.7**		**-16**		**113**		**38.1**		**18**		**-17.2**		**75.1**	
pH	None		**6.8**		**6.33**		**6.72**		**7.18**		**6.63**		**6.82**		**6.91**		**7**		**6.78**		**6.13**		**6.23**		**6.59**		**6.66**	
Phosphorus	mg/L		**1.11**		**0.25**		**0.31**		**0.34**		**0.13**		**0.57**		**0.62**		**0.69**		**0.11**		**0.41**		**1.11**		**2.06**		**0.44**	
Silicon (Dissolved)	µg/L		**31,600**	J	**20,300**		**25,700**		**26,300**		**24,500**		**28,800**		**31,200**		**27,200**		**18,400**		**33,500**		**34,600**		**33,800**		**31,100**	
Specific gravity	none		**1**		--		--		--		--		--		--		--		--		--		--		--		--	
Sulfate	mg/L		**0.09**	J	**0.3**		**3.5**		**1.2**		**2.7**		**0.066**	J	**13.9**		**1.6**		**10.2**		**71.2**		**0.103**	J	**0.112**	J	**7.9**	
Sulfide	mg/L		0.05	UJ	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
Temperature	deg C		**17.42**		**16.94**		**13.93**		**14.96**		**15.1**		**14.15**		**14.51**		**16.28**		**16.56**		**13.64**		**14.44**		**15.2**		**14.58**	
Total Chloride	mg/L		**1.2**		**10.1**		**3.6**		**2.2**		**1.5**		**8.7**		**24.5**		**2**		**1.9**		**5.6**		**2.8**		**6.8**		**10.7**	
Total Cyanide	mg/L		**0.003**	J	**0.008**	J	**0.007**	J	0.003	U	0.003	U	**0.009**	J	**0.005**	J	**0.005**	J	**0.02**		**0.06**		**0.006**	J	**0.07**		**0.01**	
Total Fluoride	mg/L	4	**1.5**		**6.5**		**0.2**		**0.7**		**1**		**1.9**		**0.2**		**0.4**		**3.9**		**0.2**		**0.4**		**0.7**		**0.3**	
Total Organic Carbon	mg/L		--		--		--		--		--		**3**		**7.4**		**7.2**		**1.3**		**2.1**		**7.7**		**6.1**		**2.8**	
Total Organic Halides (TOX)	µg/L		--		--		--		--		--		**4**	J	**10**		10	U	**11**		10	U	10	U	10	U	**5**	J
Volume	Gal		**4**		**30**		**43**		**21**		**4**		**56**		**20**		**6**		**1.2**		**0.8**		**0.4**		**0.4**		**0.4**	
Metals (Dissolved)																												
Aluminum	µg/L		**52**		**373**		50	U	50	U	50	U	50	U	50	U	50	U	**46**	J	50	U	50	U	50	U	50	U
Antimony	µg/L		--		--		--		--		--		0.05	U	**0.05**	J	**0.05**	J	**0.14**		--		--		--		--	
Arsenic	µg/L	150	--		--		--		--		--		**0.49**	J	**0.71**		**19.4**		**5.42**		--		--		--		--	
Beryllium	µg/L		--		--		5	U	5	U	5	U	5	U	5	U	5	U	5	U	--		--		--		--	
Cadmium	µg/L	0.25	--		--		5	U	5	U	5	U	5	U	5	U	5	U	5	U	--		--		--		--	
Calcium metal	µg/L		**17,100**		**23,800**		**39,800**		**27,300**		**24,700**		**46,900**		**75,800**		**69,500**		**12,700**		**33,400**		**83,800**		**67,300**		**66,500**	
Chromium	µg/L		--		--		5	U	5	U	5	U	5	U	5	U	5	U	5	U	--		--		--		--	
Copper	µg/L	3.5	--		--		10	U	10	U	10	U	10	U	10	U	10	U	10	U	--		--		--		--	
Iron	µg/L		**32,600**		**10,800**		**56**		**6,090**		**733**		**11,700**		**28,500**		**11,200**		**19**	J	**32,000**		**22,200**		**18,000**		**4,940**	
Iron 2+	µg/L		**6,000**		**2,000**		**0**		**2,000**		**1,700**		**0**		**2,300**		**2,400**		**0**		**3,600**		**3,200**		**3,400**		**3,400**	
Iron 3+	µg/L		**26,600**		**8,800**		**56**		**4,090**		**-967**		**11,700**		**26,200**		**8,800**		**19**		**28,400**		**19,000**		**14,600**		**1,540**	
Lead	µg/L	0.54	**0.191**		**0.211**		**--**		--		--		0.02	U	0.022	U	**0.03**		0.021	U	--		--		--		--	
Magnesium	µg/L		**11,300**		**7,390**		**17,100**		**14,400**		**10,000**		**18,300**		**40,900**		**38,100**		**3,410**		**21,700**		**46,600**		**34,800**		**36,900**	
Manganese	µg/L		**1,180**		**668**		**2,350**		**425**		**1,070**		**2,030**		**2,380**		**3,130**		**301**		**1,170**		**2,620**		**2,270**		**3,470**	
Mercury	µg/L	0.012	--		--		--		--		--		0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	--		--		--		--	
Nickel	µg/L		--		--		20	U	20	U	20	U	20	U	20	U	20	U	20	U	--		--		--		--	
Potassium	µg/L		**6,860**		**3,300**		**4,190**		**1,220**	J	2,000	U	**5,900**		**8,080**		**1,880**	J	**2,370**		**3,450**		**2,890**		**2,110**		**2,270**	
Silver	µg/L		--		--		10	U	10	U	10	U	10	U	10	U	10	U	10	U	--		--		--		--	
Sodium	µg/L		**6,300**		**18,400**		**8,230**		**12,500**		**9,420**		**17,100**		**19,500**		**13,300**		**13,400**		**9,000**		**12,800**		**16,600**		**15,100**	
Metals (Total)																												
Antimony	µg/L		--		--		--		--		--		0.05	U	**0.05**	J	**0.06**	J	**0.2**		--		--		--		--	
Arsenic	µg/L	5	--		--		--		--		--		**0.63**		**0.95**		**19.3**		**4.74**		--		--		--		--	
Beryllium	µg/L		--		--		--		--		--		5	U	5	U	5	U	5	U	--		--		--		--	
Cadmium	µg/L	5	--		--		--		--		--		5	U	5	U	5	U	5	U	--		--		--		--	
Chromium	µg/L	50	--		--		--		--		--		5	U	5	U	**5.8**		5	U	--		--		--		--	
Copper	µg/L	1,300	--		--		--		--		--		10	U	10	U	**12.6**		**5.5**	J	--		--		--		--	
Lead	µg/L	15	--		--		--		--		--		**0.268**		**0.519**		**2.35**		**1.41**		--		--		--		--	
Mercury	µg/L	2	--		--		--		--		--		0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	--		--		--		--	
Nickel	µg/L		--		--		--		--		--		20	U	20	U	20	U	20	U	--		--		--		--	
Silver	µg/L		--		--		--		--		--		10	U	10	U	10	U	10	U	--		--		--		--	

Notes:

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample
WG-FB = groundwater field blank

Table 4-1
Groundwater and Surface Water Sampling Results - Conventionals and Metals
September and December 2007

	Location ID	Screening Level Values	MW-30-D		MW-30-I		MW-30-I		MW-30-S		MW-30-S		MW-35-A		MW-35-D		MW-35-I		MW-41-D		MW-41-I		MW-46-A		MW-46-A		MW-46-D	
	Sample ID		AV-120607-15		MW-30I-092407		AV-120607-14		MW-30S-092407		AV-120607-13		MW-35A-091807		MW-35D-091807		MW-35-I-091907		MW-41D-091807		MW-41I-091707		MW-46A-091907		MW-96A-091907		MW-46D-091907	
	Sample Date		12/6/2007		9/24/2007		12/6/2007		9/24/2007		12/6/2007		9/18/2007		9/18/2007		9/19/2007		9/18/2007		9/17/2007		9/19/2007		9/19/2007		9/19/2007	
	Sample Time		12:20		11:45		11:30		11:00		10:30		10:45		11:30		07:00		10:00		15:50		16:10		16:20		14:15	
	Sample Matrix		WG		WG		WG		WG		WG		WG		WG		WG		WG		WG		WG		WG-DUP		WG	
Conventionals																												
Alkalinity, Total as CaCO3	mg/L		--		**626**		--		**76**		--		**191**		**216**		**202**		**188**		--		**153**		**150**		**274**	
Ammonia	mg/L		--		**0.11**		--		**1.34**		--		**0.54**		**0.15**		0.05	U	**0.72**		--		**0.37**		**0.37**		**0.78**	
Conductivity	uS		--		**956**		--		**222**		--		**408**		**379**		**368**		**358**		**404**		**377**		--		**530**	
Density	g/ml		--		**1.01**		--		**1**		--		**1**		**1.03**		**1**		**0.94**		--		**1.01**		**0.99**		**0.99**	
Density	none		--		--		--		--		--		--		--		--		--		--		--		--		--	
Dissolved oxygen	mg/L		--		**3.27**		--		**2.3**		--		**0.95**		**0.63**		**2.25**		**0.88**		**1.08**		**1.15**		--		**1.33**	
Free Cyanide	µg/L	5.2	10	U	**5**		10	U	5	U	**20**		5	U	5	U	5	U	5	U	--		5	U	5	U	5	U
Nitrate + Nitrite	mg/L		--		0.05	U	--		**0.32**		--		**0.15**		**0.015**	J	**0.014**	J	**0.035**	J	--		**0.11**		**0.1**		**0.14**	
ortho-Phosphate	mg/L		--		--		--		--		--		**0.05**		**0.4**		**0.28**		0.02	U	--		**0.03**		0.01	U	0.01	U
Orthophosphate as Phosphorus	mg/L		--		**0.29**		--		**0.39**		--		--		--		--		--		--		--		--		--	
Oxidation-Reduction Potential	mV		--		**189.9**		--		**223.1**		--		**-16**		**72**		**131.8**		**-0.9**		**175.2**		**100.4**		--		**129**	
pH	None		--		**6.4**		--		**7.1**		--		**6.18**		**6.18**		**6.38**		**6.36**		**6.16**		**4.99**		--		**4.77**	
Phosphorus	mg/L		--		**0.34**		--		**0.48**		--		**0.98**		**0.45**		**0.34**		**0.34**		--		**0.58**		**0.6**		**0.38**	
Silicon (Dissolved)	µg/L		--		**20,300**		--		**21,700**		--		**35,100**		**31,500**		**26,000**		**37,400**		--		**33,500**		**33,300**		**36,600**	
Specific gravity	none		--		--		--		--		--		--		--		--		--		--		--		--		--	
Sulfate	mg/L		--		**1.6**		--		**2.8**		--		**4.7**		**0.081**	J	**4.4**		**0.5**		--		**14.4**		**14.5**		**16.1**	
Sulfide	mg/L		--		0.05	U	--		**0.08**		--		0.05	U	0.05	U	0.05	U	0.05	U	--		0.05	U	0.05	U	0.05	U
Temperature	deg C		--		**14.31**		--		**16.65**		--		**13.61**		**13.68**		**14.6**		**15.54**		**16.5**		**13.58**		--		**15.73**	
Total Chloride	mg/L		--		**4.5**		--		**1.1**		--		**2.5**		**1.8**		**2.3**		**2.9**		--		**2.6**		**2.6**		**6.3**	
Total Cyanide	mg/L		--		**0.02**		--		**2.1**		--		0.003	U	**0.009**	J	0.003	U	0.003	U	--		**0.007**	J	0.003	U	**0.12**	
Total Fluoride	mg/L	4	**0.3**		**0.3**		**0.2**		**31.2**		**14.3**		**0.2**		**0.2**	J	**0.17**	J	**0.3**		--		**0.2**		**0.2**		**0.3**	
Total Organic Carbon	mg/L		--		**6.1**		--		**3.2**		--		--		--		--		--		--		--		--		--	
Total Organic Halides (TOX)	µg/L		--		**7**	J	--		**6**	J	--		--		--		--		--		--		--		--		--	
Volume	Gal		--		**0.4**		--		**0.4**		--		**0.6**		**0.3**		**0.4**		**0.6**		**0.3**		**0.4**		--		**0.4**	
Metals (Dissolved)																												
Aluminum	µg/L		--		50	U	--		**67**		--		50	U	50	U	50	U	50	U	--		50	U	50	U	50	U
Antimony	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Arsenic	µg/L	150	--		--		--		--		--		--		--		--		--		--		--		--		--	
Beryllium	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Cadmium	µg/L	0.25	--		--		--		--		--		--		--		--		--		--		--		--		--	
Calcium metal	µg/L		--		**105,000**		--		**5,010**		--		**32,900**		**47,300**		**43,300**		**36,600**		--		**29,700**		**29,600**		**50,300**	
Chromium	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Copper	µg/L	3.5	--		--		--		--		--		--		--		--		--		--		--		--		--	
Iron	µg/L		--		**328**		--		**765**		--		**28,700**		**2,780**		**3.1**	J	**11,600**		--		**21,600**		**21,300**		**13,500**	
Iron 2+	µg/L		--		**600**		--		**0**		--		**1,600**		**2,200**		**0**		**4,800**		**0**		**3,200**		--		**2,300**	
Iron 3+	µg/L		--		**-272**		--		**765**		--		**27,100**		**580**		**3.1**		**6,800**				**18,400**		**21,300**		**11,200**	
Lead	µg/L	0.54	--		--		--		--		--		--		--		--		--		--		--		--		--	
Magnesium	µg/L		--		**49,500**		--		**1,870**		--		**19,900**		**20,600**		**19,500**		**19,700**		--		**16,800**		**16,700**		**35,000**	
Manganese	µg/L		--		**4,420**		--		**25.8**		--		**920**		**644**		**62.6**		**541**		--		**811**		**797**		**1,420**	
Mercury	µg/L	0.012	--		--		--		--		--		0.2	UJ	0.2	UJ	--		0.2	UJ	--		0.2	UJ	0.2	UJ	0.2	UJ
Nickel	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Potassium	µg/L		--		**4,320**		--		**1,660**	J	--		**3,350**	J	**2,970**	J	**1,810**	J	**1,580**	J	--		3,400	UJ	**3,890**	J	2,000	UJ
Silver	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Sodium	µg/L		--		**62,900**		--		**59,700**		--		**10,500**		**8,550**		**11,100**		**8,670**		--		**8,880**		**8,920**		**16,800**	
Metals (Total)			--				--				--																	
Antimony	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Arsenic	µg/L	5	--		--		--		--		--		--		--		--		--		--		--		--		--	
Beryllium	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Cadmium	µg/L	5	--		--		--		--		--		--		--		--		--		--		--		--		--	
Chromium	µg/L	50	--		--		--		--		--		--		--		--		--		--		--		--		--	
Copper	µg/L	1,300	--		--		--		--		--		--		--		--		--		--		--		--		--	
Lead	µg/L	15	--		--		--		--		--		--		--		--		--		--		--		--		--	
Mercury	µg/L	2	--		--		--		--		--		--		--		--		--		--		--		--		--	
Nickel	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	
Silver	µg/L		--		--		--		--		--		--		--		--		--		--		--		--		--	

Notes:

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample
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Table 4-1
Groundwater and Surface Water Sampling Results - Conventionals and Metals
September and December 2007

	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	MW-46-I MW-46I-091907 9/19/2007 13:20 WG		MW-47-A MW-47A-092007 9/20/2007 12:25 WG		MW-47-D MW-47D-092007 9/20/2007 11:40 WG		MW-47-I MW-47I-092007 9/20/2007 11:00 WG		MW-48-A MW-48A-092007 9/20/2007 13:35 WG		MW-48-D MW-48D-092007 9/20/2007 14:35 WG		MW-48-I MW-48I-092007 9/20/2007 15:35 WG		MW-49-D MW-49D-092507 9/25/2007 10:10 WG		MW-50-A MW-50A-092407 9/24/2007 13:45 WG		MW-50-D MW-50D-092407 9/24/2007 15:15 WG		MW-50-S MW-50S-092507 9/25/2007 09:30 WG		MW-51-A MW-51A-092507 9/25/2007 12:35 WG		MW-51-D MW-51D-092507 9/25/2007 11:40 WG		MW-51-I MW-51I-092507 9/25/2007 10:45 WG	
Conventionals																														
Alkalinity, Total as CaCO3	mg/L		**388**		**252**		**166**		**134**		**197**		**388**		**1,400**		**218**		**290**		**199**		**226**		**383**		**386**		**394**	
Ammonia	mg/L		**0.009**	J	**0.85**		**0.26**		**0.047**	J	**0.68**		**0.39**		**0.98**		**0.82**		**0.21**		**0.78**		**0.08**		**0.37**		**1.93**		**0.017**	J
Conductivity	uS		**773**		**482**		**316**		**270**		**419**		**760**		**5182**		**462**		**536**		**420**		**455**		**717**		**667**		**744**	
Density	g/ml		**1**		--		--		--		--		--		--		**1.03**		**1**		**1**		**1.01**		**1.01**		**1.02**		**1.01**	
Density	none		--		--		--		--		--		--		--		--		--		--		--		--		--		--	
Dissolved oxygen	mg/L		**0.99**		**2**		**0.52**		**2.84**		**1.02**		**0.49**		**0.36**		**0.99**		**1.34**		**0.57**		**5.71**		**0.48**		**0.7**		**1.86**	
Free Cyanide	µg/L	5.2	5	U	5	U	5	U	5	U	5	U	**14**		5	U	5	U	5	U	5	U	5	U	5	U	5	U	**51**	
Nitrate + Nitrite	mg/L		**3.95**		**0.08**		**0.03**	J	**1.82**		**0.038**	J	**0.021**	J	**0.61**		**0.06**		0.05	U	**0.036**	J	0.05	U	**0.014**	J	**0.09**		0.05	U
ortho-Phosphate	mg/L		**0.22**		**0.03**		**0.02**		**0.09**		**0.06**		**0.16**		**4.85**		--		--		--		--		--		--		--	
Orthophosphate as Phosphorus	mg/L		--		--		--		--		--		--		--		**0.06**		**0.06**		**0.06**		**0.28**		**0.04**		**0.05**		**0.14**	
Oxidation-Reduction Potential	mV		**319.5**		**58.9**		**64.5**		**256.8**		**38.5**		**-2.3**		**-185.1**		**29.8**		**38.2**		**19.4**		**180.8**		**18.4**		**23.2**		**266.8**	
pH	None		**6.14**		**5.89**		**6.31**		**6.17**		**6.18**		**6.82**		**10**		**6.37**		**6.18**		**6.38**		**6.62**		**6.61**		**6.5**		**6.52**	
Phosphorus	mg/L		**0.21**		**0.99**		**0.16**		**0.08**		**0.66**		**0.31**		**4.96**		**0.82**		**0.38**		**1.06**		**0.29**		**0.48**		**0.87**		**0.14**	
Silicon (Dissolved)	µg/L		**30,400**		**32,700**	J	**32,000**	J	**26,400**	J	**27,200**	J	**28,000**	J	**25,400**	J	**35,600**		**26,200**		**34,600**		**24,300**		**25,900**		**30,300**		--	
Specific gravity	none		--		**1.03**		**1.01**		**0.99**		**1.02**		**1.02**		**1.01**		--		--		--		--		--		--		--	
Sulfate	mg/L		**36.9**		**7.2**		**5.1**		**10.8**		**15.5**		**10.9**		**28.4**		**0.088**	J	**13.1**		**8**		**25.2**		**11.2**		**1**		**19.2**	
Sulfide	mg/L		**0.11**	J	0.05	UJ	0.05	UJ	0.05	UJ	0.05	UJ	0.05	UJ	**0.3**	J	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	**0.004**	J	0.05	U
Temperature	deg C		**14.54**		**14.48**		**13.52**		**13.76**		**13.09**		**13.18**		**13.75**		**13.26**		**13.61**		**13.73**		**14.51**		**12.92**		**13**		**13.57**	
Total Chloride	mg/L		**4.3**		**2.1**		**1.8**		**2.2**		**4.2**		**2.2**		**2.1**		**3.5**		**4**		**4.2**		**1.2**		**4.8**		**5.3**		**2.4**	
Total Cyanide	mg/L		**0.36**		**0.03**		**0.009**	J	**0.01**		**0.02**		**0.54**		**187**		**0.005**	J	**0.05**		**0.06**		**0.01**		**0.06**		**0.11**		**0.76**	
Total Fluoride	mg/L	4	**1.9**		**0.6**		**0.2**		**0.2**		**0.3**		**17.4**		**788**		**0.3**		**0.3**		**0.3**		**0.5**		**0.6**		**0.5**		**7.3**	
Total Organic Carbon	mg/L		--		--		--		--		--		--		--		**4.5**		**2.6**		**2.5**		**5.6**		**3.2**		**2.9**		**6.1**	
Total Organic Halides (TOX)	µg/L		--		--		--		--		--		--		--		10	U	**6**	J	10	U	**4**	J	**7**	J	**5**	J	**4**	J
Volume	Gal		**1.5**		**0.8**		**0.4**		**0.4**		**0.8**		**1**		**0.5**		**0.4**		**0.4**		**0.4**		**0.6**		**0.8**		**0.4**		**0.5**	
Metals (Dissolved)																														
Aluminum	µg/L		50	U	50	U	50	U	**31**	J	50	U	50	U	**393**		50	U	50	U	50	U	50	U	50	U	50	U	--	
Antimony	µg/L		--		--		--		--		--		--		--		--		--		--		--		**0.06**	J	**0.03**	J	--	
Arsenic	µg/L	150	--		--		--		--		--		--		--		--		--		--		--		**6.47**		**1.28**		--	
Beryllium	µg/L		--		--		--		--		--		--		--		--		--		--		--		5	U	5	U	--	
Cadmium	µg/L	0.25	--		--		--		--		--		--		--		--		--		--		--		5	U	5	U	--	
Calcium metal	µg/L		**49,900**		**22,100**		**31,300**		**24,800**		**21,900**		**24,500**		**10,100**		**43,000**		**54,100**		**38,700**		**26900**		**64,900**		**75,400**		--	
Chromium	µg/L		--		--		--		--		--		--		--		--		--		--		--		5	U	5	U	--	
Copper	µg/L	3.5	--		--		--		--		--		--		--		--		--		--		--		10	U	10	U	--	
Iron	µg/L		**75**		**20,300**		**5,670**		20	U	**8,450**		**4,980**		**65,900**		**22,800**		**6,370**		**17,600**		**15**	J	**6,550**		**25,100**		--	
Iron 2+	µg/L		**0**		**2,700**		**4,200**		**0**		**3,100**		**2,800**		--		**2,700**		**2,400**		**3,000**		**0**		**3,900**		**3,400**		**0**	
Iron 3+	µg/L		**75**		**17,600**		**1,470**		**20**		**5,350**		**2,180**		**65,900**		**20,100**		**3,970**		**14,600**		**15**		**2,650**		**21,700**			
Lead	µg/L	0.54	--		--		--		--		--		--		--		--		--		--		--		**0.03**		0.02	U	--	
Magnesium	µg/L		**27,900**		**13,400**		**16,100**		**12,500**		**10,900**		**13,500**		**867**		**21,200**		**21,200**		**19,500**		**12,400**		**28,500**		**37,000**		--	
Manganese	µg/L		**252**		**545**		**142**		**1.9**	J	**723**		**96.8**		**274**		**2,550**		**2,990**		**2,040**		**461**		**3,550**		**2,790**		--	
Mercury	µg/L	0.012	0.2	UJ	--		--		--		--		--		--		--		--		--		--		0.2	UJ	0.2	UJ	--	
Nickel	µg/L		--		--		--		--		--		--		--		--		--		--		--		20	U	20	U	--	
Potassium	µg/L		**973**	J	**4,730**		2,000	U	2,000	U	**3,110**		**1,460**	J	4,000	U	**2,060**		**6,360**		**1,470**	J	**904**	J	**7,190**		**2,990**		--	
Silver	µg/L		--		--		--		--		--		--		--		--		--		--		--		10	U	10	U	--	
Sodium	µg/L		**102,000**		**68,000**		**9,170**		**13,000**		**51,000**		**148,000**		**1,470,000**		**7,430**		**22,600**		**8,330**		**63,000**		**54,100**		**18,200**		--	
Metals (Total)																														
Antimony	µg/L		--		--		--		--		--		--		--		--		--		--		--		**0.06**	J	**0.04**	J	**0.14**	
Arsenic	µg/L	5	--		--		--		--		--		--		--		--		--		--		--		**7.99**		**1.04**		**2.44**	
Beryllium	µg/L		--		--		--		--		--		--		--		--		--		--		--		5	U	5	U	**0.5**	J
Cadmium	µg/L	5	--		--		--		--		--		--		--		--		--		--		--		5	U	5	U	5	U
Chromium	µg/L	50	--		--		--		--		--		--		--		--		--		--		--		5	U	5	U	**7.9**	
Copper	µg/L	1,300	--		--		--		--		--		--		--		--		--		--		--		10	U	10	U	**16.7**	
Lead	µg/L	15	--		--		--		--		--		--		--		--		--		--		--		**0.338**		**0.138**		**3.21**	
Mercury	µg/L	2	--		--		--		--		--		--		--		--		--		--		--		0.2	UJ	0.2	UJ	0.2	UJ
Nickel	µg/L		--		--		--		--		--		--		--		--		--		--		--		20	U	20	U	20	U
Silver	µg/L		--		--		--		--		--		--		--		--		--		--		--		10	U	10	U	10	U

Notes:
Refer to Section 3.1 for a discussion of screening level selection.
Detected values are shown in bold.
Shaded values exceed screening levels. However, when non-detect
values at reporting limits exceed screening levels, these concentrations
were not shaded.

J = the result is an estimated concenration that is less than the
reporting limits but greater than or equal to the detection limit
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample
WG-FB = groundwater field blank

Table 4-1
Groundwater and Surface Water Sampling Results - Conventionals and Metals
September and December 2007

	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	MW-51-I AV-120607-17 12/6/2007 13:45 WG		MW-8-A MW-8A-092107 9/21/2007 12:50 WG		MW-8-A MW-8A-FB-092107 9/21/2007 13:40 WG-FB		MW-8-D MW-58D-072107 9/21/2007 11:45 WG-DUP		MW-8-D MW-8D-092107 9/21/2007 11:35 WG		MW-94-1-A MW-94-1A-091807 9/18/2007 WG		MW-94-1-D MW-94-1D-091807 9/18/2007 WG		MW-94-1-I MW-94-1I-091807 9/18/2007 WG		MW-94-2-A MW-144-2A-091807 9/18/2007 WG-DUP		MW-94-2-A MW-94-2A-091807 9/18/2007 WG		MW-94-2-D MW-94-2D-091807 9/18/2007 WG		MW-94-2-I MW-94-2I-091907 9/19/2007 WG		PW-19 PW19-092607 9/26/2007 11:00 WG		PW-20 PW-20-092607 9/26/2007 11:30 WG	
Conventionals																														
Alkalinity, Total as CaCO3	mg/L		**396**		**185**		--		**166**		**165**		**170**		**194**		**619**		**139**		**142**		**400**		**410**		**228**		**228**	
Ammonia	mg/L		**0.05**		**0.29**		--		**0.09**		**0.09**		**0.12**		**0.97**		**0.031**	J	0.05	U	0.05	U	**1.92**		**0.037**	J	**0.02**	J	0.05	U
Conductivity	uS		--		**402**		**13**		--		**347**		**337**		**381**		**1206**		--		**291**		**817**		**780**		--		--	
Density	g/ml		--		--		--		--		--		--		**0.98**		**1.01**		**1**		**0.97**		**1.01**		**0.99**		**1.02**		**1.01**	
Density	none		**1**		--		--		--		--		--		--		--		--		--		--		--		--		--	
Dissolved oxygen	mg/L		--		**1.07**		**4.64**		--		**1.39**		**0.47**		**0.76**		**2.39**		--		**0.44**		**1.1**		**1.47**		--		--	
Free Cyanide	µg/L	5.2	**6**	J	5	U	--		**18**		**14**		5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Nitrate + Nitrite	mg/L		**0.013**	J	**0.031**	J	--		**0.02**	J	**0.023**	J	**0.2**		**0.1**		**0.42**		**0.029**	J	**0.1**		**0.08**		**0.63**		**0.24**		**0.23**	
ortho-Phosphate	mg/L		--		**0.05**		--		**0.02**		**0.01**		**0.34**		**0.03**		**0.17**		**0.18**		**0.18**		**0.04**		**0.1**		--		--	
Orthophosphate as Phosphorus	mg/L		**0.11**		--		--		--		--		--		--		--		--		--		--		--		**0.35**		**0.26**	
Oxidation-Reduction Potential	mV		--		**38.8**		**479**		--		**33.9**		**32.8**		**32.9**		**132.1**		--		**171.2**		**24.8**		**96.7**		--		--	
pH	None		--		**6.6**		**6.04**		--		**7.33**		**6.4**		**6.06**		**6.57**		--		**6.74**		**6.34**		**6.57**		--		--	
Phosphorus	mg/L		**0.42**		**0.37**		--		**0.11**		**0.1**		--		**0.38**		**0.16**		**0.17**		**0.18**		**0.49**		**0.12**		**0.36**		**0.29**	
Silicon (Dissolved)	µg/L		**19,200**		**25,300**	J	--		**26,100**	J	**26,000**	J	**25,200**		**37,100**		**27,400**		**23,400**		**23,100**		**37,100**		**27,700**		**22,800**		**23,100**	
Specific gravity	none		--		**1**		--		**1.04**		**0.99**		--		--		--		--		--		--		--		--		--	
Sulfate	mg/L		**19.8**		**13.9**		--		**15.6**		**15.6**		**8.4**		**3.5**		**25.4**		**15.7**		**15.7**		**19.2**		**31.4**		**12.6**		**11.7**	
Sulfide	mg/L		**0.14**	J	0.05	UJ	--		0.05	UJ	0.05	UJ	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
Temperature	deg C		--		**13.44**		**20.43**		--		**13.07**		**13.07**		**13.53**		**14.07**		--		**13.1**		**13.8**		**14.62**		--		--	
Total Chloride	mg/L		**1.8**		**3.9**		--		**3.3**		**3.3**		**2.6**		**4.5**		**49.1**		**3.3**		**3.3**		**19.7**		**5.7**		**3.8**		**3.8**	
Total Cyanide	mg/L		**0.88**		**0.008**	J	--		**0.1**		**0.1**		**0.004**	J	**0.02**		**0.04**		0.003	U	**0.004**	J	**0.07**		**0.03**		**0.006**	J	**0.006**	J
Total Fluoride	mg/L	4	**6.6**		**0.3**		--		**0.4**		**0.4**		**0.4**		**0.2**		**0.3**		**0.2**		**0.2**		**0.2**		**8.7**		**0.5**		**0.5**	
Total Organic Carbon	mg/L		**6.3**		**2**		--		**1.2**		**1.1**		--		--		--		**0.42**	J	**0.36**	J	**10.3**		**4.4**		--		--	
Total Organic Halides (TOX)	µg/L		**20**		**4**	J	--		**4**	J	**4**	J	--		--		--		4	J	**5**	J	**1,680**		**632**		--		--	
Volume	Gal		--		**0.4**		**0**		--		**0.4**		**0.8**		**0.6**		**0.3**		--		**0.8**		**0.3**		**0.5**		--		--	
Metals (Dissolved)																														
Aluminum	µg/L		50	U	50	U	--		**42**	J	50	U	50	U	50	U	50	U	50	U	50	U	50	U	**71**		50	U	50	U
Antimony	µg/L		--		--		--		--		--		--		--		--		0.05	U	0.05	U	0.05	U	0.05	U	--		--	
Arsenic	µg/L	150	--		--		--		--		--		--		--		--		**2.37**		**2.34**		**0.78**		**0.8**		--		--	
Beryllium	µg/L		--		--		--		--		--		--		--		--		5	U	5	U	5	U	--		5	U	5	U
Cadmium	µg/L	0.25	--		--		--		--		--		--		--		--		5	U	5	U	5	U	--		5	U	5	U
Calcium metal	µg/L		**51,700**		**35,400**		--		**32,300**		**32,100**		**36,000**		**35,100**		**71,000**		**33,300**		**32,900**		**50,900**		**38,500**		**50,400**		**53,400**	
Chromium	µg/L		--		--		--		--		--		--		--		--		5	U	5	U	5	U	--		5	U	5	U
Copper	µg/L	3.5	--		--		--		--		--		--		--		--		10	U	10	U	10	U	--		10	U	10	U
Iron	µg/L		**292**		**9,820**		--		**5,410**		**5,360**		**4,820**		**20,100**		**18**	J	20	U	20	U	**15,900**		**1,630**		**54**		**19**	J
Iron 2+	µg/L		--		**2,400**		**0**		--		**2,500**		**2,200**		**1,800**		**0**		--		**0**		**1,600**		**1,800**		--		--	
Iron 3+	µg/L		**292**		**7,420**				**5,410**		**2,860**		**2,620**		**18,300**		**18**		**20**		**20**		**14,300**		**-170**		**54**		**19**	
Lead	µg/L	0.54	--		--		--		--		--		--		--		--		0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Magnesium	µg/L		**24,100**		**17,000**		--		**16,100**		**16,000**		**16,400**		**21,500**		**37,500**		**14,500**		**14,300**		**32,800**		**18,000**		**19,700**		**19,900**	
Manganese	µg/L		**86.4**		**1310**		--		**116**		**113**		**1,280**		**647**		**138**		**60.2**		**59.1**		**346**		**96**		**807**		**4.1**	J
Mercury	µg/L	0.012	--		--		--		--		--		0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	--		--	
Nickel	µg/L		--		--		--		--		--		--		--		--		20	U	20	U	20	U	--		20	U	20	U
Potassium	µg/L		**2,790**		**3,290**		--		2,000	U	2,000	U	**4,860**		**1,330**	J	**2,140**	J	**5,610**		**5,210**		**3,030**	J	**3,270**	J	**5,690**		**4,900**	
Silver	µg/L		--		--		--		--		--		--		--		--		10	U	10	U	10	U	--		10	U	10	U
Sodium	µg/L		**114,000**		**12,200**		--		**10,800**		**10,800**		**9,280**		**8,750**		**197,000**		**8,650**		**8,550**		**103,000**		**145,000**		**11,000**		**11,100**	
Metals (Total)			--																											
Antimony	µg/L		--		--		--		--		--		--		--		--		0.05	U	0.05	U	0.05	U	0.05	U	--		--	
Arsenic	µg/L	5	--		--		--		--		--		--		--		--		**2.07**		**2.38**		**0.63**		**0.96**		--		--	
Beryllium	µg/L		--		--		--		--		--		--		--		--		5	U	5	U	5	U	**0.6**	J	--		--	
Cadmium	µg/L	5	--		--		--		--		--		--		--		--		5	U	5	U	5	U	5	U	--		--	
Chromium	µg/L	50	--		--		--		--		--		--		--		--		5	U	5	U	5	U	5	U	--		--	
Copper	µg/L	1,300	--		--		--		--		--		--		--		--		10	U	10	U	10	U	10	U	--		--	
Lead	µg/L	15	--		--		--		--		--		--		--		--		**0.053**		**0.096**		**0.369**		**0.036**		--		--	
Mercury	µg/L	2	--		--		--		--		--		--		--		--		0.2	UJ	0.2	UJ	0.2	UJ	0.2	UJ	--		--	
Nickel	µg/L		--		--		--		--		--		--		--		--		20	U	20	U	20	U	20	U	--		--	
Silver	µg/L		--		--		--		--		--		--		--		--		10	U	10	U	10	U	10	U	--		--	

Notes:

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample
WG-FB = groundwater field blank

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	SP-2-D SP-2D-092007 9/20/2007 11:45 WG		SP-2-I SP-2I-091907 9/19/2007 16:15 WG		SP-7-D SP-57D-092107 9/21/2007 10:30 WG-DUP		SP-7-D SP-7D-092107 9/21/2007 10:25 WG		SP-7-D SP-7D-121007 12/10/2007 14:15 WG		SP-7-I SP-7I-092007 9/20/2007 16:50 WG		SP-7-I SP-7I-121007 12/10/2007 16:30 WG		SP-7-S SP-7S-092007 9/20/2007 16:30 WG		T3-3 T3-3-092407 9/24/2007 13:00 WG	
PAHs															**J**	--					
1,1'-Biphenyl	µg/L			**0.047**		0.021	U	**0.0031**	**J**	0.02	U	--		**0.0086**	**J**	--		0.019	U	**0.043**	
1-Methylnaphthalene	µg/L			**0.0039**	**J**	0.021	U	**0.0038**	**J**	0.02	U	--		**0.015**	**J**	--		**50**		**2.1**	
2-Methylnaphthalene	µg/L			**0.0069**	**J**	**0.02**	**J**	**0.0036**	**J**	**0.0031**	**J**	--		**0.0045**	**J**	--		**0.059**		**0.053**	
Acenaphthene	µg/L			0.02	U	0.021	U	0.019	U	0.02	U	--		**0.0054**	**J**	--		**1.4**		**0.72**	
Acenaphthylene	µg/L			0.02	U	0.021	U	0.019	U	0.02	U	--		0.021	U	--		0.19	U	0.068	U
Anthracene	µg/L			**0.0038**	**J**	0.021	U	0.019	U	0.02	U	--		0.021	U	--		**0.11**	**J**	**0.13**	
Benzo(a)anthracene	µg/L		0.1	**0.0048**	**J**	0.021	U	0.019	U	**0.0039**	**J**	--		0.021	U	--		**0.054**		0.02	U
Benzo(a)pyrene	µg/L	0.1	1.0	0.02	U	0.021	U	0.019	U	0.02	U	--		0.021	U	--		**0.035**		0.02	U
Benzo(b)fluoranthene	µg/L		0.1	0.02	U	0.021	U	0.019	U	**0.004**	**J**	--		0.11	U	--		**0.049**		0.02	U
Benzo(g,h,i)perylene	µg/L			0.02	U	0.021	U	0.019	U	0.02	U	--						**0.045**		0.02	U
Benzo(k)fluoranthene	µg/L		0.1	0.02	U	0.021	U	0.019	U	0.02	U	--		**0.038**		--		**0.009**	**J**	0.02	U
Chrysene	µg/L		0.01	**0.005**	**J**	0.021	U	0.019	U	**0.0035**	**J**	--		**0.5**		--		**0.097**		0.02	U
Dibenzo(a,h)anthracene	µg/L		0.1	0.02	U	0.021	U	0.019	U	**0.004**	**J**	--		**0.023**		--		**0.011**	**J**	0.02	U
Dibenzofuran	µg/L			0.02	U	0.021	U	0.019	U	0.02	U	--		**0.073**		--		**0.58**		**0.57**	
Fluoranthene	µg/L			**0.0074**	**J**	0.021	U	0.019	U	0.02	U	--		**0.03**		--		**0.2**		**0.034**	
Fluorene	µg/L			**0.01**	**J**	0.021	U	0.019	U	0.02	U	--		**0.048**		--		**2**		**1.2**	
Indeno(1,2,3-cd)pyrene	µg/L		0.1	0.02	U	0.021	U	0.019	U	**0.0041**	**J**	--		**0.21**		--		**0.035**		**0.0036**	**J**
Naphthalene	µg/L			**0.12**		**0.043**		**0.013**	**J**	0.02	U	--		**0.027**		--		**0.64**		**0.47**	
Phenanthrene	µg/L			**0.019**	**J**	0.021	U	**0.0062**	**J**	**0.0069**	**J**	--		**0.12**		--		**1.2**		**0.037**	
Pyrene	µg/L			**0.0077**	**J**	0.021	U	**0.0036**	**J**	**0.0053**	**J**	--		**0.081**		--		**0.46**		**0.15**	
Total PAHs	µg/L			**0.01**		0.02	U	**0.01**		**0.01**		--		**0.01**		--		**0.05**		**0.01**	
PCBs																					
Aroclor 1016	µg/L			0.2	U	0.02	U	--		--		--		--		--		--		--	
Aroclor 1221	µg/L			0.39	U	0.039	U	--		--		--		--		--		--		--	
Aroclor 1232	µg/L			0.2	U	0.02	U	--		--		--		--		--		--		--	
Aroclor 1242	µg/L			0.2	U	0.02	U	--		--		--		--		--		--		--	
Aroclor 1248	µg/L			0.2	U	0.02	U	--		--		--		--		--		--		--	
Aroclor 1254	µg/L			0.2	U	0.02	U	--		--		--		--		--		--		--	
Aroclor 1260	µg/L			0.2	U	0.02	U	--		--		--		--		--		--		--	
Total PCBs	µg/L	0.1		0.39	U	0.039	U	--		--		--		--		--		--		--	
Pesticides																					
4,4'-DDD	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
4,4'-DDE	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
4,4'-DDT	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Aldrin	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
alpha-BHC	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
alpha-Chlordane	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
beta-BHC	µg/L			0.0097	U	**0.014**	**J**	--		--		--		--		--		--		--	
delta-BHC	µg/L			0.0097	U	**0.0025**	**J**	--		--		--		--		--		--		--	
Dieldrin	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Endosulfan I	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Endosulfan II	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Endosulfan sulfate	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Endrin	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Endrin aldehyde	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
Endrin ketone	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	
gamma-BHC (Lindane)	µg/L			0.0097	U	**0.0017**	**J**	--		--		--		--		--		--		--	
gamma-Chlordane	µg/L			0.0097	U	**0.0058**	**J**	--		--		--		--		--		--		--	
Heptachlor	µg/L			0.0097	U	0.0098	U	--		--		--		--		--		--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	SP-2-D SP-2D-092007 9/20/2007 11:45 WG		SP-2-I SP-2I-091907 9/19/2007 16:15 WG		SP-7-D SP-57D-092107 9/21/2007 10:30 WG-DUP		SP-7-D SP-7D-092107 9/21/2007 10:25 WG		SP-7-D SP-7D-121007 12/10/2007 14:15 WG		SP-7-I SP-7I-092007 9/20/2007 16:50 WG		SP-7-I SP-7I-121007 12/10/2007 16:30 WG		SP-7-S SP-7S-092007 9/20/2007 16:30 WG		T3-3 T3-3-092407 9/24/2007 13:00 WG	
Heptachlor epoxide	µg/L			0.0097	U	**0.0067**	**J**	--		--		--		--		--		--		--	
Methoxychlor	µg/L			0.0097	U	**0.0066**	**J**	--		--		--		--		--		--		--	
Toxaphene	µg/L			0.49	U	0.49	U	--		--		--		--		--		--		--	
SVOC																					
1,2,4-Trichlorobenzene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
1,2-Dichlorobenzene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
1,2-Diphenylhydrazine	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
1,3-Dichlorobenzene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
1,4-Dichlorobenzene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2,4,5-Trichlorophenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2,4,6-Trichlorophenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2,4-Dichlorophenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2,4-Dimethylphenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2,4-Dinitrophenol	µg/L			25	U	24	U	--		--		--		--		--		--		--	
2,4-Dinitrotoluene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2,6-Dinitrotoluene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2-Chloronaphthalene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2-Chlorophenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2-Methylphenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
2-Nitroaniline	µg/L			25	U	24	U	--		--		--		--		--		--		--	
2-Nitrophenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
3,3'-Dichlorobenzidine	µg/L			25	U	24	U	--		--		--		--		--		--		--	
3-Nitroaniline	µg/L			25	U	24	U	--		--		--		--		--		--		--	
4,6-Dinitro-2-methylphenol	µg/L			25	U	24	U	--		--		--		--		--		--		--	
4-Bromophenylphenylether	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
4-Chloro-3-methylphenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
4-Chloroaniline	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
4-Chlorophenyl-phenylether	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
4-Methylphenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
4-Nitroaniline	µg/L			25	U	24	U	--		--		--		--		--		--		--	
4-Nitrophenol	µg/L			25	U	24	U	--		--		--		--		--		--		--	
Aniline	µg/L			25	U	24	U	--		--		--		--		--		--		--	
Azobenzene	µg/L			--		--		--		--		--		--		--		--		--	
Benzidine	µg/L			50	U	48	U	--		--		--		--		--		--		--	
Benzoic acid	µg/L			25	U	24	U	--		--		--		--		--		--		--	
Benzyl alcohol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
bis(2-Chloroethoxy)methane	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
bis(2-Chloroethyl)ether	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
bis(2-chloroisopropyl)ether	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
bis(2-Ethylhexyl)phthalate	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Butylbenzylphthalate	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Carbazole	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Diethylphthalate	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Dimethylphthalate	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Di-n-butylphthalate	µg/L			**0.43**	**J**	9.6	U	--		--		--		--		--		--		--	
Di-n-octylphthalate	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Hexachlorobenzene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Hexachlorobutadiene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Hexachlorocyclopentadiene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Hexachloroethane	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	

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Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	SP-2-D SP-2D-092007 9/20/2007 11:45 WG		SP-2-I SP-2I-091907 9/19/2007 16:15 WG		SP-7-D SP-57D-092107 9/21/2007 10:30 WG-DUP		SP-7-D SP-7D-092107 9/21/2007 10:25 WG		SP-7-D SP-7D-121007 12/10/2007 14:15 WG		SP-7-I SP-7I-092007 9/20/2007 16:50 WG		SP-7-I SP-7I-121007 12/10/2007 16:30 WG		SP-7-S SP-7S-092007 9/20/2007 16:30 WG		T3-3 T3-3-092407 9/24/2007 13:00 WG	
Isophorone	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Nitrobenzene	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
n-Nitroso-di-methylamine	µg/L			25	U	24	U	--		--		--		--		--		--		--	
N-Nitroso-di-n-propylamine	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
n-Nitrosodiphenylamine	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
Pentachlorophenol	µg/L			25	U	24	U	--		--		--		--		--		--		--	
Phenol	µg/L			10	U	9.6	U	--		--		--		--		--		--		--	
TPH																					
TPH-Diesel Range	µg/L	500		--		--		--		--		240	U	--		**5,800**		--		**2,600**	J
TPH-Gasoline Range	µg/L	800		--		--		--		--		250	U	--		250	U	--		**280**	J
TPH-Residual Range	µg/L	500		--		--		--		--		480	U	--		**830**		--		**450**	J
VOC																					
1,1,1,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,1,1-Trichloroethane	µg/L	200		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,1,2,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,1,2-Trichloroethane	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,1-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,1-Dichloroethene	µg/L	7		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,1-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,2,3-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
1,2,3-Trichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,2,4-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
1,2,4-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	**3.4**	
1,2-Dibromo-3-chloropropane	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
1,2-Dibromoethane	µg/L			1	U	1	U	1	U	1	U	--		1	U	--		1	U	1	U
1,2-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,2-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,3,5-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	**0.21**	J
1,3-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,3-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
1,4-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
2,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
2-Butanone	µg/L			20	U	20	U	20	U	20	U	--		20	U	--		20	U	20	U
2-Chloroethylvinylether	µg/L			10	U	10	U	10	U	10	U	--		10	U	--		10	U	10	U
2-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
2-Hexanone	µg/L			20	U	20	U	20	U	20	U	--		20	U	--		20	U	20	U
4-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
4-Isopropyltoluene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
4-Methyl-2-pentanone	µg/L			20	U	20	U	20	U	20	U	--		20	U	--		20	U	20	U
Acetone	µg/L			20	U	20	U	20	U	20	U	--		20	U	--		20	U	20	U
Acrolein	µg/L			20	U	20	U	20	U	20	U	--		20	U	--		20	U	20	U
Acrylonitrile	µg/L			10	U	10	U	10	U	10	U	--		10	U	--		10	U	10	U
Benzene	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		**0.26**	J	0.5	U
Bromobenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
Bromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Bromodichloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Bromoform	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Bromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Carbon disulfide	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	SP-2-D SP-2D-092007 9/20/2007 11:45 WG		SP-2-I SP-2I-091907 9/19/2007 16:15 WG		SP-7-D SP-57D-092107 9/21/2007 10:30 WG-DUP		SP-7-D SP-7D-092107 9/21/2007 10:25 WG		SP-7-D SP-7D-121007 12/10/2007 14:15 WG		SP-7-I SP-7I-092007 9/20/2007 16:50 WG		SP-7-I SP-7I-121007 12/10/2007 16:30 WG		SP-7-S SP-7S-092007 9/20/2007 16:30 WG		T3-3 T3-3-092407 9/24/2007 13:00 WG	
Carbon tetrachloride	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Chlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Chloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Chloroform	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Chloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
cis-1,2-Dichloroethene	µg/L	70		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
cis-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Dibromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Dibromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Dichlorodifluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Dichloromethane	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
Ethylbenzene	µg/L	700		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		**0.15**	**J**	**0.13**	**J**
Hexachlorobutadiene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		2	U	2	U
Isopropylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		**13**		**1.3**	**J**
m,p-Xylenes	µg/L	1,000[2,]		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	**0.52**	
Methyltert-butylether	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Naphthalene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		**1**	**J**	**11**	
n-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		**3.3**		2	U
n-Propylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		**16**		**2.1**	
o-Xylene	µg/L	1,000[2]		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		**0.2**	**J**	0.5	U
sec-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		**2.5**		**1.4**	**J**
Styrene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
tert-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	--		2	U	--		**0.37**	**J**	**0.37**	**J**
Tetrachloroethene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Toluene	µg/L	1,000		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		**0.59**		**0.2**	**J**
trans-1,2-Dichloroethene	µg/L	100		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
trans-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Trichloroethene	µg/L	2.5		0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Trichlorofluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		0.5	U	--		0.5	U	0.5	U
Vinyl chloride	µg/L	0.025		0.042	U	0.042	U	0.5	U	0.042	U	--		0.042	U	--		0.042	U	0.042	U

Notes:

[1] TEF Factors from Amendatory Section WAC 173-340-708

[2] Screening level is for total xylenes which is the sum of m,p-Xylenes and 0-Xylenes

Total PAHs calculated using toxicity equivalency factors for the seven PAHs, per MTCA. Non-detect samples were summed using half the reported concentration.
Refer to Section 3.1 for a discussion of screening level selection.
Detected values are shown in bold.
Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit
TEF = Toxic Equivalency Factors
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors^1	EVGR-02A EVGR-02A-092507 9/25/2007 14:15 WG		EVGR-02D EVGR-02D-092507 9/25/2007 14:20 WG		EVGR-02I EVGR-02I-092507 9/25/2007 15:00 WG		EVGR-02S EVGR-02S-092507 9/25/2007 15:00 WG		MW-30-D AV-120607-15 12/6/2007 12:20 WG		MW-30-I AV-120607-14 12/6/2007 11:30 WG		MW-30-S AV-120607-13 12/6/2007 10:30 WG		MW-35-A MW-35A-091807 9/18/2007 10:45 WG		MW-35-D MW-35D-091807 9/18/2007 11:30 WG	
PAHs																					
1,1'-Biphenyl	µg/L			**0.0046**	**J**	**0.018**	**J**	**0.065**		**0.11**		**0.0039**	**J**	0.019	U	0.019	U	0.021	U	0.02	U
1-Methylnaphthalene	µg/L			0.021	U	0.02	U	**0.0081**	**J**	**0.0073**	**J**	0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
2-Methylnaphthalene	µg/L			0.021	U	**0.0037**	**J**	**0.01**	**J**	**0.013**	**J**	0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Acenaphthene	µg/L			0.021	U	0.02	U	0.02	U	**0.011**	**J**	0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Acenaphthylene	µg/L			0.021	U	0.02	U	0.02	U	**0.0084**	**J**	0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Anthracene	µg/L			0.021	U	**0.0043**	**J**	**0.0051**	**J**	**0.013**	**J**	0.019	U	**0.0037**	**J**	0.019	U	0.021	U	0.02	U
Benzo(a)anthracene	µg/L		0.1	**0.0068**	**J**	**0.0038**	**J**	**0.0065**	**J**	**0.023**		**0.0048**	**J**	0.019	U	**0.0071**	**J**	0.021	U	0.02	U
Benzo(a)pyrene	µg/L	0.1	1.0	0.021	U	0.02	U	0.02	U	**0.019**	**J**	0.019	U	0.019	U	**0.0072**	**J**	0.021	U	0.02	U
Benzo(b)fluoranthene	µg/L		0.1	**0.0064**	**J**	0.02	U	**0.0055**	**J**	**0.032**		0.019	U	0.019	U	**0.011**	**J**	0.021	U	0.02	U
Benzo(g,h,i)perylene	µg/L			0.021	U	0.02	U	**0.0029**	**J**	**0.018**	**J**	0.019	U	0.019	U	**0.0058**	**J**	0.021	U	0.02	U
Benzo(k)fluoranthene	µg/L		0.1	0.021	U	0.02	U	0.02	U	**0.011**	**J**	0.019	U	0.019	U	**0.0032**	**J**	0.021	U	0.02	U
Chrysene	µg/L		0.01	**0.0042**	**J**	0.02	U	**0.01**	**J**	**0.035**		**0.0043**	**J**	0.019	U	**0.005**	**J**	0.021	U	0.02	U
Dibenzo(a,h)anthracene	µg/L		0.1	0.021	U	0.02	U	0.02	U	**0.0039**	**J**	0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Dibenzofuran	µg/L			0.021	U	0.02	U	0.02	U	**0.0048**	**J**	0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Fluoranthene	µg/L			**0.0089**	**J**	0.02	U	**0.01**	**J**	**0.048**		**0.005**	**J**	0.019	U	**0.0078**	**J**	0.021	U	0.02	U
Fluorene	µg/L			0.021	U	**0.0055**	**J**	**0.02**	**J**	**0.034**		0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Indeno(1,2,3-cd)pyrene	µg/L		0.1	**0.0036**	**J**	0.02	U	**0.0031**	**J**	**0.019**	**J**	0.019	U	0.019	U	**0.0042**	**J**	0.021	U	0.02	U
Naphthalene	µg/L			**0.0075**	**J**	**0.069**		**0.27**		**0.48**		0.019	U	**0.0058**	**J**	**0.0039**	**J**	0.021	U	0.02	U
Phenanthrene	µg/L			**0.007**	**J**	**0.01**	**J**	**0.037**		**0.077**		0.019	U	0.019	U	0.019	U	0.021	U	0.02	U
Pyrene	µg/L			**0.006**	**J**	0.02	U	**0.0088**	**J**	**0.044**		**0.028**		0.019	U	**0.0082**	**J**	0.021	U	0.02	U
Total PAHs	µg/L			**0.01**		**0.01**		**0.01**		**0.03**		**0.01**		**0.01**		**0.01**		0.02	U	0.02	
PCBs																					
Aroclor 1016	µg/L			0.02	U	0.021	U	0.02	U	0.02	U	--		--		--		0.02	U	0.02	U
Aroclor 1221	µg/L			0.04	U	0.042	U	0.04	U	0.04	U	--		--		--		0.039	U	0.039	U
Aroclor 1232	µg/L			0.02	U	0.021	U	0.02	U	0.02	U	--		--		--		0.02	U	0.02	U
Aroclor 1242	µg/L			0.02	U	0.021	U	0.02	U	0.02	U	--		--		--		0.02	U	0.02	U
Aroclor 1248	µg/L			0.02	U	0.021	U	0.02	U	0.02	U	--		--		--		0.02	U	0.02	U
Aroclor 1254	µg/L			0.02	U	0.021	U	0.02	U	0.02	U	--		--		--		0.02	U	0.02	U
Aroclor 1260	µg/L			0.02	U	0.021	U	0.02	U	0.02	U	--		--		--		0.02	U	0.02	U
Total PCBs	µg/L	0.1		0.04	U	0.042	U	0.04	U	0.04	U	--		--		--		0.039	U	0.039	U
Pesticides																					
4,4'-DDD	µg/L			0.01	U	0.016	U	0.01	U	0.0099	U	--		--		--		--		--	
4,4'-DDE	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
4,4'-DDT	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Aldrin	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
alpha-BHC	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
alpha-Chlordane	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
beta-BHC	µg/L			0.01	U	0.011	U	0.01	U	**0.0009**	**J**	--		--		--		--		--	
delta-BHC	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Dieldrin	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Endosulfan I	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Endosulfan II	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Endosulfan sulfate	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Endrin	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Endrin aldehyde	µg/L			0.01	U	0.011	U	0.01	U	**0.0019**	**J**	--		--		--		--		--	
Endrin ketone	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
gamma-BHC (Lindane)	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
gamma-Chlordane	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Heptachlor	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	EVGR-02A EVGR-02A-092507 9/25/2007 14:15 WG		EVGR-02D EVGR-02D-092507 9/25/2007 14:20 WG		EVGR-02I EVGR-02I-092507 9/25/2007 15:00 WG		EVGR-02S EVGR-02S-092507 9/25/2007 15:00 WG		MW-30-D AV-120607-15 12/6/2007 12:20 WG		MW-30-I AV-120607-14 12/6/2007 11:30 WG		MW-30-S AV-120607-13 12/6/2007 10:30 WG		MW-35-A MW-35A-091807 9/18/2007 10:45 WG		MW-35-D MW-35D-091807 9/18/2007 11:30 WG	
Heptachlor epoxide	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Methoxychlor	µg/L			0.01	U	0.011	U	0.01	U	0.0099	U	--		--		--		--		--	
Toxaphene	µg/L			0.5	U	0.52	U	0.5	U	0.5	U	--		--		--		--		--	
SVOC																					
1,2,4-Trichlorobenzene	µg/L			--		--		--		--		--		--		--		--		--	
1,2-Dichlorobenzene	µg/L			--		--		--		--		--		--		--		--		--	
1,2-Diphenylhydrazine	µg/L			--		--		--		--		--		--		--		--		--	
1,3-Dichlorobenzene	µg/L			--		--		--		--		--		--		--		--		--	
1,4-Dichlorobenzene	µg/L			--		--		--		--		--		--		--		--		--	
2,4,5-Trichlorophenol	µg/L			--		--		--		--		--		--		--		--		--	
2,4,6-Trichlorophenol	µg/L			--		--		--		--		--		--		--		--		--	
2,4-Dichlorophenol	µg/L			--		--		--		--		--		--		--		--		--	
2,4-Dimethylphenol	µg/L			--		--		--		--		--		--		--		--		--	
2,4-Dinitrophenol	µg/L			--		--		--		--		--		--		--		--		--	
2,4-Dinitrotoluene	µg/L			--		--		--		--		--		--		--		--		--	
2,6-Dinitrotoluene	µg/L			--		--		--		--		--		--		--		--		--	
2-Chloronaphthalene	µg/L			--		--		--		--		--		--		--		--		--	
2-Chlorophenol	µg/L			--		--		--		--		--		--		--		--		--	
2-Methylphenol	µg/L			--		--		--		--		--		--		--		--		--	
2-Nitroaniline	µg/L			--		--		--		--		--		--		--		--		--	
2-Nitrophenol	µg/L			--		--		--		--		--		--		--		--		--	
3,3'-Dichlorobenzidine	µg/L			--		--		--		--		--		--		--		--		--	
3-Nitroaniline	µg/L			--		--		--		--		--		--		--		--		--	
4,6-Dinitro-2-methylphenol	µg/L			--		--		--		--		--		--		--		--		--	
4-Bromophenylphenylether	µg/L			--		--		--		--		--		--		--		--		--	
4-Chloro-3-methylphenol	µg/L			--		--		--		--		--		--		--		--		--	
4-Chloroaniline	µg/L			--		--		--		--		--		--		--		--		--	
4-Chlorophenyl-phenylether	µg/L			--		--		--		--		--		--		--		--		--	
4-Methylphenol	µg/L			--		--		--		--		--		--		--		--		--	
4-Nitroaniline	µg/L			--		--		--		--		--		--		--		--		--	
4-Nitrophenol	µg/L			--		--		--		--		--		--		--		--		--	
Aniline	µg/L			--		--		--		--		--		--		--		--		--	
Azobenzene	µg/L			--		--		--		--		--		--		--		--		--	
Benzidine	µg/L			--		--		--		--		--		--		--		--		--	
Benzoic acid	µg/L			--		--		--		--		--		--		--		--		--	
Benzyl alcohol	µg/L			--		--		--		--		--		--		--		--		--	
bis(2-Chloroethoxy)methane	µg/L			--		--		--		--		--		--		--		--		--	
bis(2-Chloroethyl)ether	µg/L			--		--		--		--		--		--		--		--		--	
bis(2-chloroisopropyl)ether	µg/L			--		--		--		--		--		--		--		--		--	
bis(2-Ethylhexyl)phthalate	µg/L			--		--		--		--		--		--		--		--		--	
Butylbenzylphthalate	µg/L			--		--		--		--		--		--		--		--		--	
Carbazole	µg/L			--		--		--		--		--		--		--		--		--	
Diethylphthalate	µg/L			--		--		--		--		--		--		--		--		--	
Dimethylphthalate	µg/L			--		--		--		--		--		--		--		--		--	
Di-n-butylphthalate	µg/L			--		--		--		--		--		--		--		--		--	
Di-n-octylphthalate	µg/L			--		--		--		--		--		--		--		--		--	
Hexachlorobenzene	µg/L			--		--		--		--		--		--		--		--		--	
Hexachlorobutadiene	µg/L			--		--		--		--		--		--		--		--		--	
Hexachlorocyclopentadiene	µg/L			--		--		--		--		--		--		--		--		--	
Hexachloroethane	µg/L			--		--		--		--		--		--		--		--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	EVGR-02A EVGR-02A-092507 9/25/2007 14:15 WG		EVGR-02D EVGR-02D-092507 9/25/2007 14:20 WG		EVGR-02I EVGR-02I-092507 9/25/2007 15:00 WG		EVGR-02S EVGR-02S-092507 9/25/2007 15:00 WG		MW-30-D AV-120607-15 12/6/2007 12:20 WG		MW-30-I AV-120607-14 12/6/2007 11:30 WG		MW-30-S AV-120607-13 12/6/2007 10:30 WG		MW-35-A MW-35A-091807 9/18/2007 10:45 WG		MW-35-D MW-35D-091807 9/18/2007 11:30 WG	
Isophorone	µg/L			--		--		--		--		--		--		--		--		--	
Nitrobenzene	µg/L			--		--		--		--		--		--		--		--		--	
n-Nitroso-di-methylamine	µg/L			--		--		--		--		--		--		--		--		--	
N-Nitroso-di-n-propylamine	µg/L			--		--		--		--		--		--		--		--		--	
n-Nitrosodiphenylamine	µg/L			--		--		--		--		--		--		--		--		--	
Pentachlorophenol	µg/L			--		--		--		--		--		--		--		--		--	
Phenol	µg/L			--		--		--		--		--		--		--		--		--	
TPH																					
TPH-Diesel Range	µg/L	500		--		--		--		--		--		--		--		--		--	
TPH-Gasoline Range	µg/L	800		--		--		--		--		--		--		--		--		--	
TPH-Residual Range	µg/L	500		--		--		--		--		--		--		--		--		--	
VOC																					
1,1,1,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,1,1-Trichloroethane	µg/L	200		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,1,2,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,1,2-Trichloroethane	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,1-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,1-Dichloroethene	µg/L	7		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	**0.45**	**J**
1,1-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,2,3-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
1,2,3-Trichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,2,4-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
1,2,4-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
1,2-Dibromo-3-chloropropane	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
1,2-Dibromoethane	µg/L			1	U	1	U	1	U	1	U	--		--		--		1	U	1	U
1,2-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,2-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,3,5-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
1,3-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,3-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
1,4-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
2,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
2-Butanone	µg/L			20	U	20	U	20	U	20	U	--		--		--		20	U	20	U
2-Chloroethylvinylether	µg/L			10	U	10	U	10	U	10	U	--		--		--		10	U	10	U
2-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
2-Hexanone	µg/L			20	U	20	U	20	U	20	U	--		--		--		20	U	20	U
4-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
4-Isopropyltoluene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
4-Methyl-2-pentanone	µg/L			20	U	20	U	20	U	20	U	--		--		--		20	U	20	U
Acetone	µg/L			20	U	20	U	20	U	20	U	--		--		--		20	U	20	U
Acrolein	µg/L			20	U	20	U	20	U	20	U	--		--		--		20	U	20	U
Acrylonitrile	µg/L			10	U	10	U	10	U	10	U	--		--		--		10	U	10	U
Benzene	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Bromobenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
Bromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Bromodichloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Bromoform	µg/L			0.5	U	0.5	U	0.5	U	**0.31**	**J**	--		--		--		0.5	U	0.5	U
Bromomethane	µg/L			0.5	UJ	0.5	UJ	0.5	UJ	0.5	UJ	--		--		--		0.5	U	0.5	U
Carbon disulfide	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	EVGR-02A EVGR-02A-092507 9/25/2007 14:15 WG		EVGR-02D EVGR-02D-092507 9/25/2007 14:20 WG		EVGR-02I EVGR-02I-092507 9/25/2007 15:00 WG		EVGR-02S EVGR-02S-092507 9/25/2007 15:00 WG		MW-30-D AV-120607-15 12/6/2007 12:20 WG		MW-30-I AV-120607-14 12/6/2007 11:30 WG		MW-30-S AV-120607-13 12/6/2007 10:30 WG		MW-35-A MW-35A-091807 9/18/2007 10:45 WG		MW-35-D MW-35D-091807 9/18/2007 11:30 WG	
Carbon tetrachloride	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Chlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Chloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Chloroform	µg/L			0.5	U	**1.1**		0.5	U	**1.6**		--		--		--		0.5	U	0.5	U
Chloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
cis-1,2-Dichloroethene	µg/L	70		0.5	U	**1.2**		0.5	U	0.5	U	--		--		--		0.5	U	**11**	
cis-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Dibromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Dibromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Dichlorodifluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Dichloromethane	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
Ethylbenzene	µg/L	700		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Hexachlorobutadiene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
Isopropylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
m,p-Xylenes	µg/L	1,000 [2,]		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Methyltert-butylether	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Naphthalene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
n-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
n-Propylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
o-Xylene	µg/L	1,000 [2]		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
sec-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
Styrene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
tert-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	--		--		--		2	U	2	U
Tetrachloroethene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Toluene	µg/L	1,000		0.5	U	0.5	U	**0.12**	**J**	0.5	U	--		--		--		0.5	U	0.5	U
trans-1,2-Dichloroethene	µg/L	100		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	**0.19**	**J**
trans-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Trichloroethene	µg/L	2.5		0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Trichlorofluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	--		--		--		0.5	U	0.5	U
Vinyl chloride	µg/L	0.025		0.042	U	**0.25**	**J**	0.042	U	0.042	U	--		--		--		0.042	U	**0.09**	**J**

Notes:

[1] TEF Factors from Amendatory Section WAC 173-340-708

[2] Screening level is for total xylenes which is the sum of m,p-Xylenes and 0-Xylenes

Total PAHs calculated using toxicity equivalency factors for the seven PAHs, per MTCA. Non-detect samples were summed using half the reported concentration.
Refer to Section 3.1 for a discussion of screening level selection.
Detected values are shown in bold.
Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit
TEF = Toxic Equivalency Factors
U = not detected above the laboratory reporting limit indicated
WG = groundwater
WG-DUP = groundwater duplicate sample

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-35-I MW-35-I-091907 9/19/2007 07:00 WG		MW-41-D MW-41D-091807 9/18/2007 10:00 WG		MW-46-A MW-46A-091907 9/19/2007 16:10 WG		MW-46-A MW-96A-091907 9/19/2007 16:20 WG - DUP		MW-46-D MW-46D-091907 9/19/2007 14:15 WG		MW-46-I MW-46I-091907 9/19/2007 13:20 WG		MW-47-A MW-47A-092007 9/20/2007 12:25 WG		MW-47-D MW-47D-092007 9/20/2007 11:40 WG		MW-47-I MW-47I-092007 9/20/2007 11:00 WG	
PAHs																					
1,1'-Biphenyl	µg/L			**0.003**	**J**	**0.0091**	**J**	**0.0067**	**J**	**0.0079**	**J**	**0.0029**	**J**	**0.0049**	**J**	**0.016**	**J**	0.019	U	0.02	U
1-Methylnaphthalene	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
2-Methylnaphthalene	µg/L			0.019	U	0.02	U	0.019	U	**0.0023**	**J**	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Acenaphthene	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Acenaphthylene	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Anthracene	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	**0.0086**	**J**	**0.028**		0.019	U	0.02	U
Benzo(a)anthracene	µg/L		0.1	0.019	U	0.02	U	**0.0044**	**J**	**0.0041**	**J**	0.019	U	**0.016**	**J**	0.019	U	0.019	U	**0.0044**	**J**
Benzo(a)pyrene	µg/L	0.1	1.0	0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Benzo(b)fluoranthene	µg/L		0.1	0.019	U	0.02	U	**0.0029**	**J**	0.019	U	0.019	U	**0.058**		0.019	U	0.019	U	0.02	U
Benzo(g,h,i)perylene	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	**0.021**		0.019	U	0.019	U	0.02	U
Benzo(k)fluoranthene	µg/L		0.1	0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	**0.014**	**J**	0.019	U	0.019	U	0.02	U
Chrysene	µg/L		0.01	0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	**0.036**		0.019	U	0.019	U	0.02	U
Dibenzo(a,h)anthracene	µg/L		0.1	0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	**0.0059**	**J**	0.019	U	0.019	U	0.02	U
Dibenzofuran	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Fluoranthene	µg/L			0.019	U	0.02	U	**0.0088**	**J**	**0.0068**	**J**	0.019	U	**0.027**		0.019	U	0.019	U	**0.0074**	**J**
Fluorene	µg/L			0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Indeno(1,2,3-cd)pyrene	µg/L		0.1	0.019	U	0.02	U	0.019	U	0.019	U	0.019	U	**0.023**		0.019	U	0.019	U	0.02	U
Naphthalene	µg/L			0.019	U	0.02	U	0.019	U	0.025	U	0.019	U	0.02	U	0.019	U	0.019	U	0.02	U
Phenanthrene	µg/L			0.019	U	0.02	U	**0.0071**	**J**	**0.0065**	**J**	0.019	U	**0.011**	**J**	0.019	U	0.019	U	0.02	U
Pyrene	µg/L			0.019	U	0.02	U	**0.0073**	**J**	**0.0047**	**J**	0.019	U	**0.031**		0.019	U	0.019	U	**0.0051**	**J**
Total PAHs	µg/L			0.01		0.02		**0.01**		**0.01**		0.01	U	**0.02**		0.01		0.01		**0.01**	
PCBs																					
Aroclor 1016	µg/L			0.02	U	0.022	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U
Aroclor 1221	µg/L			0.039	U	0.043	U	0.039	U	0.039	U	0.039	U	0.039	U	0.039	U	0.039	U	0.039	U
Aroclor 1232	µg/L			0.02	U	0.022	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U
Aroclor 1242	µg/L			0.02	U	0.022	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U
Aroclor 1248	µg/L			0.02	U	0.022	U	0.02	U	0.02	U	0.02	U	**0.13**		0.02	U	0.02	U	0.02	U
Aroclor 1254	µg/L			0.02	U	0.022	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U
Aroclor 1260	µg/L			0.02	U	0.022	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U
Total PCBs	µg/L	0.1		0.039	U	0.043	U	0.039	U	0.039	U	0.039	U	**0.13**		0.039	U	0.039	U	0.039	U
Pesticides																					
4,4'-DDD	µg/L			--		--		--		--		--		--		--		--		--	
4,4'-DDE	µg/L			--		--		--		--		--		--		--		--		--	
4,4'-DDT	µg/L			--		--		--		--		--		--		--		--		--	
Aldrin	µg/L			--		--		--		--		--		--		--		--		--	
alpha-BHC	µg/L			--		--		--		--		--		--		--		--		--	
alpha-Chlordane	µg/L			--		--		--		--		--		--		--		--		--	
beta-BHC	µg/L			--		--		--		--		--		--		--		--		--	
delta-BHC	µg/L			--		--		--		--		--		--		--		--		--	
Dieldrin	µg/L			--		--		--		--		--		--		--		--		--	
Endosulfan I	µg/L			--		--		--		--		--		--		--		--		--	
Endosulfan II	µg/L			--		--		--		--		--		--		--		--		--	
Endosulfan sulfate	µg/L			--		--		--		--		--		--		--		--		--	
Endrin	µg/L			--		--		--		--		--		--		--		--		--	
Endrin aldehyde	µg/L			--		--		--		--		--		--		--		--		--	
Endrin ketone	µg/L			--		--		--		--		--		--		--		--		--	
gamma-BHC (Lindane)	µg/L			--		--		--		--		--		--		--		--		--	
gamma-Chlordane	µg/L			--		--		--		--		--		--		--		--		--	
Heptachlor	µg/L			--		--		--		--		--		--		--		--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID	Screening Level Values	TEF Factors[1]	MW-35-I	MW-41-D	MW-46-A	MW-46-A	MW-46-D	MW-46-I	MW-47-A	MW-47-D	MW-47-I
	Sample ID			MW-35-I-091907	MW-41D-091807	MW-46A-091907	MW-96A-091907	MW-46D-091907	MW-46I-091907	MW-47A-092007	MW-47D-092007	MW-47I-092007
	Sample Date			9/19/2007	9/18/2007	9/19/2007	9/19/2007	9/19/2007	9/19/2007	9/20/2007	9/20/2007	9/20/2007
	Sample Time			07:00	10:00	16:10	16:20	14:15	13:20	12:25	11:40	11:00
	Sample Matrix			WG	WG	WG	WG - DUP	WG	WG	WG	WG	WG
Heptachlor epoxide	µg/L			--	--	--	--	--	--	--	--	--
Methoxychlor	µg/L			--	--	--	--	--	--	--	--	--
Toxaphene	µg/L			--	--	--	--	--	--	--	--	--
SVOC												
1,2,4-Trichlorobenzene	µg/L			--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/L			--	--	--	--	--	--	--	--	--
1,2-Diphenylhydrazine	µg/L			--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/L			--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	µg/L			--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	µg/L			--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	µg/L			--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	µg/L			--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	µg/L			--	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	µg/L			--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	µg/L			--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	µg/L			--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	µg/L			--	--	--	--	--	--	--	--	--
2-Chlorophenol	µg/L			--	--	--	--	--	--	--	--	--
2-Methylphenol	µg/L			--	--	--	--	--	--	--	--	--
2-Nitroaniline	µg/L			--	--	--	--	--	--	--	--	--
2-Nitrophenol	µg/L			--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	µg/L			--	--	--	--	--	--	--	--	--
3-Nitroaniline	µg/L			--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	µg/L			--	--	--	--	--	--	--	--	--
4-Bromophenylphenylether	µg/L			--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	µg/L			--	--	--	--	--	--	--	--	--
4-Chloroaniline	µg/L			--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	µg/L			--	--	--	--	--	--	--	--	--
4-Methylphenol	µg/L			--	--	--	--	--	--	--	--	--
4-Nitroaniline	µg/L			--	--	--	--	--	--	--	--	--
4-Nitrophenol	µg/L			--	--	--	--	--	--	--	--	--
Aniline	µg/L			--	--	--	--	--	--	--	--	--
Azobenzene	µg/L			--	--	--	--	--	--	--	--	--
Benzidine	µg/L			--	--	--	--	--	--	--	--	--
Benzoic acid	µg/L			--	--	--	--	--	--	--	--	--
Benzyl alcohol	µg/L			--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	µg/L			--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	µg/L			--	--	--	--	--	--	--	--	--
bis(2-chloroisopropyl)ether	µg/L			--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	µg/L			--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	µg/L			--	--	--	--	--	--	--	--	--
Carbazole	µg/L			--	--	--	--	--	--	--	--	--
Diethylphthalate	µg/L			--	--	--	--	--	--	--	--	--
Dimethylphthalate	µg/L			--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	µg/L			--	--	--	--	--	--	--	--	--
Di-n-octylphthalate	µg/L			--	--	--	--	--	--	--	--	--
Hexachlorobenzene	µg/L			--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	µg/L			--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	µg/L			--	--	--	--	--	--	--	--	--
Hexachloroethane	µg/L			--	--	--	--	--	--	--	--	--

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors^1	MW-35-I MW-35-I-091907 9/19/2007 07:00 WG		MW-41-D MW-41D-091807 9/18/2007 10:00 WG		MW-46-A MW-46A-091907 9/19/2007 16:10 WG		MW-46-A MW-96A-091907 9/19/2007 16:20 WG - DUP		MW-46-D MW-46D-091907 9/19/2007 14:15 WG		MW-46-I MW-46I-091907 9/19/2007 13:20 WG		MW-47-A MW-47A-092007 9/20/2007 12:25 WG		MW-47-D MW-47D-092007 9/20/2007 11:40 WG		MW-47-I MW-47I-092007 9/20/2007 11:00 WG	
Isophorone	µg/L			--		--		--		--		--		--		--		--		--	
Nitrobenzene	µg/L			--		--		--		--		--		--		--		--		--	
n-Nitroso-di-methylamine	µg/L			--		--		--		--		--		--		--		--		--	
N-Nitroso-di-n-propylamine	µg/L			--		--		--		--		--		--		--		--		--	
n-Nitrosodiphenylamine	µg/L			--		--		--		--		--		--		--		--		--	
Pentachlorophenol	µg/L			--		--		--		--		--		--		--		--		--	
Phenol	µg/L			--		--		--		--		--		--		--		--		--	
TPH																					
TPH-Diesel Range	µg/L	500		--		--		--		--		--		--		--		--		--	
TPH-Gasoline Range	µg/L	800		--		--		--		--		--		--		--		--		--	
TPH-Residual Range	µg/L	500		--		--		--		--		--		--		--		--		--	
VOC																					
1,1,1,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,1-Trichloroethane	µg/L	200		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,2,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,2-Trichloroethane	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1-Dichloroethene	µg/L	7		**0.25**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	**0.17**	**J**	0.5	U	0.5	U
1,1-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2,3-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,2,3-Trichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2,4-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dibromo-3-chloropropane	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dibromoethane	µg/L			1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,3,5-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,3-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,3-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,4-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
2,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
2-Butanone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U
2-Chloroethylvinylether	µg/L			10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
2-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
2-Hexanone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U
4-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
4-Isopropyltoluene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
4-Methyl-2-pentanone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U
Acetone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U
Acrolein	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U
Acrylonitrile	µg/L			10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Benzene	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Bromobenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Bromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Bromodichloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Bromoform	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Bromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Carbon disulfide	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-35-I MW-35-I-091907 9/19/2007 07:00 WG		MW-41-D MW-41D-091807 9/18/2007 10:00 WG		MW-46-A MW-46A-091907 9/19/2007 16:10 WG		MW-46-A MW-96A-091907 9/19/2007 16:20 WG - DUP		MW-46-D MW-46D-091907 9/19/2007 14:15 WG		MW-46-I MW-46I-091907 9/19/2007 13:20 WG		MW-47-A MW-47A-092007 9/20/2007 12:25 WG		MW-47-D MW-47D-092007 9/20/2007 11:40 WG		MW-47-I MW-47I-092007 9/20/2007 11:00 WG	
Carbon tetrachloride	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chloroform	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	µg/L	70		**8.3**		0.5	U	**0.84**		**0.9**		**0.97**		0.5	U	**67**		0.5	U	0.5	U
cis-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dibromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dibromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dichlorodifluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dichloromethane	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Ethylbenzene	µg/L	700		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Hexachlorobutadiene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Isopropylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
m,p-Xylenes	µg/L	1,000 [2,]		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methyltert-butylether	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Naphthalene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
n-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
n-Propylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
o-Xylene	µg/L	1,000 [2]		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
sec-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Styrene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
tert-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Toluene	µg/L	1,000		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
trans-1,2-Dichloroethene	µg/L	100		**0.43**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	**2.5**		0.5	U	0.5	U
trans-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Trichloroethene	µg/L	2.5		**9.9**		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	**1.6**		0.5	U	0.5	U
Trichlorofluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Vinyl chloride	µg/L	0.025		**0.13**	**J**	0.042	U	**0.17**	**J**	**0.17**	**J**	0.042	U	0.042	U	**3.3**		0.042	U	0.042	U

Notes:

[1] TEF Factors from Amendatory Section WAC 173-340-708

[2] Screening level is for total xylenes which is the sum of m,p-Xylenes and 0-Xylenes

Total PAHs calculated using toxicity equivalency factors for the seven PAHs, per MTCA. Non-detect samples were summed using half the reported concentration.

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit

TEF = Toxic Equivalency Factors

U = not detected above the laboratory reporting limit indicated

WG = groundwater

WG-DUP = groundwater duplicate sample

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-48-A MW-48A-092007 9/20/2007 13:35 WG		MW-48-D MW-48D-092007 9/20/2007 14:35 WG		MW-48-I MW-48I-092007 9/20/2007 15:35 WG		MW-51-A MW-51A-092507 9/25/2007 12:35 WG		MW-51-D MW-51D-092507 9/25/2007 11:40 WG		MW-51-I MW-51I-092507 9/25/2007 10:45 WG		MW-8-A MW-8A-FB-092107 9/21/2007 13:40 WG		MW-94-1-A MW-94-1A-091807 9/18/2007 WG		MW-94-1-D MW-94-1D-091807 9/18/2007 WG	
PAHs																					
1,1'-Biphenyl	µg/L			0.019	U	0.02	U	**0.025**		0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
1-Methylnaphthalene	µg/L			0.019	U	0.02	U	**0.13**		0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
2-Methylnaphthalene	µg/L			0.019	U	0.02	U	**0.094**		0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Acenaphthene	µg/L			0.019	U	0.02	U	**0.016**	**J**	0.0077	U	**0.028**		--		--		0.019	U	0.019	U
Acenaphthylene	µg/L			0.019	U	0.02	U	**0.0061**	**J**	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Anthracene	µg/L			**0.0068**	**J**	0.02	U	**0.01**	**J**	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Benzo(a)anthracene	µg/L		0.1	0.019	U	0.02	U	0.019	U	0.0077	U	**0.0028**	**J**	--		--		0.019	U	0.019	U
Benzo(a)pyrene	µg/L	0.1	1.0	0.019	U	0.02	U	0.019	U	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Benzo(b)fluoranthene	µg/L		0.1	0.019	U	0.02	U	**0.017**	**J**	0.0077	U	**0.0026**	**J**	--		--		0.019	U	0.019	U
Benzo(g,h,i)perylene	µg/L			0.019	U	0.02	U	0.019	U	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Benzo(k)fluoranthene	µg/L		0.1	0.019	U	0.02	U	0.019	U	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Chrysene	µg/L		0.01	0.019	U	0.02	U	**0.0052**	**J**	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Dibenzo(a,h)anthracene	µg/L		0.1	0.019	U	0.02	U	0.019	U	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Dibenzofuran	µg/L			0.019	U	0.02	U	**0.0079**	**J**	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Fluoranthene	µg/L			**0.0053**	**J**	0.02	U	**0.027**		0.0077	U	**0.009**		--		--		0.019	U	0.019	U
Fluorene	µg/L			0.019	U	0.02	U	**0.013**	**J**	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Indeno(1,2,3-cd)pyrene	µg/L		0.1	0.019	U	0.02	U	**0.0038**	**J**	0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Naphthalene	µg/L			0.019	U	0.02	U	**1.3**		0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Phenanthrene	µg/L			0.019	U	0.02	U	**0.047**		0.0077	U	0.0077	U	--		--		0.019	U	0.019	U
Pyrene	µg/L			0.019	U	0.02	U	**0.026**		0.0077	U	**0.0045**	**J**	--		--		0.019	U	0.019	U
Total PAHs	µg/L			0.01		0.02	U	**0.01**		0.01		**0.01**		--		--		0.01	U	0.01	
PCBs																					
Aroclor 1016	µg/L			0.02	U	0.02	U	0.19	U	0.027	U	0.02	U	--		--		0.02	U	0.02	U
Aroclor 1221	µg/L			0.039	U	0.039	U	0.38	U	0.054	U	0.039	U	--		--		0.039	U	0.039	U
Aroclor 1232	µg/L			0.02	U	0.02	U	0.19	U	0.027	U	0.02	U	--		--		0.02	U	0.02	U
Aroclor 1242	µg/L			0.02	U	0.02	U	0.19	U	0.027	U	0.02	U	--		--		0.02	U	0.02	U
Aroclor 1248	µg/L			0.02	U	0.02	U	0.19	U	0.027	U	0.02	U	--		--		**0.05**		0.02	U
Aroclor 1254	µg/L			0.02	U	0.02	U	0.19	U	0.027	U	0.02	U	--		--		0.02	U	0.02	U
Aroclor 1260	µg/L			0.02	U	0.02	U	0.19	U	0.027	U	0.02	U	--		--		0.02	U	0.02	U
Total PCBs	µg/L	0.1		0.039	U	0.039	U	0.38	U	0.054	U	0.039	U	--		--		**0.05**		0.039	U
Pesticides																					
4,4'-DDD	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
4,4'-DDE	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
4,4'-DDT	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Aldrin	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
alpha-BHC	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
alpha-Chlordane	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
beta-BHC	µg/L			--		--		--		**0.0068**	**J**	**0.0043**	**J**	--		--		--		--	
delta-BHC	µg/L			--		--		--		**0.0014**	**J**	0.0096	U	--		--		--		--	
Dieldrin	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Endosulfan I	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Endosulfan II	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Endosulfan sulfate	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Endrin	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Endrin aldehyde	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Endrin ketone	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
gamma-BHC (Lindane)	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
gamma-Chlordane	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Heptachlor	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	**Location ID** **Sample ID** **Sample Date** **Sample Time** **Sample Matrix**	**Screening Level Values**	**TEF Factors**[1]	**MW-48-A** **MW-48A-092007** **9/20/2007** **13:35** **WG**		**MW-48-D** **MW-48D-092007** **9/20/2007** **14:35** **WG**		**MW-48-I** **MW-48I-092007** **9/20/2007** **15:35** **WG**		**MW-51-A** **MW-51A-092507** **9/25/2007** **12:35** **WG**		**MW-51-D** **MW-51D-092507** **9/25/2007** **11:40** **WG**		**MW-51-I** **MW-51I-092507** **9/25/2007** **10:45** **WG**		**MW-8-A** **MW-8A-FB-092107** **9/21/2007** **13:40** **WG**		**MW-94-1-A** **MW-94-1A-091807** **9/18/2007** **WG**		**MW-94-1-D** **MW-94-1D-091807** **9/18/2007** **WG**	
Heptachlor epoxide	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Methoxychlor	µg/L			--		--		--		0.014	U	0.0096	U	--		--		--		--	
Toxaphene	µg/L			--		--		--		0.67	U	0.48	U	--		--		--		--	
SVOC																					
1,2,4-Trichlorobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
1,2-Dichlorobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
1,2-Diphenylhydrazine	µg/L			--		--		--		--		--		--		--		--		--	
1,3-Dichlorobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
1,4-Dichlorobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
2,4,5-Trichlorophenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
2,4,6-Trichlorophenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
2,4-Dichlorophenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
2,4-Dimethylphenol	µg/L			--		--		--		**R**		**R**		--		--		--		--	
2,4-Dinitrophenol	µg/L			--		--		--		3.9	U	3.9	U	--		--		--		--	
2,4-Dinitrotoluene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
2,6-Dinitrotoluene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
2-Chloronaphthalene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
2-Chlorophenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
2-Methylphenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
2-Nitroaniline	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
2-Nitrophenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
3,3'-Dichlorobenzidine	µg/L			--		--		--		2	U	2	U	--		--		--		--	
3-Nitroaniline	µg/L			--		--		--		0.96	U	0.96	U	--		--		--		--	
4,6-Dinitro-2-methylphenol	µg/L			--		--		--		2	U	2	U	--		--		--		--	
4-Bromophenylphenylether	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
4-Chloro-3-methylphenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
4-Chloroaniline	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
4-Chlorophenyl-phenylether	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
4-Methylphenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
4-Nitroaniline	µg/L			--		--		--		0.96	U	0.96	U	--		--		--		--	
4-Nitrophenol	µg/L			--		--		--		2	U	2	U	--		--		--		--	
Aniline	µg/L			--		--		--		0.96	U	0.96	U	--		--		--		--	
Azobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Benzidine	µg/L			--		--		--		2	U	2	U	--		--		--		--	
Benzoic acid	µg/L			--		--		--		4.8	U	4.8	U	--		--		--		--	
Benzyl alcohol	µg/L			--		--		--		4.8	U	4.8	U	--		--		--		--	
bis(2-Chloroethoxy)methane	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
bis(2-Chloroethyl)ether	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
bis(2-chloroisopropyl)ether	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
bis(2-Ethylhexyl)phthalate	µg/L			--		--		--		**0.13**	**J**	**0.33**	**J**	--		--		--		--	
Butylbenzylphthalate	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Carbazole	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Diethylphthalate	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Dimethylphthalate	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Di-n-butylphthalate	µg/L			--		--		--		0.94	U	1.1	U	--		--		--		--	
Di-n-octylphthalate	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Hexachlorobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Hexachlorobutadiene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Hexachlorocyclopentadiene	µg/L			--		--		--		0.96	U	0.96	U	--		--		--		--	
Hexachloroethane	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-48-A MW-48A-092007 9/20/2007 13:35 WG		MW-48-D MW-48D-092007 9/20/2007 14:35 WG		MW-48-I MW-48I-092007 9/20/2007 15:35 WG		MW-51-A MW-51A-092507 9/25/2007 12:35 WG		MW-51-D MW-51D-092507 9/25/2007 11:40 WG		MW-51-I MW-51I-092507 9/25/2007 10:45 WG		MW-8-A MW-8A-FB-092107 9/21/2007 13:40 WG		MW-94-1-A MW-94-1A-091807 9/18/2007 WG		MW-94-1-D MW-94-1D-091807 9/18/2007 WG	
Isophorone	µg/L			--		--		--		0.2	U	**0.02**	**J**	--		--		--		--	
Nitrobenzene	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
n-Nitroso-di-methylamine	µg/L			--		--		--		2	U	2	U	--		--		--		--	
N-Nitroso-di-n-propylamine	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
n-Nitrosodiphenylamine	µg/L			--		--		--		0.2	U	0.2	U	--		--		--		--	
Pentachlorophenol	µg/L			--		--		--		0.96	U	0.96	U	--		--		--		--	
Phenol	µg/L			--		--		--		0.48	U	0.48	U	--		--		--		--	
TPH																					
TPH-Diesel Range	µg/L	500		--		--		--		--		--		--		--		--		--	
TPH-Gasoline Range	µg/L	800		--		--		--		--		--		--		--		--		--	
TPH-Residual Range	µg/L	500		--		--		--		--		--		--		--		--		--	
VOC																					
1,1,1,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,1,1-Trichloroethane	µg/L	200		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,1,2,2-Tetrachloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,1,2-Trichloroethane	µg/L	5		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,1-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	**0.12**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	**9.6**	
1,1-Dichloroethene	µg/L	7		**0.2**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	**4.4**	
1,1-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,2,3-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
1,2,3-Trichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,2,4-Trichlorobenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
1,2,4-Trimethylbenzene	µg/L			2	U	2	U	**0.16**	**J**	2	U	2	U	2	U	2	U	2	U	4	U
1,2-Dibromo-3-chloropropane	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
1,2-Dibromoethane	µg/L			1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	2	U
1,2-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,2-Dichloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	**0.24**	**J**
1,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,3,5-Trimethylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
1,3-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,3-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
1,4-Dichlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
2,2-Dichloropropane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
2-Butanone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	40	U
2-Chloroethylvinylether	µg/L			10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	U
2-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
2-Hexanone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	40	U
4-Chlorotoluene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
4-Isopropyltoluene	µg/L			2	U	2	U	**0.3**	**J**	2	U	2	U	2	U	2	U	2	U	4	U
4-Methyl-2-pentanone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	40	U
Acetone	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	40	U
Acrolein	µg/L			20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U	**R**	
Acrylonitrile	µg/L			10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	U
Benzene	µg/L	5		0.5	U	0.5	U	**2.4**		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Bromobenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
Bromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Bromodichloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Bromoform	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Bromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	UJ	0.5	UJ	0.5	UJ	0.5	U	0.5	U	1	U
Carbon disulfide	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-48-A MW-48A-092007 9/20/2007 13:35 WG		MW-48-D MW-48D-092007 9/20/2007 14:35 WG		MW-48-I MW-48I-092007 9/20/2007 15:35 WG		MW-51-A MW-51A-092507 9/25/2007 12:35 WG		MW-51-D MW-51D-092507 9/25/2007 11:40 WG		MW-51-I MW-51I-092507 9/25/2007 10:45 WG		MW-8-A MW-8A-FB-092107 9/21/2007 13:40 WG		MW-94-1-A MW-94-1A-091807 9/18/2007 WG		MW-94-1-D MW-94-1D-091807 9/18/2007 WG	
Carbon tetrachloride	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Chlorobenzene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Chloroethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Chloroform	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Chloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
cis-1,2-Dichloroethene	µg/L	70		**65**		0.5	U	0.5	U	**3.9**		0.5	U	0.5	U	0.5	U	**1.4**		**580**	
cis-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Dibromochloromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Dibromomethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Dichlorodifluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Dichloromethane	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
Ethylbenzene	µg/L	700		0.5	U	0.5	U	**0.27**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Hexachlorobutadiene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
Isopropylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
m,p-Xylenes	µg/L	1,000[2,]		0.5	U	0.5	U	**0.52**		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Methyltert-butylether	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Naphthalene	µg/L			2	U	2	U	**1**	**J**	2	U	2	U	2	U	2	U	2	U	4	U
n-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
n-Propylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
o-Xylene	µg/L	1,000[2]		0.5	U	0.5	U	**0.25**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
sec-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
Styrene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
tert-Butylbenzene	µg/L			2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	4	U
Tetrachloroethene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Toluene	µg/L	1,000		0.5	U	0.5	U	**0.89**		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
trans-1,2-Dichloroethene	µg/L	100		**1**		0.5	U	0.5	U	**0.38**	**J**	0.5	U	0.5	U	0.5	U	0.5	U	**2.6**	
trans-1,3-Dichloropropene	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Trichloroethene	µg/L	2.5		**2.1**		0.5	U	0.5	U	**1.7**		0.5	U	0.5	U	0.5	U	**0.54**		**7.2**	
Trichlorofluoromethane	µg/L			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	1	U
Vinyl chloride	µg/L	0.025		**2.6**		0.042	U	0.042	U	**0.22**	**J**	0.042	U	0.042	U	0.5	U	0.042	U	**39**	

Notes:

[1] TEF Factors from Amendatory Section WAC 173-340-708

[2] Screening level is for total xylenes which is the sum of m,p-Xylenes and 0-Xylenes

Total PAHs calculated using toxicity equivalency factors for the seven PAHs, per MTCA. Non-detect samples were summed using half the reported concentration.

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit

TEF = Toxic Equivalency Factors

U = not detected above the laboratory reporting limit indicated

WG = groundwater

WG-DUP = groundwater duplicate sample

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-94-1-I MW-94-1I-091807 9/18/2007 WG		MW-94-2-A MW-144-2A-091807 9/18/2007 WG-DUP		MW-94-2-A MW-94-2A-091807 9/18/2007 WG		MW-94-2-D MW-94-2D-091807 9/18/2007 WG		MW-94-2-I MW-94-2I-091907 9/19/2007 WG		PW-19 PW19-092607 9/26/2007 11:00 WG		PW-20 PW-20-092607 9/26/2007 11:30 WG	
PAHs																	
1,1'-Biphenyl	µg/L			**0.0056**	**J**	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
1-Methylnaphthalene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
2-Methylnaphthalene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Acenaphthene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Acenaphthylene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Anthracene	µg/L			**0.35**		0.019	U	0.019	U	**0.027**		**0.028**		--		--	
Benzo(a)anthracene	µg/L		0.1	**0.026**		0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Benzo(a)pyrene	µg/L	0.1	1.0	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Benzo(b)fluoranthene	µg/L		0.1	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Benzo(g,h,i)perylene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Benzo(k)fluoranthene	µg/L		0.1	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Chrysene	µg/L		0.01	**0.0051**	**J**	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Dibenzo(a,h)anthracene	µg/L		0.1	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Dibenzofuran	µg/L			**0.024**		0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Fluoranthene	µg/L			**0.024**		0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Fluorene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Indeno(1,2,3-cd)pyrene	µg/L		0.1	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Naphthalene	µg/L			0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Phenanthrene	µg/L			**0.04**		0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Pyrene	µg/L			**0.023**		0.019	U	0.019	U	0.019	U	0.019	U	--		--	
Total PAHs	µg/L			**0.02**		0.01	U	0.01	U	0.01		0.01		--		--	
PCBs																	
Aroclor 1016	µg/L			0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Aroclor 1221	µg/L			0.059	U	0.039	U	0.039	U	0.039	U	0.039	U	--		--	
Aroclor 1232	µg/L			0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Aroclor 1242	µg/L			0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Aroclor 1248	µg/L			0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Aroclor 1254	µg/L			0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Aroclor 1260	µg/L			0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	--		--	
Total PCBs	µg/L	0.1		0.059	U	0.039	U	0.039	U	0.039	U	0.039	U	--		--	
Pesticides																	
4,4'-DDD	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
4,4'-DDE	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
4,4'-DDT	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Aldrin	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
alpha-BHC	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
alpha-Chlordane	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
beta-BHC	µg/L			--		0.0096	U	0.0096	U	0.0096	U	**0.004**	**J**	--		--	
delta-BHC	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Dieldrin	µg/L			--		0.0096	U	0.0096	U	**0.002**	**J**	0.0096	U	--		--	
Endosulfan I	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Endosulfan II	µg/L			--		0.0096	U	0.0096	U	**0.0014**	**J**	0.0096	U	--		--	
Endosulfan sulfate	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Endrin	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Endrin aldehyde	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Endrin ketone	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
gamma-BHC (Lindane)	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
gamma-Chlordane	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Heptachlor	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-94-1-I MW-94-1I-091807 9/18/2007 WG		MW-94-2-A MW-144-2A-091807 9/18/2007 WG-DUP		MW-94-2-A MW-94-2A-091807 9/18/2007 WG		MW-94-2-D MW-94-2D-091807 9/18/2007 WG		MW-94-2-I MW-94-2I-091907 9/19/2007 WG		PW-19 PW19-092607 9/26/2007 11:00 WG		PW-20 PW-20-092607 9/26/2007 11:30 WG	
Heptachlor epoxide	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Methoxychlor	µg/L			--		0.0096	U	0.0096	U	0.0096	U	0.0096	U	--		--	
Toxaphene	µg/L			--		0.48	U	0.48	U	0.48	U	0.48	U	--		--	
SVOC																	
1,2,4-Trichlorobenzene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
1,2-Dichlorobenzene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
1,2-Diphenylhydrazine	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
1,3-Dichlorobenzene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
1,4-Dichlorobenzene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2,4,5-Trichlorophenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2,4,6-Trichlorophenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2,4-Dichlorophenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2,4-Dimethylphenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2,4-Dinitrophenol	µg/L			--		24	U	24	U	24	U	24	U	--		--	
2,4-Dinitrotoluene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2,6-Dinitrotoluene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2-Chloronaphthalene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2-Chlorophenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2-Methylphenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
2-Nitroaniline	µg/L			--		24	U	24	U	24	U	24	U	--		--	
2-Nitrophenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
3,3'-Dichlorobenzidine	µg/L			--		24	U	24	U	24	U	24	U	--		--	
3-Nitroaniline	µg/L			--		24	U	24	U	24	U	24	U	--		--	
4,6-Dinitro-2-methylphenol	µg/L			--		24	U	24	U	24	U	24	U	--		--	
4-Bromophenylphenylether	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
4-Chloro-3-methylphenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
4-Chloroaniline	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
4-Chlorophenyl-phenylether	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
4-Methylphenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
4-Nitroaniline	µg/L			--		24	U	24	U	24	U	24	U	--		--	
4-Nitrophenol	µg/L			--		24	U	24	U	24	U	24	U	--		--	
Aniline	µg/L			--		24	U	24	U	24	U	24	U	--		--	
Azobenzene	µg/L			--		--		--		--		--		--		--	
Benzidine	µg/L			--		48	U	47	U	48	U	47	U	--		--	
Benzoic acid	µg/L			--		24	U	24	U	24	U	24	U	--		--	
Benzyl alcohol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
bis(2-Chloroethoxy)methane	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
bis(2-Chloroethyl)ether	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
bis(2-chloroisopropyl)ether	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
bis(2-Ethylhexyl)phthalate	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Butylbenzylphthalate	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Carbazole	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Diethylphthalate	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Dimethylphthalate	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Di-n-butylphthalate	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Di-n-octylphthalate	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Hexachlorobenzene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Hexachlorobutadiene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Hexachlorocyclopentadiene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Hexachloroethane	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	TEF Factors[1]	MW-94-1-I MW-94-1I-091807 9/18/2007 WG		MW-94-2-A MW-144-2A-091807 9/18/2007 WG-DUP		MW-94-2-A MW-94-2A-091807 9/18/2007 WG		MW-94-2-D MW-94-2D-091807 9/18/2007 WG		MW-94-2-I MW-94-2I-091907 9/19/2007 WG		PW-19 PW19-092607 9/26/2007 11:00 WG		PW-20 PW-20-092607 9/26/2007 11:30 WG	
Isophorone	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Nitrobenzene	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
n-Nitroso-di-methylamine	µg/L			--		24	U	24	U	24	U	24	U	--		--	
N-Nitroso-di-n-propylamine	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
n-Nitrosodiphenylamine	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
Pentachlorophenol	µg/L			--		24	U	24	U	24	U	24	U	--		--	
Phenol	µg/L			--		9.5	U	9.4	U	9.5	U	9.4	U	--		--	
TPH																	
TPH-Diesel Range	µg/L	500		--		--		--		--		--		--		--	
TPH-Gasoline Range	µg/L	800		--		--		--		--		--		--		--	
TPH-Residual Range	µg/L	500		--		--		--		--		--		--		--	
VOC																	
1,1,1,2-Tetrachloroethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,1,1-Trichloroethane	µg/L	200		**43**		0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,1,2,2-Tetrachloroethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,1,2-Trichloroethane	µg/L	5		**4**	**J**	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,1-Dichloroethane	µg/L			**320**		0.5	U	0.5	U	**2.6**	**J**	1	U	0.5	U	0.5	U
1,1-Dichloroethene	µg/L	7		**13**		0.5	U	0.5	U	**15**		**0.92**	**J**	0.5	U	0.5	U
1,1-Dichloropropene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,2,3-Trichlorobenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
1,2,3-Trichloropropane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,2,4-Trichlorobenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
1,2-Dibromo-3-chloropropane	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
1,2-Dibromoethane	µg/L			20	U	1	U	1	U	10	U	2	U	1	U	1	U
1,2-Dichlorobenzene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,2-Dichloroethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,2-Dichloropropane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,3,5-Trimethylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
1,3-Dichlorobenzene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,3-Dichloropropane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
1,4-Dichlorobenzene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
2,2-Dichloropropane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
2-Butanone	µg/L			400	U	20	U	20	U	200	U	40	U	20	U	20	U
2-Chloroethylvinylether	µg/L			200	U	10	U	10	U	100	U	20	U	10	U	10	U
2-Chlorotoluene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
2-Hexanone	µg/L			400	U	20	U	20	U	200	U	40	U	20	U	20	U
4-Chlorotoluene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
4-Isopropyltoluene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
4-Methyl-2-pentanone	µg/L			400	U	20	U	20	U	200	U	40	U	20	U	20	U
Acetone	µg/L			400	U	20	U	20	U	200	U	40	U	20	U	20	U
Acrolein	µg/L			400	U	20	U	20	U	200	U	40	U	20	U	20	U
Acrylonitrile	µg/L			200	U	10	U	10	U	100	U	20	U	10	U	10	U
Benzene	µg/L	5		10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Bromobenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
Bromochloromethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Bromodichloromethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Bromoform	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Bromomethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	UJ	0.5	UJ
Carbon disulfide	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U

Table 4-2
Groundwater Sampling Results - Organics
September and December 2007

Chemical	Location ID	Screening Level Values	TEF Factors[1]	MW-94-1-I		MW-94-2-A		MW-94-2-A		MW-94-2-D		MW-94-2-I		PW-19		PW-20	
	Sample ID			MW-94-1I-091807		MW-144-2A-091807		MW-94-2A-091807		MW-94-2D-091807		MW-94-2I-091907		PW19-092607		PW-20-092607	
	Sample Date			9/18/2007		9/18/2007		9/18/2007		9/18/2007		9/19/2007		9/26/2007		9/26/2007	
	Sample Time													11:00		11:30	
	Sample Matrix			WG		WG-DUP		WG		WG		WG		WG		WG	
Carbon tetrachloride	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Chlorobenzene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Chloroethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Chloroform	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Chloromethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	µg/L	70		**4,700**		**0.58**		**0.62**		**2,000**		**610**		**1.1**		**0.95**	
cis-1,3-Dichloropropene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Dibromochloromethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Dibromomethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Dichlorodifluoromethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Dichloromethane	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
Ethylbenzene	µg/L	700		10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Hexachlorobutadiene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
Isopropylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
m,p-Xylenes	µg/L	1,000 [2,]		10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Methyltert-butylether	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Naphthalene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
n-Butylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
n-Propylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
o-Xylene	µg/L	1,000 [2]		10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
sec-Butylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
Styrene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
tert-Butylbenzene	µg/L			40	U	2	U	2	U	20	U	4	U	2	U	2	U
Tetrachloroethene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Toluene	µg/L	1,000		10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
trans-1,2-Dichloroethene	µg/L	100		**11**		0.5	U	0.5	U	**9.6**		**6.9**		0.5	U	0.5	U
trans-1,3-Dichloropropene	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Trichloroethene	µg/L	2.5		**620**		0.5	U	0.5	U	5	U	**4.9**		**1.5**		**1.3**	
Trichlorofluoromethane	µg/L			10	U	0.5	U	0.5	U	5	U	1	U	0.5	U	0.5	U
Vinyl chloride	µg/L	0.025		**280**		0.042	U	0.042	U	**38**		**1.8**		0.042	U	0.042	U

Notes:

[1] TEF Factors from Amendatory Section WAC 173-340-708

[2] Screening level is for total xylenes which is the sum of m,p-Xylenes and 0-Xylenes

Total PAHs calculated using toxicity equivalency factors for the seven PAHs, per MTCA. Non-detect samples were summed using half the reported concentration.

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit

TEF = Toxic Equivalency Factors

U = not detected above the laboratory reporting limit indicated

WG = groundwater

WG-DUP = groundwater duplicate sample

Table 4-3
Groundwater Sampling Results - USTs
May 2007

Chemical	Sample ID Sample Date Sample Time Sample Matrix	Screening Level Values	T3-5 5/23/2007 11:45 WG		T3-4 5/23/2007 13:45 WG		T3-3 5/23/2007 16:00 WG	
NWTPH								
G	µg/L	1,000 [1]	250	U	250	U	250	U
Dx (DRO)	µg/L	500	250	U	**890**	**Z**	**9,900**	**Y**
Dx (RRO)	µg/L	500	500	U	500	U	**2,000**	**L**
VOCs								
Benzene	µg/L	5	0.5	U	0.5	U	0.5	U
Toluene	µg/L	1,000	0.5	U	0.5	U	0.5	U
Ethylbenzene	µg/L	700	0.5	U	0.5	U	0.5	U
m,p-Xylenes	µg/L	1,000 [2]	0.5	U	0.5	U	0.5	U
o-Xylenes	µg/L		0.5	U	0.5	U	0.5	U
Metals (Total)								
Lead	µg/L	15	**0.3**		**0.65**		**14.1**	
Metals (Dissolved)								
Lead	µg/L	0.54	**0.03**		**0.09**		**2.49**	

Notes:

[1] screening level for gasoline range organics with no detectable benzene

[2] screening level is for total xylenes which is the sum of m,p-Xylenes and 0-Xylenes

Refer to Section 3.1 for a discussion of screening level selection.

Detected values shown in bold

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

DRO = diesel range organic compounds

Dx = diesel and heavy range hydrocarbons

Gx = gasoline range organic compounds

L = the chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard

NWTPH = total petroleum hydrocarbons

RRO = residual range organic compounds

U = not detected above the laboratory reporting limit indicated

VOCs = volatile organic compounds

WG = groundwater

Y = the chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard

Z = the chromatographic fingerprint does not resemble a petroleum product

4.1.1 Fluoride

A total of 58 wells were sampled for fluoride across the Site. Three wells were sampled twice, for a total of 61 fluoride samples collected. The fluoride data collected is reported in Table 4-1. Sample results exceeding the preliminary screening level of 4 mg/L of fluoride in groundwater are noted in Table 4-1. These wells were chosen for fluoride analysis for two reasons: 1) to confirm that the requirements of the 1992 SPL Storage Area Consent Decree (a.k.a., the NPL Site) continue to be met, and 2) to identify the nature and extent of any additional fluoride-impacted groundwater.

Within the area defined by the 1992 Consent Decree, on the east side of the facility, MW-48-I had the highest concentration of fluoride, at 788 mg/L. This well is located at the southern edge of the North/North 2 landfills and the eastern edge of the SPL Storage Area. The remaining wells all had fluoride concentrations less than 32 mg/L. Thirty-eight wells sampled in this area are identified on Figure 4-1, and only six of the wells exceeded 4 mg/L. Near the Columbia River, the highest fluoride concentration was at MW-51-I at 7.3 mg/L and MW-94-2 at 8.7 mg/L. Review of fluoride data from the past 5 years at MW-51-I indicates that the fluoride concentration in this well is relatively consistent.

The 1992 Consent Decree requires that the concentration of fluoride in the perimeter shoreline wells[2] installed in the deep zone remain less than 10 times the concentrations observed during 1986 through 1990. The average concentration in those wells was 7.5 mg/kg during the period of interest and the current average is approximately 0.6 mg/kg. Therefore, the monitoring data indicates that the Site is compliance with the 1992 Consent Decree and no further action is necessary.

Monitoring well cluster MW-30 is located just outside of the 1992 Consent Decree-defined subsurface Site boundaries, but is affected by water beneath the SPL Storage Area. Discussions with Ecology confirmed that this well was located as part of the original SPL Storage Area monitoring network (Skyllingstad 2008a).

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[2] At the time of the 1992 Consent Decree, the perimeter wells installed the deep zone included MW-18D, MW-19D, MW-20D, and MW-21D. In 2003 Ecology required the reinstallation of 3 wells (18 through 20 were designated as MW-49D, MW-50D, and MW-51D) and the abandonment of MW-21D.

West of the SPL Storage Area, the primary fluoride sources were identified as the Carbon Plant Emissions Control System and the Fluoride-bearing Raw Material Storage area. The EVGR-02 well cluster, south of this area, had fluoride concentrations less than 4 mg/L, with the highest result at 3.9 mg/L. The T3-3 monitoring well, located in the shallow zone, had a fluoride concentration of 6.5 mg/L. The well is down gradient from the potrooms. Source control activities are planned within both of these areas, which will likely results in reductions in the observed fluoride concentrations once source materials have been removed to the maximum extent practicable.

On the west side of the property, there are a minimal number of fluoride sources to groundwater. The primary source was the stormwater lagoons and northern sludge lagoon, although neither have been a source for many years, as discussed in Section 2. This is evident, as there is nominal fluoride identified in groundwater on the west side of the site. The highest concentration of fluoride was found in SP-4-S, at 5.2 mg/L, which is located north of the stormwater lagoons but south of the historical sludge ponds. The other wells in the vicinity of the stormwater lagoons (SP wells) all had fluoride concentrations less than 4 mg/L. The wells in the Crowley Parcel area, denoted CMW wells, had concentrations of fluoride equal to or less than 1.0 mg/L.

4.1.2 Cyanide

Sixty-five samples were collected and analyzed for total and free cyanide from 58 wells across the Site. The Site standard for the measurement of cyanides, as has been established on the east side of the property, is free cyanide. To fully evaluate cyanide fate and transport, both free and total cyanide data are required; therefore, two cyanide samples were collected from each well sample set and measured for both free and total cyanide. Both the free and total cyanide analytical results are provided in Table 4-1.

On the west side of the Site, free cyanide was not detected in any of the wells that were sampled. The preliminary screening level for free cyanide is 200 µg/L (the MCL), with a secondary screening level of 5.2 µg/L (the surface water quality standard). None of the samples on the west side of the Site exceeded either of these screening levels. A very low estimated concentration of total cyanide was identified in CMW-16, at 0.005 mg/L.

Around the stormwater lagoons, the highest concentration of total cyanide was 0.02 mg/L found in SP-2-I. The remaining wells had concentrations of total cyanide at least an order of magnitude lower than what was identified in SP-2-I.

In the center of the plant, the only monitoring well with detectable concentrations of free cyanide was T3-3, at an estimated concentration of 6 μg/L. The method detection limit for the free cyanide analytical method is 5 μg/L. At 6 μg/L of free cyanide, the secondary screening level for free cyanide is exceeded, but concentration is well within the primary screening level of 200 μg/L. The total cyanide concentrations ranged from non-detect at 0.003 mg/L to detected at 0.02 mg/L.

On the east side of the Site, only six of the 38 wells sampled had detectable concentrations of free cyanide, with the highest value at MW-51-I. The free cyanide in this well in September was measured at 51 μg/L. This value is inconsistent with past concentrations of free cyanide in this monitoring well. The well was re-sampled in December of 2007 and found to contain concentrations of free cyanide at 6 μg/L, which is consistent with past detections of free cyanide in this well, which have ranged from non-detect at 5 μg/L to estimated at 7 μg/L. Figure 4-1 provides the total and free cyanide concentrations from the September sampling event for a number of the east side monitoring wells. The detectable free cyanide concentrations in the six wells was in excess of the secondary screening level of 5 μg/L, but not in excess of the primary screening level of 200 μg/L. The total cyanide concentrations ranged from 187 mg/L to non-detect at 0.003 mg/L.

4.1.3 Priority Pollutants and Organics

Complete analyses of priority pollutants were performed on samples from 12 wells. Additional organic constituents were sampled on a number of additional wells. For metals, arsenic was the only priority pollutant metal that was detected in excess of the preliminary screening levels in four of the 12 wells sampled. Arsenic was detected in SP-2-D at 0.017 mg/L, EVGR-02-I at 0.0193 mg/L, EVGR-02-S at 0.005 mg/L, and MW-51-A at 0.008 mg/L; the preliminary screening level for arsenic is 0.005 mg/L. The arsenic data results are presented in Table 4-1. Background concentrations of arsenic in the groundwater were reviewed by examining data collected from the deep production wells at the Site during the 1990s. Arsenic concentrations were often detected in low concentrations. Comparison of the historical background production well data and this 2007 monitoring well data reveals that these detections of arsenic are similar to background concentrations and not resulting from Site contaminants.

Samples were collected for PAHs in 34 wells. A total of 37 samples were analyzed for PAHs, including benzo(a)pyrene. The preliminary screening level for cPAHs (measured on a benzo(a)pyrene-basis) in groundwater is 0.1 μg/L. There were no exceedances of the preliminary screening levels. The PAH and benzo(a)pyrene data is provided in Table 4-2. Prior to the remedial actions for the East Landfill, benzo(a)pyrene was found in groundwater in historical monitoring wells MW 91-5D and MW 91-6D at concentrations of 1.7 and 0.37 μg/L, respectively. The MW 91-5D well was located just west of the MW 35 well cluster. The MW 91-6D well was located between the MW 35 and MW 94-1 current well clusters. The current monitoring indicates that benzo(a)pyrene is not detectable in the groundwater at the MW 35 and MW 94-1 well clusters. This is further evidence of the effectiveness of the East Landfill remedial actions performed to isolate waste from groundwater.

Twenty-nine PCB samples were collected from 28 wells across the Site. Twenty-seven of the samples were non-detect for PCBs at the laboratory detection limit. The secondary preliminary screening level for PCB, based upon the surface water quality standard, is 0.014 μg/L. It should be noted that for all of the samples the laboratory detection limit for an individual Aroclor is greater than 0.014 μg/L. Two samples had detectable levels of PCB Aroclor 1248, MW-46-I at 0.13 μg/L and MW-94-1-A at 0.05 μg/L. The primary preliminary screening level for groundwater for PCB mixtures is 0.1 μg/L. MW-46-I is located on the west side of the East Landfill, near the area where the CPU water discharge pipeline was placed. Evaluation of these monitoring wells' historical PCB concentration reveals a downward trend in PCB concentration in the groundwater. During the fourth quarter of 2003, MW 46-I had a PCB concentration of 0.97 μg/L, compared to September 2007 when the PCB concentration was 0.13 μg/L. A lower detection limit was achieved during the September 2007 monitoring event, as MW 94-1-A was found to be non-detect at 0.19 μg/L, but this sampling event found the groundwater to contain 0.05 μg/L of PCBs. Both of these wells are approximately 100 feet from the Columbia River. The downward trend provides evidence of the successful removal and control of the PCB source materials upon the completion of the East Landfill project.

Table 4-2 presents the full data set collected during this sampling event for organic constituents, including pesticides, VOCs, and SVOCs, for the 12 wells that were evaluated for priority pollutants. Twenty-three additional wells were sampled for VOCs, resulting in an additional 26 VOC samples, for a total of 38 VOC samples.

Review of the VOC data reveals that groundwater in eight monitoring wells have exceedances of the drinking water MCLs or the MTCA Method A cleanup levels. The COPCs are TCE, cis-1,2 dichloroethene, 1,1,2-trichloroethane, and vinyl chloride. Vinyl chloride, cis-1,2-dichloroethene, and 1,1,2-trichloroethane are degradation products of TCE in groundwater. The preliminary screening level for groundwater for TCE is 5 μg/L and for vinyl chloride is 2 μg/L, as noted in Section 3.1. The preliminary screening level for cis-1,2 dichloroethene is 5 μg/L and for 1,1,2-trichloroethane is 70 μg/L.

MW-35-I, MW-94-1-I, and MW-94-1-D have TCE exceedances, at 9.9, 620, and 7.2, respectively, of the preliminary screening levels. This data is in Table 4-2 and Figure 4-2. Historical data trends are presented on Figure 2-4. Review of the trends shown on Figure 2-4 and new data for TCE in these wells shows a steady downward trend in TCE concentration since 2003, which matches the action taken in the East Landfill project to remove and contain the TCE sources. In addition, review of historical data from 2001 confirms this significant downward trend. For example, the TCE concentration in MW-94-1-I in 2001 was 4,200 μg/L and in 2007 was 620 μg/L.

Eight wells, MW-47-A, MW-48-A, MW-51-A, MW-46-A, MW-94-1-I, MW-94-1-D, MW-94-2-I, and MW-94-2-D, have vinyl chloride exceedances of the preliminary screening levels. Figure 4-2 and Table 4-2 both provide this data. The highest vinyl chloride value seen in this sampling event was 280 μg/L at MW-94-1-I. The vinyl chloride data result trends since 2003 are provided in Figure 2-4 and reveal that a steady decline in vinyl chloride in all but one of the monitoring wells that have vinyl chloride exceedances. This trend continues with this data set. This downward trend in vinyl chloride concentration in groundwater verifies the success of the remedial actions of containment and removal of the source materials in 2003.

In 2001, the vinyl chloride in MW-94-1-I was 380 µg/L and in 2007 vinyl chloride was 280 µg/L in this same monitoring well. The vinyl chloride in the groundwater at MW-94-2-D does not show as significant a reduction between 2003 and 2007; however, since 2001 there has been a significant reduction at this well. In 2001, vinyl chloride was 47 µg/L and in 2007 vinyl chloride was 38 µg/L in MW-94-2-D. In MW 35-I and MW 35-D, vinyl chloride had not historically been detected. In this sampling event, a lower analytical detection limit was achieved and vinyl chloride was detected in each well, at 0.13 and 0.09 µg/L, respectively. Both vinyl chloride concentrations in these wells are below the preliminary screening levels. Vinyl chloride is a degradation product of TCE and as TCE concentrations in groundwater decline, it is expected that there will be continued fluctuations in the concentration of vinyl chloride in groundwater.

Four monitoring wells have exceedances of the MCL for cis-1,2-dichloroethene. These wells are MW-94-1-I, MW-94-1-D, MW-94-2-I, and MW-94-2-D. The highest concentration of cis-1,2 dichloroethene was found in MW-94-1-I at 4,700 µg/L. This is an increase from 2001, when the well had a concentration of 3,400 µg/L. Increases in concentration of cis-1,2 dichloroethene were also seen in MW-94-2-I and MW-94-2-D. The data from 2007 is in Table 4-2.

MW-94-1-I was the only monitoring well to have an exceedances of the MCL for 1,1,2-trichloroethane. Between 2001 and 2007, the concentration of 1,1,2-trichloroethane has decreased in this well, from 230 µg/L to 43 µg/L. The 2007 data is in Table 4-2.

4.1.4 Total Petroleum Hydrocarbons

TPH was sampled in three locations during the September and December 2007 sampling events. This data is presented in Table 4-2. These locations were SP-7-I and SP-7-D, near the Crowley Parcel, and T3-3, near the dike USTs. The TPH-impacted media at the Crowley Parcel is discussed in the Section 2.3. The three wells at the dike USTs were sampled in May 2007 and the data is presented in Table 4-3. T3-3 was sampled both in May and September. The concentration of TPH-Dx in September is reduced from the

May sampling event from 9,900 μg/L to 2,600 μg/L; however, both values exceed the 500 μg/L preliminary screening level for TPH-Dx in groundwater. The TPH-Dx that was quantified during the May sampling event had interferences that may have elevated the TPH concentrations. These interferences were not in the groundwater samples in September, likely explaining the reduced concentration in TPH-Dx from May to September. The May sampling event showed that BTEX was not present in any of the wells near the dike USTs. Wells SP-7-I and T3-3 both have TPH-Dx concentrations in excess of the preliminary screening levels of 500 μg/L for TPH-Dx. Lead was detected in T3-3, T3-4, and T3-5 at concentrations below the primary preliminary screening level at15 μg/L; however, all three samples were detected in excess of the secondary preliminary screening level of 0.014 μg/L.

4.1.5 Clark Public Utility Wells

After the purchase of the northeastern area of land, CPU built a natural gas power plant on this site. This location is identified on Figure 2-1. CPU installed two wells. These wells are to the north/northwest of the Site and the TCE source area. Alcoa contacted the CPU and the CPU shared their analytical results of the groundwater that is pumped for cooling water by the CPU. A summary of the data provided by the CPU is in Table 4-4. The data shows that fluoride and cyanide are not present in the groundwater that is pumped by the CPU. Vinyl chloride is not present in the groundwater pumped by the CPU, but TCE has been detected in all of the samples collected since 2001. A significant downward trend has been occurring in the TCE concentration in the CPU groundwater since the TCE removal action was completed in 2003 by Alcoa. There are no exceedances of the preliminary screening level for groundwater for TCE in the CPU groundwater pumped by the CPU wells. The highest TCE concentration was in 2001 at 2.2 μg/L. The most recent data, collected on November 13, 2007, had a TCE concentration in the groundwater of 1.6 μg/L, below the screening levels presented in Table 3-1.

Table 4-4
Clark Public Utility Production Well Water Sampling Data

Analyte	Date Sampled	Units	Screening Level Values	Result	MRL
1,1-Dichloroethylene	12/31/2001	µg/L	7	ND	0.5
1,1-Dichloroethylene	12/9/2002	µg/L	7	ND	0.2
1,1-Dichloroethylene	7/14/2004	µg/L	7	ND	0.5
1,1-Dichloroethylene	12/13/2004	µg/L	7	ND	0.5
1,1-Dichloroethylene	7/20/2005	µg/L	7	ND	0.5
1,1-Dichloroethylene	1/23/2006	µg/L	7	ND	0.5
1,1-Dichloroethylene	1/23/2007	µg/L	7	ND	0.5
1,1-Dichloroethylene	5/15/2007	µg/L	7	ND	0.5
1,1-Dichloroethylene	9/4/2007	µg/L	7	ND	0.5
1,1-Dichloroethylene	11/13/2007	µg/L	7	ND	1.5
cis-1,2,-dichloroethylene	12/31/2001	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	12/9/2002	µg/L	70	ND	0.1
cis-1,2,-dichloroethylene	7/14/2004	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	12/13/2004	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	7/20/2005	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	1/23/2006	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	1/23/2007	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	5/15/2007	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	9/4/2007	µg/L	70	ND	0.5
cis-1,2,-dichloroethylene	11/13/2007	µg/L	70	ND	0.5
Cyanide	12/13/2001	mg/L		ND	0.01
Cyanide	12/9/2002	mg/L		ND	0.01
Cyanide	7/14/2004	mg/L		ND	0.01
Cyanide	1/11/2005	mg/L		ND	0.02
Fluoride	12/13/2001	mg/L	4	ND	0.2
Fluoride	12/9/2002	mg/L	4	ND	0.2
Fluoride	7/14/2004	mg/L	4	ND	0.2
Fluoride	1/11/2005	mg/L	4	ND	0.2
trans-1,2-dichloroethylene	12/31/2001	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	12/9/2002	µg/L	100	ND	0.2
trans-1,2-dichloroethylene	7/14/2004	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	12/13/2004	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	7/20/2005	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	1/23/2006	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	1/23/2007	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	5/15/2007	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	9/4/2007	µg/L	100	ND	0.5
trans-1,2-dichloroethylene	11/13/2007	µg/L	100	ND	0.5
Trichloroethylene	12/31/2001	µg/L	2.5	**2.2**	0.5
Trichloroethylene	12/9/2002	µg/L	2.5	**2.1**	0.2
Trichloroethylene	7/14/2004	µg/L	2.5	**1.9**	0.5
Trichloroethylene	12/13/2004	µg/L	2.5	**1.4**	0.5
Trichloroethylene	7/20/2005	µg/L	2.5	**1.5**	0.5
Trichloroethylene	1/23/2006	µg/L	2.5	**1.5**	0.5
Trichloroethylene	1/23/2007	µg/L	2.5	**1.4**	0.5
Trichloroethylene	5/15/2007	µg/L	2.5	**1.6**	0.5
Trichloroethylene	9/4/2007	µg/L	2.5	**1.6**	0.5
Trichloroethylene	11/13/2007	µg/L	2.5	**1.6**	0.5

Table 4-4
Clark Public Utility Production Well Water Sampling Data

Analyte	Date Sampled	Units	Screening Level Values	Result	MRL
Vinyl Chloride	12/31/2001	µg/L	0.025	ND	0.5
Vinyl Chloride	12/9/2002	µg/L	0.025	ND	0.2
Vinyl Chloride	7/14/2004	µg/L	0.025	ND	0.5
Vinyl Chloride	12/13/2004	µg/L	0.025	ND	0.5
Vinyl Chloride	7/20/2005	µg/L	0.025	ND	0.5
Vinyl Chloride	1/23/2006	µg/L	0.025	ND	0.5
Vinyl Chloride	1/23/2007	µg/L	0.025	ND	0.5
Vinyl Chloride	5/15/2007	µg/L	0.025	ND	0.5
Vinyl Chloride	9/4/2007	µg/L	0.025	ND	0.5
Vinyl Chloride	11/13/2007	µg/L	0.025	ND	0.5

Notes:

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

MRL = method reporting limit

ND = not detected

4.2 Surface Water Quality

One sample was collected of the Columbia River water from the Alcoa dock. The Columbia River sample was collected for information purposes for use in the geochemical modeling. The sample contained fluoride at 0.127 mg/L and total cyanide at 0.02 mg/L. Free cyanide was not detected in the sample, at 5 μg/L. This data is presented in Table 4-1.

4.3 Soil Quality

The results of characterization soil sampling analysis conducted for the purpose of assessing the presence of COPCs and assisting in remedial cleanup decisions are described below. Soil sampling and analysis was conducted by Evergreen and Alcoa. Additionally, the POV conducted sampling as a part of the due diligence process for the potential purchase of the Alcoa property. Some of the POV data collected is pertinent to the RI/FS and is discussed in Section 4.3.6.

4.3.1 Carbon Storage

Soil samples were selected for laboratory analysis from 17 test pits excavated in the vicinity of the Carbon Storage Building (Figure 3-2). Twenty-four soil samples were analyzed for total PAHs (Table 4-5) and total lead (Table 4-6).

Visual observation of test pit soils indicate carbon impacts were relatively uniformly distributed in close proximity to the margins of the Carbon Storage building and distinguishable by dark discoloration that appeared to be generally shallower than 1 foot bgs, with slightly deeper discoloration at TP-32 (southwest of Building 52) and TP-35 (at the margin of the access road north of Building 52).

Analytical testing of seven surface soil samples from test pits adjacent to the Carbon Storage building detected lead at concentrations ranging from 18 to 76.7 ppm, exceeding the established naturally occurring background concentration of 17 ppm for Clark County (Ecology 1994); however, all concentrations detected were below the MTCA Method A Cleanup Level of 1,000 ppm for Industrial Properties, and as such, further investigation or cleanup regarding lead in soil in the vicinity of the Carbon Storage building does not appear to be not warranted.

Analytical testing of 24 selected soil samples from the vicinity of the Carbon Storage building indicate the highest concentrations of total PAHs are within the upper 6 inches of land surface, typically ranging between 58 and 2,379 ppm with the highest total PAH concentration detected of 16,953 ppm (TP-32, 0 to 6 inches depth). Similarly, the highest concentrations of total cPAHs on a total toxic equivalent basis to benzo(a)pyrene, were detected within the upper 6 inches of land surface, ranging between 7.56 to 530 ppm with the highest concentration of 2,544 ppm, detected at TP-32. Not surprisingly, both total PAH and cPAH concentrations are relatively lower in deeper samples below 0.5 foot depth at all locations where analyzed. All total toxicity equivalent factor (TEF) adjusted cPAH concentrations detected in the upper 6 inches of land surface exceed a Method C Cleanup Level for Industrial Properties, 18 mg/kg, as do deeper samples at various locations.

Table 4-5
Soil Sampling Results - PAHs

Sample Location	Sample Number	Sample Date	Sample Depth (feet bgs)	Acenaphthene		Acenaphthylene		Anthracene		Fluoranthene		Fluorene		Naphthalene		Phenanthrene		Pyrene		Benzo (a) anthracene		Benzo (a) pyrene		Benzo (b) fluoranthene		Benzo (ghi) perylene		Benzo (k) fluoranthene		Chrysene		Dibenzo (a,h) anthrace		Indeno (1,2,3-cd) pyren		Total cPAHs	
				Laboratory Analytical Testing Results mg/kg (ppm)																																	
				Non-Carcinogenic																Carcinogenic																	
Screening Level Values																						2															
Toxicity Equivalency Factor (unitless)[1]																				0.1		1		0.1				0.1		0.01		0.1		0.1			
ATP-1	TP1-072507	7/25/2007	0 - 0.5	**1.6**		0.038	U	**2.2**		**25**		**0.58**		**0.44**		**11**		**24**		**15**		**18**		**20**		**11**		**7.5**		**19**		**2.6**		**9**		**23.6**	
ATP-2	TP2-072507	7/25/2007	0 - 0.5	**2.9**		0.051	U	**6.3**		**65**		**1.4**		**0.48**		**27**		**55**		**35**		**39**		**46**		**20**		**19**		**39**		**4.6**		**19**		**51.75**	
ATP-3	TP3-072507	7/25/2007	0 - 0.5	**5**		0.089	U	**6.7**		**89**		**1.7**		**0.45**		**37**		**82**		**47**		**58**		**70**		**38**		**26**		**57**		**8.3**		**34**		**77.1**	
ATP-4	TP4-072507	7/25/2007	0 - 0.5	**1.2**		0.051	U	**1.9**		**28**		**0.43**		**0.15**		**9.8**		**26**		**18**		**23**		**27**		**15**		**10**		**21**		**3.7**		**13**		**30.38**	
ATP-7	TP7-072507	7/25/2007	0 - 0.5	**8.3**		0.053	U	**14**		**140**		**5.1**		**0.78**		**86**		**130**		**55**		**58**		**70**		**31**		**28**		**64**		**8.7**		**28**		**77.61**	
ATP-12	TP12-072507	7/25/2007	0 - 0.5	**3.4**		0.085	U	**4**		**57**		**1.1**		**0.32**		**22**		**53**		**33**		**38**		**47**		**25**		**21**		**37**		**6.2**		**22**		**51.29**	
TP-1	0531-201	5/31/2007	3	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0103	U
TP-1	0531-202	5/31/2007	4	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0108	U
TP-3	0531-205	5/31/2007	3	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0103	U
TP-3	0531-206	5/31/2007	4	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0108	U
TP-4	0531-207	5/31/2007	3	0.0698	U	0.0698	U	**0.0822**		**3.6**		0.0698	U	0.0698	U	0.0698	U	**3.57**		**19**		**0.976**		**48.4**		**0.814**		**15.1**		**157**		**0.794**		**0.788**		**10.9542**	
TP-4	0531-208	5/31/2007	4	0.0174	U	0.0174	U	0.0174	U	0.0174	U	0.0174	U	0.0174	U	0.0174	U	**0.0375**		**0.0673**		**0.0901**		**0.0524**		0.0174	U	**0.125**		**0.19**		0.0174	U	0.0174	U	**0.1182**	
TP-6	0531-211	5/31/2007	3	0.0141	U	0.0141	U	0.0141	U	**0.95**		0.0141	U	0.0141	U	**0.0233**		**0.371**		**1.11**		0.0141	U	**2.31**		0.0141	U	0.7050	U	**8.13**		0.0141	U	0.0141	U	**0.467**	
TP-6	0531-212	5/31/2007	4	0.0177	U	0.0177	U	0.0177	U	**0.129**		0.0177	U	0.0177	U	0.0177	U	**0.0567**		0.0177	U	0.0177	U	0.0177	U	0.0177	U	0.0177	U	0.0177	U	0.0177	U	0.0177	U	0.0134	U
TP-9	0601-216	6/1/2007	2.5 - 2.5	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	**0.0136**		0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	**0.0103**	
TP-9	0601-217	6/1/2007	3.5 - 3.5	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0153	U	0.0231	U
TP-14	0601-224	6/1/2007	3.5 - 3.5	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0136	U	0.0103	U
TP-14	0601-225	6/1/2007	4.5 - 4.5	0.0139	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0143	U	0.0108	U
TP-17	0601-229	6/1/2007	3.5 - 3.5	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0135	U	0.0102	U
TP-19	0601-231	6/1/2007	3.5 - 3.5	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0138	U	0.0104	U
TP-25	071030-425a	10/30/2007	0 - 0.5	**16.7**		1.57	U	**26.3**		**331**		**5.72**		**1.79**		**118**		**350**		**169**		**214**		**198**		**173**		**223**		**229**		**50.7**		**160**		**296.36**	
TP-25	071030-425b	10/30/2007	0.5 - 1	0.381	U	0.381	U	0.381	U	**1.42**		0.381	U	0.381	U	**0.459**		**1.53**		**0.749**		**1.04**		**1.2**		**1.06**		**1.21**		**1.22**		0.3810	U	**0.849**		**1.4721**	
TP-27	071030-427a	10/30/2007	0 - 0.5	**1.81**		1.59	U	**2.43**		**30.5**		1.59	U	1.59	U	**13.3**		**35.5**		**18.5**		**23.4**		**22.5**		**19.4**		**21.5**		**28.3**		**7.64**		**16.5**		**32.35**	
TP-27	071030-427b	10/30/2007	0.5 - 1	0.0757	U	0.0757	U	0.0757	U	**0.358**		0.0757	U	0.0757	U	**0.144**		**0.351**		**0.211**		**0.263**		**0.286**		**0.217**		**0.281**		**0.305**		**0.0757**		**0.181**		**0.3695**	
TP-28	071030-428a	10/30/2007	0 - 0.5	**12.7**		1.65	U	**28.7**		**352**		**5.06**		1.65	U	**116**		**351**		**186**		**240**		**225**		**179**		**232**		**238**		**49.9**		**164**		**328.07**	
TP-28	071030-428c	10/30/2007	1 - 1.5	**9.11**		7.65	U	**11.9**		**104**		7.65	U	7.65	U	**50.7**		**114**		**54**		**65.5**		**50.8**		**43.6**		**66.9**		**73.3**		**13.6**		**40.6**		**88.82**	
TP-30	071030-430a	10/30/2007	0 - 0.5	**1.84**		1.57	U	**2.95**		**37.9**		1.57	U	1.57	U	**19.7**		**44.1**		**25.5**		**32.9**		**34.3**		**28.1**		**29.2**		**40.2**		**8.78**		**24.7**		**45.55**	
TP-30	071030-430b	10/30/2007	0.5 - 1	0.0664	U	0.0664	U	0.0664	U	**0.15**		0.0664	U	0.0664	U	0.0664	U	**0.175**		**0.0984**		**0.132**		**0.135**		**0.136**		**0.162**		**0.159**		0.0664	U	**0.105**		**0.1903**	
TP-31	071030-431a	10/30/2007	0 - 0.5	**6.86**		1.51	U	**10.9**		**90.6**		**3.39**		**1.91**		**45.5**		**97.7**		**45.1**		**56**		**51.7**		**46.3**		**56.2**		**64.1**		**12.8**		**40.2**		**77.24**	
TP-31	071030-431b	10/30/2007	0.5 - 1	0.0386	U	0.0386	U	0.0386	U	**0.096**		0.0386	U	0.0386	U	0.0386	U	**0.0953**		**0.0714**		**0.0977**		**0.119**		**0.081**		**0.0519**		**0.0821**		0.0386	U	**0.0842**		**0.1331**	
TP-32	071030-432a	10/30/2007	0 - 0.5	**270**		8.22	U	**217**		**2,030**		**70**		**25.5**		**805**		**1,910**		**1,460**		**1,970**		**2,520**		**1,370**		**800**		**1,550**		**325**		**1,630**		**2,659**	
TP-32	071030-432c	10/30/2007	1 - 1.5	**26.1**		19	U	**31.1**		**271**		19	U	19	U	**135**		**282**		**151**		**191**		**234**		**119**		**68.6**		**192**		**29.1**		**134**		**254.59**	
TP-33	071030-433a	10/30/2007	0 - 0.5	**42.7**		8.67	U	**83**		**601**		**26.8**		8.67	U	**316**		**536**		**339**		**408**		**494**		**270**		**196**		**355**		**68.5**		**312**		**552.5**	
TP-33	071030-433b	10/30/2007	0.5 - 1	0.984	U	0.984	U	0.984	U	**4.15**		0.984	U	0.984	U	**2.12**		**3.9**		**2.42**		**3.08**		**3.86**		**2.07**		**1.52**		**3**		0.9840	U	**2.19**		**4.1582**	
TP-35	071030-435a	10/30/2007	0 - 0.5	7.78	U	7.78	U	7.78	U	**96.4**		7.78	U	7.78	U	**29.3**		**98.2**		**57.9**		**83.2**		**83.2**		**71.3**		**76.1**		**74**		**20.5**		**64.5**		**114.16**	
TP-35	071030-435c	10/30/2007	1 - 1.5	1.91	U	1.91	U	1.91	U	**4.87**		1.91	U	1.91	U	1.91	U	**5.2**		**3.26**		**4.84**		**6.19**		**4.08**		**2.17**		**4.15**		1.91	U	**3.9**		**6.53**	
TP-36	071030-436a	10/30/2007	0 - 0.5	7.68	U	7.68	U	7.68	U	**47.4**		7.68	U	7.68	U	**15.4**		**49.1**		**28.3**		**38.9**		**38.6**		**33.7**		**43.7**		**39.4**		**9.81**		**29.7**		**54.31**	
TP-36	071030-436b	10/30/2007	2 - 2.5	3.56	U	3.56	U	3.56	U	**14.2**		3.56	U	3.56	U	**5.72**		**15.3**		**7.11**		**8**		**7.24**		**6.52**		**9.21**		**10.9**		3.56	U	**5.12**		**11.16**	
TP-36	071030-436c	10/30/2007	5.5 - 6	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	0.0357	U	**0.027**	
TP-38	071030-438a	10/30/2007	0 - 0.5	3.41	U	3.41	U	3.41	U	**9.23**		3.41	U	3.41	U	3.41	U	**10.4**		**4.8**		**5.49**		**4.9**		**4.56**		**6.76**		**8.03**		3.41	U	**3.78**		**7.7648**	

Table 4-5
Soil Sampling Results - PAHs

Sample Location	Sample Number	Sample Date	Sample Depth (feet bgs)	Laboratory Analytical Testing Results mg/kg (ppm)																																	
				Non-Carcinogenic																Carcinogenic																	
				Acenaphthene		Acenaphthylene		Anthracene		Fluoranthene		Fluorene		Naphthalene		Phenanthrene		Pyrene		Benzo (a) anthracene		Benzo (a) pyrene		Benzo (b) fluoranthene		Benzo (ghi) perylene		Benzo (k) fluoranthene		Chrysene		Dibenzo (a,h) anthrace		Indeno (1,2,3-cd) pyren		Total cPAHs	
TP-39	071030-439a	10/30/2007	0 - 0.5	3.72	U	3.72	U	3.72	U	**31.2**		3.72	U	3.72	U	**11**		**30.8**		**16.5**		**21.5**		**20.3**		**17.60**		**22.7**		**23.8**		**4.39**		**14.9**		**29.62**	
TP-39	071030-439b	10/30/2007	0.5 - 1	0.0636	U	0.0636	U	0.0636	U	**0.519**		0.0636	U	0.0636	U	**0.184**		**0.556**		**0.274**		**0.366**		**0.362**		**0.322**		**0.404**		**0.438**		**0.0919**		**0.259**		**0.5095**	
TP-41	071030-441a	10/30/2007	0 - 0.5	3.17	U	3.17	U	3.17	U	**23.5**		3.17	U	3.17	U	**7.48**		**24.2**		**13.3**		**17.8**		**18.8**		**14.9**		**19.7**		**20**		**3.59**		**12.4**		**24.78**	
TP-41	071030-441b	10/30/2007	0.5 - 1	0.0288	U	0.0288	U	0.0288	U	0.0288	U	0.0288	U	0.0288	U	0.0288	U	0.0288	U	0.0288	U	**0.0289**		**0.0333**		**0.0306**		**0.0331**		**0.0343**		0.0288	U	0.0288	U	**0.0416**	

Notes:

[1] TEF Factors from Amendatory Section WAC 173-340-708

Total PAHs calculated using toxicity equivalency factors for the seven PAHs, per MTCA. Non-detect samples were summed using half the reported concentration.

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit

U = not detected above the laboratory reporting limit indicated

Table 4-6
Carbon Storage Soil Results - Lead

Sample Location	Sample Number	Sample Date	Sample Depth (feet bgs)	Laboratory Analytical Testing Results (mg/kg)
Screening Level Value				1,000
ATP-25	071030-425a	30-Oct-07	0 - 0.5	**22.1**
ATP-28	071030-428a	30-Oct-07	0 - 0.5	**23.6**
ATP-31	071030-431a	30-Oct-07	0 - 0.5	**38.3**
ATP-32	071030-432a	30-Oct-07	0 - 0.5	**76.7**
ATP-33	071030-433a	30-Oct-07	0 - 0.5	**36.3**
ATP-36	071030-436a	30-Oct-07	0 - 0.5	**18.**
ATP-39	071030-439a	30-Oct-07	0 - 0.5	**24.7**

Notes:

Clark County background concentrations of lead in soil is 17 mg/kg.

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

bgs = below ground surface

4.3.2 East Carbon Storage

Samples were collected in two locations near the rail line that runs into the Carbon Storage building and four locations in the field east of the Carbon Storage building. All of the samples collected were analyzed for PAHs. The sample data is in Table 4-5 and the sample locations are provided in Figure 3-2. Sample results were summed using the MTCA TEF method for the cPAHs.

Alcoa excavated two test pits along the railroad track that enters the south side of carbon storage building and sampled the soil below the ballast. The total TEF adjusted cPAHs were found to be 23.6 and 51.75 mg/kg in the two test pits. Alcoa further excavated another 11 test pits from west to east across the field east of the Carbon Storage building. Four test pits were sampled for PAHs at a depth of 0 to 6 inches. The test pits appeared to be visually free from materials that may contain PAHs, such as coal tar pitch. This field had been historically used as a lay down area of cable from ACPC. The four surface samples for total TEF adjusted cPAHs ranged in concentration from 30.38 mg/kg to 77.61 mg/kg.

4.3.3 Carbon Plant Bakes

Analytical testing of 36 discrete soil samples collected from 21 test pits installed through each of the three Bake Pit floors detected fluoride at concentrations ranging between 81 and 479 ppm. Analytical testing of 14 selected soil samples from eight of the test pits (TP-1, TP-3, TP-4, TP-6, TP-9, TP-14, TP-17, and TP-19) did not detect PAHs above laboratory MRLs except from TP-4 and TP-6. Total TEF adjusted cPAHs were detected in TP-4 and TP-6 at concentrations of 250.12 and 12.89 ppm, respectively, in underdrain gravel encountered at a depth of 3 feet below Bake Pit concrete floor. Total TEF adjusted PAHs were detected at markedly lower concentrations in underlying sand fill (depth of 4 feet bgs) at 0.56 and 0.19 ppm, respectively.

4.3.4 Vanexco/Rod Mill Electrical Yards

Soil sampling was conducted in the electrical yards near the Vanexco/Rod Mill facility. The soil samples S1 to S12 were collected from the former electrical equipment and transformer rail locations. These samples were analyzed for PCBs. PCBs were quantified in the samples, but only two samples had results in excess of 1.0 mg/kg.

Samples S3 and S6 had total PCB concentrations of 1.1 and 3.8 mg/kg, respectively. These sample results are in Table 4-7 and the sample locations are identified on Figure 3-2. These concentrations are below the MTCA Method A cleanup goal in soil for industrial use sites.

Table 4-7
Soil Sampling Results - PCBs
July 2007

Location ID			S1		S2		S3		S4		S5		S6		S7		S8		S9		S10		S11		S12		ATP-14		ATP-15		ATP-16	
Sample ID			S1-072507		S2-072507		S3-072507		S4-072507		S5-072507		S6-072507		S7-072507		S8-072507		S9-072507		S10-072507		S11-072507		S12-072507		TP14-072507		TP15-072507		TP16-072507	
Sample Date		Screening Level Values	7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007		7/25/2007	
Sample Time			10:30		10:35		10:40		10:45		09:00		09:05		09:10		10:15		10:15		09:49		09:50		11:10		11:30		11:44		11:58	
Sample Matrix			SO		SO		SO		SO		SO		SO		SO		SO		SO		SO		SO		SO		SO		SO		SO	
PCBs																																
Aroclor 1016	µg/kg		9.8	U	110	U	210	U	9.7	U	46	U	660	U	53	U	28	U	20	U	9.8	U	20	U	29	UJ	9.7	U	20	U	19	U
Aroclor 1221	µg/kg		9.8	U	110	U	210	U	9.7	U	46	U	660	U	53	U	28	U	20	U	9.8	U	20	U	29	UJ	9.7	U	20	U	19	U
Aroclor 1232	µg/kg		9.8	U	110	U	210	U	9.7	U	46	U	660	U	53	U	28	U	20	U	9.8	U	20	U	29	UJ	9.7	U	20	U	19	U
Aroclor 1242	µg/kg		9.8	U	110	U	210	U	9.7	U	46	U	660	U	53	U	28	U	20	U	9.8	U	20	U	29	UJ	9.7	U	20	U	19	U
Aroclor 1248	µg/kg		9.8	UJ	110	UJ	210	UJ	9.7	UJ	91	UJ	660	UJ	110	UJ	28	UJ	20	UJ	9.8	UJ	20	UJ	**75**		14	UJ	20	U	19	U
Aroclor 1254	µg/kg		**20**	**J**	**210**	**J**	**320**	**J**	**12**	**J**	**320**	**J**	**2,300**	**J**	**330**	**J**	**53**	**J**	**40**	**J**	**43**	**J**	**40**	**J**	**180**		**28**	**J**	20	U	19	U
Aroclor 1260	µg/kg		**35**	**J**	**130**	**J**	**800**	**J**	**13**	**J**	**210**	**J**	**1,500**	**J**	**270**	**J**	28	UJ	20	UJ	**43**		**33**	**J**	**110**		**16**	**J**	20	U	19	U
Total PCBs	µg/kg	1,000	**55**		**340**		**1,120**		**25**		**530**		**3,800**		**600**		**53**		**40**		**86**		**73**		**365**		**44**		20	U	19	U

Notes:

Total PCBs were calculated by summing all detected Aroclors. For samples with no reported detections, the highest reporting limit is given instead.

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations were not shaded.

J = the result is an estimated concenration that is less than the reporting limits but greater than or equal to the detection limit

SO = soil

U = not detected above the laboratory reporting limit indicated

4.3.5 Vanexco/Rod Mill Historical Road

Three samples were collected of road bed material from the south/southwest side of the Vanexco/Rod Mill facility. These samples were TP14, TP15, and TP16. Historical photographs indicated that a road bed and parking lot were once present in these locations. Currently there is asphalt in this location. Test pits were excavated test pits along the edge of the existing asphalt, exposing the historical road surface. Samples were collected of this road surface material in three locations and analyzed for PCBs. All three samples had total PCB concentrations less than the screening level of 1.0 mg/kg.

4.3.6 Characterization of Fluoride-Bearing Materials

Soil sampling was conducted in multiple locations across the Site, resulting in 57 samples. This data is summarized in Table 4-8. Ten of the 57 samples collected were visually distinct (i.e., termed gray soil) and contained high fractions of fluoride-bearing raw materials and waste. The concentration of total fluoride these samples ranged from 1,180 to 171,000 mg/kg and the concentration of fluoride in the SPLP leachate ranged from 0.7 to 78.8 mg/L.

The remaining 47 samples were collected either at depth intervals below fluoride-bearing raw materials or under the concrete floor of the carbon bakes. These samples were analyzed for total fluoride and ranged 79.9 to 5,530 mg/kg. The samples were also analyzed by extracting leachate using SPLP and analyzing the leachate for fluoride. The SPLP fluoride extraction results in the samples ranged from not detect at 0.5 mg/L to 20.6 mg/L. The ratio of the two analytical results was used to calculate the Site-wide K_d for fluoride, per the MTCA procedure for calculating K_d values, resulting in the average Site-Wide K_d of 228.

Table 4-8
Soil Sampling Results - Fluoride

Sample Location	Sample Number	Sample Date	Sample Depth	Matrix	Soil mg/kg		Leachate mg/L		Distribution Coefficient, Kd
Soil Screening Level					210,000				--
Groundwater Screening Level							4		--
S260	0808-260	8-Aug-07	0 - 0.5	Gravelly Silt^1	**19,700**		**63.60**		--
S261	0808-261	8-Aug-07	0 - 0.5	Gravelly Silt^1	**122,000**		**50.20**		--
S262	0808-262	8-Aug-07	0 - 0.5	Sand	**347**		**0.90**		386
S263	0808-263	8-Aug-07	0 - 0.5	Sand^1	**6,510**		**56.80**		--
S264	0808-264a	8-Aug-07	0 - 0.5	Sand^1	**1,500**		**2.90**		--
S264	0816-264b	16-Aug-07	1.5 - 2	Sand	**80**		**0.60**		133
S265	0808-265a	8-Aug-07	0 - 0.5	Sand^1	**1,630**		**1.80**		--
S265	0816-265b	16-Aug-07	1 - 1.5	Sand	**232**		**2.40**		97
S266	0816-266a	8-Aug-07	0 - 0.5	Sand^1	**4,240**		**4.10**		--
S266	0816-266b	16-Aug-07	2 - 2.5	Sand	**272**		**10.80**		25
S267	0816-267a	8-Aug-07	0 - 0.5	Sand^1	**3,050**		**20.60**		--
S267	0816-267b	16-Aug-07	1 - 1.5	Sand	**368**		**10.90**		34
S268	0816-268a	8-Aug-07	0 - 0.5	Sand^1	**26,900**		**89.00**		--
S268	0816-268b	16-Aug-07	1.5 - 2	Sand	**1,720**		**4.70**		366
S269	0816-269a	8-Aug-07	0 - 0.5	Sand^1	**171,000**		**78.80**		--
S269	0816-269b	16-Aug-07	0.5 - 1	Sand	**1,230**		**20.60**		60
S270	0816-270a	8-Aug-07	0 - 0.5	Sand^1	**1,180**		**3.50**		--
S270	0816-270b	16-Aug-07	1.5 - 2	Sand	**222**		**1.40**		159
S271	0808-271	8-Aug-07	0 - 0.5	Sand	**1,050**		**15.30**		69
S272	0808-272	8-Aug-07	0 - 0.5	Sand	**150**		**0.70**		214
S273	0808-273	8-Aug-07	0 - 0.5	Sand	**537**		**7.20**		75
S274	0808-274	8-Aug-07	0 - 0.5	Sand	**5,530**		**34.80**		159
S275	0808-275	8-Aug-07	0 - 0.5	Sand	**1,550**		**19.30**		80
S276	0808-276	8-Aug-07	0 - 0.5	Sand	**1,350**		**1.10**		1227
S277	0808-277	8-Aug-07	0 - 0.5	Sand	**441**		**7.30**		60
TP-1	0531-201	31-May-07	3.	Gravel	**178**		**0.52**		342
TP-1	0531-202	31-May-07	4.	Sand	**97**		0.50	U	193
TP-2	0531-203	31-May-07	3.5	Gravel	**136**		**0.86**		158
TP-2	0531-204	31-May-07	4.5	Sand	**99**		**0.61**		163
TP-3	0531-205	31-May-07	3.	Gravel	**148**		**1.24**		119
TP-3	0531-206	31-May-07	4.	Sand	**95**		0.50	U	190
TP-4	0531-207	31-May-07	3.	Gravel	**145**		**1.03**		141
TP-4	0531-208	31-May-07	4.	Sand	**479**		0.50	U	958
TP-5	0531-209	31-May-07	3.	Gravel	**328**		**0.69**		475
TP-5	0531-210	31-May-07	4.	Sand	**461**		**1.76**		262
TP-6	0531-211	31-May-07	3.	Gravel	**257**		0.50	U	514
TP-6	0531-212	31-May-07	4.	Sand	**314**		**1.39**		226
TP-7	0601-213	1-Jun-07	2.5	Gravel	**112**		**1.43**		78
TP-7	0601-214	1-Jun-07	3.5	Sand	**229**		0.50	U	458
TP-8	0601-215	1-Jun-07	3.5	Sand	**413**		**0.67**		616
TP-9	0601-216	1-Jun-07	2.5	Gravel	**202**		**0.62**		326
TP-9	0601-217	1-Jun-07	3.5	Sand	**436**		**1.31**		333
TP-10	0601-218	1-Jun-07	3.5	Sand	**297**		**0.61**		487
TP-11	0601-219	1-Jun-07	2.5	Gravel	**168**		0.50	U	336

Table 4-8
Soil Sampling Results - Fluoride

Sample Location	Sample Number	Sample Date	Sample Depth	Matrix	Soil mg/kg		Leachate mg/L		Distribution Coefficient, Kd
Soil Screening Level					210,000				--
Groundwater Screening Level							4		--
TP-11	0601-220	1-Jun-07	3.5	Sand	**349**		0.50	U	698
TP-12	0601-221	1-Jun-07	3.	Gravel	**137**		0.50	U	274
TP-12	0601-222	1-Jun-07	4.	Sand	**182**		0.50	U	364
TP-13	0601-223	1-Jun-07	4.5	Sand	**132**		**0.94**		140
TP-14	0601-224	1-Jun-07	3.5	Gravel	**120**		0.50	U	240
TP-14	0601-225	1-Jun-07	4.5	Sand	**110**		**0.73**		151
TP-15	0601-226	1-Jun-07	4.	Sand	**147**		**0.65**		226
TP-16	0601-227	1-Jun-07	3.	Gravel	**105**		0.50	U	210
TP-16	0601-228	1-Jun-07	4.	Sand	**82**		**0.57**		144
TP-17	0601-229	1-Jun-07	3.5	Gravel	**156**		**0.70**		223
TP-17	0601-230	1-Jun-07	4.5	Sand	**128**		**4.45**		29
TP-18	0601-231	1-Jun-07	3.5	Sand	**162**		**0.57**		284
TP-19	0601-232	1-Jun-07	3.5	Gravel	**143**		0.50	U	286
TP-19	0601-233	1-Jun-07	4.5	Sand	**81**		0.50	U	162
TP-20	0601-234	1-Jun-07	3.5	Sand	**90**		**1.74**		52
TP-21	0601-235	1-Jun-07	3.5	Gravel	**151**		**1.17**		129
TP-21	0601-236	1-Jun-07	4.5	Sand	**110**		0.50	U	220

Notes:

[1] Samples containing a proportion of reacted ore (such as gray soils) were not included in the average Kd calculation. The two highest calculated Kd values were also omitted from the average.

Average Kd coefficient = 228

Refer to Section 3.1 for a discussion of screening level selection.

Detected values are shown in bold.

Shaded values exceed screening levels. However, when non-detect values at reporting limits exceed screening levels, these concentrations

U = not detected above the laboratory reporting limit indicated

4.3.7 Port of Vancouver Sampling

Through the process of conducting due diligence for the potential purchase of the Alcoa property by the POV, the POV's consultant collected samples from the shoreline along the west side of the East Landfill to the Alcoa dock. During this sampling event, the POV collected 13 samples and analyzed them for PCBs, PAHs, VOCs, metals, and total cyanide. The sample results for the metals, VOCs, and total cyanide were all below the preliminary soil screening levels. Eight samples had detectable quantities of PCBs. Four of those samples had detectable quantities of PCBs above 1.0 mg/kg, the MTCA Method A cleanup goal for soil for unrestricted reuse. After further reviewing the locations of these samples (as shown on Figure 3-2) it was revealed that these samples are below the ordinary high water mark for the Columbia River and would be addressed as part of the sediment remediation work. Within the dike, there were three locations where the POV identified tar material and collected samples. These samples contained total TEF-adjusted cPAHs exceeding the preliminary screening levels. This material appeared to possibly be a tar-like material from the historical anode production process. Materials that exceed PAH cleanup levels would be removed from the dike during the sediment remediation work.

4.4 Data Validation

The samples collected as part of the groundwater sampling effort were analyzed by CAS in Kelso, Washington. All but one of the groundwater and surface water laboratory sample delivery groups (SDGs) were validated by EcoChem, Inc.; the remaining data set was validated by Anchor. The Alcoa soil data was analyzed by ARI in Seattle Washington and validated by Laboratory Data Consultants (LDC). Data validation reports were prepared for each of the laboratory SDGs. The data validation by EcoChem and LDC was performed under EPA Level III Guidelines. The data validation completed by Anchor was performed to the highest level of validation possible with the data available, which was to EPA Level II Guidelines. Validation was performed using recognized EPA and ASTM protocols, as applicable to each method.

The laboratory reports were reviewed and compared to the chain-of-custody submitted to the laboratory to ensure that all samples were analyzed for the requested analyses and results reported. As part of the validation procedure, the validator reviewed the laboratory's performance for holding time compliance for both the extraction and analytical fractions of the analysis, where applicable. The following QC criteria were reviewed for each method analyzed to ensure the data reported met the designated criteria:

- Method blank results
- Field duplicates
- Laboratory duplicates
- Instrument performance checks
- Initial calibrations
- Continuing calibrations
- Surrogate spikes
- Matrix spikes/matrix spike duplicates
- Laboratory control samples
- Internal standards
- Field QA/QC samples

Data that did not meet the Work Plan-designated QC requirements or the technical requirements of the method, or that was a laboratory deviation from a specified protocol, has been qualified based on qualifiers designated by the EPA (USEPA 1999). The data validation packets are included in Appendix H.

5 HYDROGEOLOGICAL INVESTIGATIONS

This section describes the Site hydrogeology, focusing on hydraulic parameters, groundwater flow direction and rates, and interactions between groundwater, surface water, and the CPU wells at the Site. These descriptions are based on the results of lithologies encountered during drilling and measurements of groundwater and surface water elevations, incorporating both current and historical investigations.

5.1 Regional and Site Geology

Published reports were used to determine the regional geology, including U.S. Geological Survey reports and historical site investigation reports. The Site is located in the Portland Basin within the Columbia River floodplain. The Sandy River Mudstone and the Troutdale Formation are the oldest sediments in the Portland Basin. The Troutdale Formation overlies the Sandy River Mudstone.

The Troutdale Formation is overlain by sediments deposited during Pleistocene catastrophic flooding of the Columbia River (Trimble 1963). These flood deposits have been termed the Unconsolidated Sedimentary Aquifer (USA) (Swanson 1993). The USA is overlain by Quaternary Alluvium deposits consisting of very poorly consolidated silt and sand on the floodplains of the modern Columbia River (Madin 1990). In developed areas along the river shoreline, the Quaternary Alluvium is overlain by artificial fill consisting primarily of dredged river sand.

The Site geology has been determined by evaluating the findings of the investigations completed on Site and the findings from investigations completed on nearby properties. Early Site investigations by Robinson Noble and Hart Crowser identified the presence of the following geologic units, from shallow to deep:

- Dredge Fill
- Quaternary Alluvium
- Troutdale Formation

Subsequent to Hart Crowser's work at the Site, regional investigations by the U.S. Geological Survey and recent investigations on nearby properties have determined that the unit previously identified as the Troutdale Formation is actually the USA.

5.2 Site Hydrogeologic Units

The four hydrogeologic units identified by Hart Crowser continue to be used in current Site investigations and are defined below.

- **Shallow Zone**: Dredge fill sand thickness ranges from about 7 to 25 feet depending upon the location. The Shallow Zone tends to be deeper (more than 20 feet) on the east side of the Site because of extensive filling activities that took place historically in that area. Groundwater is present in this zone seasonally. Groundwater in this zone may be locally perched on the finer grained materials in the underlying Intermediate Zone. Many monitoring wells screened in this zone are dry in late summer and fall.
- **Intermediate Zone**: This unit extends from an average of about 15 to 35 feet bgs. The top of this zone is the original ground surface present before dredge fill was placed in the 1940s. In certain locations, such as the East Landfill, this unit extends downward to as deep as 60 feet bgs. The Intermediate Zone is Quaternary Alluvium comprised of silt, fine sand, and clay, with lower hydraulic conductivity than the overlying Shallow Zone.
- **Deep Zone:** This unit extends from an average of about 35 to 95 feet bgs. However, in the southern part of the site, the Deep Zone extends as deep as 125 feet bgs. The Deep Zone is comprised of Quaternary Alluvium fine to medium sand.
- **Aquifer Zone:** The top of the Aquifer Zone is about 95 feet bgs in the northern portion of the site down to about 125 feet bgs in the southern site area near the river shoreline. The base of the Aquifer Zone has not been reached by Site borings. This unit was previously identified as the Troutdale Formation, but has subsequently been redefined by the U.S. Geological Survey as the USA. The identification of the Aquifer Zone as the USA is based primarily on the extremely high hydraulic conductivity of regional wells screened in this unit and the composition of the gravel. The coarse-grained flood deposits of the USA are the most permeable aquifer in the Portland Basin (Swanson 1993). Due to the high hydraulic conductivity of the USA, no regional supply wells extend down into the underlying Troutdale Formation. The Alcoa plant supply wells are screened in the Aquifer Zone (USA), as are neighboring high yield supply wells operated by CPU, POV, and Great Western Malting Company. For the purposes of the Alcoa RI, and to be consistent with

previous nomenclature of historical Alcoa reports, the USA will continue to be named the Aquifer Zone for Alcoa Site work.

The locations of subsurface hydrogeologic cross sections are shown on Figure 3-1. The hydrogeologic cross sections on Figures 5-1 to 5-8 represent typical subsurface conditions across the entire Site, with particular focus on sections that extent from upland areas to the Columbia River shoreline.

5.3 Hydraulic Parameter Estimates

In order to estimate groundwater velocities and groundwater fluxes, estimates of horizontal hydraulic conductivity and effective porosity of the Shallow, Intermediate, Deep, and Aquifer Zones are required. Estimated values of hydraulic conductivity at the site are based on site-specific slug testing performed by Hart Crowser (Hart Crowser 1987b) and estimated values of effective porosity from literature.

Based on an evaluation of slug tests performed at 48 monitoring wells, Hart Crowser estimated the horizontal hydraulic conductivity of the four hydrogeologic units investigated at the site to be the following:

- Shallow Zone ranged between 10^{-4} and 10^{-2} centimeters per second (cm/sec), or approximately 0.25 to 25 feet/day
- Intermediated Zone ranged between 10^{-6} and 10^{-4} cm/sec, or approximately 0.0025 to 0.25 feet/day
- Deep Zone ranged between 10^{-4} and 10^{-2} cm/sec, or approximately 0.25 to 25 feet/day
- Aquifer Zone ranged between 10^{-3} and 10^{-2} cm/sec, or approximately 2.5 to 25 feet/day

With the exception of the horizontal hydraulic conductivity estimate for the Aquifer Zone, these values fall within the ranges of the general scientific literature and are consistent with the nature of the materials observed during drilling. As discussed previously, the coarse-grained flood deposits of the Aquifer Zone are the most permeable aquifer in the Portland Basin (Swanson 1993), and the hydrogeologic unit in which most of the regional supply wells are completed. Given the extremely high horizontal hydraulic conductivity of the Aquifer Zone, the estimates derived from slug testing by Hart Crowser appear to be biased low and are likely associated with the limitations of using slug tests to characterize such a highly permeable hydrogeologic unit.

Parametrix has completed extensive groundwater flow and contaminant transport modeling for another site in the region with similar hydrogeology (Parametrix 2004). The Site is included in the domain of the Parametrix model, although no water level data from the Site were used in the calibration process. Based on calibrated model results and a review of the literature for the region, Parametrix estimated the horizontal hydraulic conductivity of the shallow alluvium in the area to be 5 feet/day. The shallow alluvium identified by Parametrix corresponds to the Shallow, Intermediate, and Deep Zones identified at the site. Parametrix used a calibrated horizontal hydraulic conductivity of 10,000 feet/day for the USA, which is equivalent to the Aquifer Zone.

For the purpose of estimating groundwater flow velocities and groundwater fluxes, the horizontal hydraulic conductivity of the Shallow, Intermediate, Deep, and Aquifer Zones are assumed to be 5, 5, 50, and 10,000 feet/day, respectively.

No Site-specific data for total or effective porosity are available. Based on the lithologies of the materials encountered at the Site, the total porosity of the saturated materials at the Site probably ranges between 25 and 50 percent (Freeze and Cherry 1979), with the finer-grained Intermediate Zone likely having a total porosity closer to 50 percent. Effective porosity is defined as that portion of the total porosity contributing to flow. Given the relatively fine-grained nature of the materials (i.e., silt and clay) in the Intermediate Zone, much of this porosity is not likely interconnected. Accordingly, the effective porosity was assumed to be one half of the total porosity, or approximately 25 percent. The coarser-grained Shallow and Deep Zones, consisting of sands, and the Aquifer Zone, consisting of gravels, likely have lower total porosity than the Intermediate Zone. However, due to their coarser nature, there are likely fewer blocked pore spaces in the Shallow, Deep, and Aquifer Zones and effective porosity is likely closer to the total porosity. Accordingly, the effective porosity of the Shallow, Deep, and Aquifer Zones is assumed to be 30 percent.

5.4 Groundwater Elevations and Inferred Flow Directions

As discussed in Section 3.3.3, groundwater elevation data were collected continuously from 33 monitoring wells using time-synchronized pressure transducers and dataloggers during the period October 5 through October 11, 2007. This approach to collecting groundwater elevation data was pursued for two reasons. First, because the Site is relatively large and because previous investigations indicated groundwater elevations responded rapidly to tidal fluctuations, this approach was the only way to collect data that could be meaningfully interpreted. The second reason is again related to anticipated tidal influence of the Columbia River on Site groundwater elevations. While groundwater flow directions proximal to the Columbia River might diurnally alternate based on tidal influence, the net flow direction over the longer term will be related to a longer-term average of groundwater elevations.

Because many of the Shallow Zone monitoring wells were dry during September and October 2007, pressure transducers and dataloggers were not deployed in Shallow Zone monitoring wells. Therefore the discussion of groundwater elevations and inferred flow directions is focused on the Intermediate, Deep, and Aquifer Zones.

Average groundwater elevations for the Site monitoring wells were developed using the groundwater elevation data collected at 15-minute intervals during the period from 6 PM on October 5 through 4 PM on October 11, 2007. These average groundwater elevations for the Intermediate, Deep, and Aquifer Zones are on Figures 5-9 through 5-11, respectively. These figures also illustrate the average stage of the Columbia River for the same monitoring period as measured from the Alcoa dock. Inclusion of the average Columbia River stage on the groundwater elevation figures facilitates an evaluation of interactions between groundwater and the Columbia River.

A review of Figures 5-9, 5-10, and 5-11 indicates that with some minor exceptions, average groundwater elevations within each of the groundwater zones do not vary significantly across the Site. Thus, the horizontal hydraulic gradients in each of the groundwater zones are relatively flat, especially in the Aquifer Zone. Given the relatively flat horizontal hydraulic gradient, the heterogeneous nature of the alluvial materials observed in the Intermediate and Deep Zones, and variations in screened interval depth for the monitoring wells, groundwater elevation contour lines were not drawn on Figures 5-9, 5-10, and 5-11. Drawing groundwater elevation contour lines would require technically inappropriate speculation, or in the case of the Aquifer Zone, would not be possible because the maximum variation in average groundwater elevation across the entire site is 0.06 feet.

Average groundwater elevations for the Intermediate Zone are illustrated on Figure 5-9. These data indicate that over most of the portions of the Site where data are available, groundwater is flowing to the south towards the Columbia River. Assuming the Columbia River stage of 4.18 feet is representative of Intermediate Zone groundwater elevations along the river bank, the available data indicate Intermediate Zone groundwater along the southern portion of the Site is discharging into the Columbia River. The average groundwater elevation at monitoring well EVGR-01-I, which is located on the northern portion of the Site, is lower than the average groundwater elevations in many of the Intermediate Zone monitoring wells to the south. This suggests there may be an approximately east-west trending hydraulic divide south of monitoring well EVGR-01-I, with Intermediate Zone groundwater on the northern portion of the site flowing to the north, away from the Columbia River. Pumping from the two cooling water supply wells at the River Road Generating Plant is a potential cause for this apparent hydraulic divide.

Average groundwater elevations for the Deep Zone are illustrated on Figure 5-10, and the inferred direction of groundwater flow in the Deep Zone is similar to the inferred groundwater flow direction in the Intermediate Zone. The average groundwater elevation data suggest that groundwater is flowing to the south towards the Columbia River over most portions of the Site where data are available. Assuming the Columbia River stage of 4.18 feet is representative of Deep Zone groundwater elevations along the river bank, the available data indicate Deep Zone groundwater along the southern portion of the Site is discharging into the Columbia River. The average groundwater elevations at monitoring wells EVGR-01-D and MW-47-1D, which are located on the northern portion of the Site, are lower than the average groundwater elevations in some of the Deep Zone monitoring wells to the south. This suggests there may be an approximately east-west trending hydraulic divide south of monitoring wells EVGR-01-D and MW-47-1D, with Deep Zone groundwater on the northern portion of the site flowing to the north, away from the Columbia River.

Pumping from the two cooling water supply wells at the River Road Generating Plant is a potential cause for this apparent hydraulic divide.

Figure 5-11 illustrates average groundwater elevations for the Aquifer Zone. The maximum variation in average groundwater elevation in the Aquifer Zone across the entire site is 0.06 feet. This variation is indicative of a relatively flat horizontal hydraulic gradient, and is reasonable given the extremely high permeability of the Aquifer Zone. Assuming the Columbia River stage of 4.18 feet is representative of Aquifer Zone groundwater elevations along the river bank, the available data indicate the Aquifer Zone may be gaining water from the Columbia River. Pumping from the two cooling water supply wells at the River Road Generating Plant might be inducing this potential discharge from the Columbia River. This discharge would be consistent with the results of the calibrated groundwater flow and contaminant transport model prepared by Parametrix (2004), which also suggests pumping by the River Road Generating Plant induces discharge from the Columbia River. However, given the very small spatial variation in groundwater elevations within the Aquifer Zone across the entire Site (i.e., 0.06 feet), which is approaching the practical accuracy and precision of water level measurement methods (i.e., approximately 0.02 feet), any discussion regarding groundwater flow directions would be speculative.

5.5 Estimated Groundwater Velocities

This section describes the development of groundwater velocity estimates for the Intermediate Zone and Deep Zone in the vicinity of the East Landfill proximal to the Columbia River. Groundwater velocity estimates are focused on these two hydrogeologic units for the following reasons. Groundwater velocity estimates were not developed for the Shallow Zone because many of the Shallow Zone monitoring wells were dry in September and October 2007 and no average groundwater elevation data are available for the period of October 5 through October 11, 2007. As illustrated on Figure 5-11 and discussed in Section 5.4, the maximum spatial variation in average groundwater elevations for Aquifer Zone monitoring wells at the Site is 0.06 feet. Given this small spatial variation in average groundwater elevations in the Aquifer Zone, it would not be technically appropriate to speculate on groundwater flow directions and quantify horizontal hydraulic gradients in the Aquifer Zone.

Development of groundwater velocity estimates are focused on the vicinity of the East Landfill proximal to the Columbia River because this is the primary area where exceedances of the preliminary screening levels for the COPCs have been identified based on water quality data collected in 2007. As discussed in Section 4, impacts to groundwater by VOCs and fluoride above the preliminary screening levels are limited to the Intermediate Zone and Deep Zone in the East Landfill area, with the following exceptions. Vinyl chloride was detected in Aquifer Zone monitoring wells MW-47, MW-48, and MW-51 at concentrations exceeding the preliminary screening level of 0.2 μg/L; however, calculating the groundwater velocity in the Aquifer Zone is not possible with the available hydrology data, due to flat water level gradient. Fluoride was detected in Shallow Zone monitoring well MW-30-S; however, there are no average groundwater elevation data for the Shallow Zone, making it impossible to calculate groundwater velocity in the Shallow Zone.

In order to calculate groundwater velocities, estimates of the following hydrogeologic parameters are required: horizontal hydraulic conductivity, horizontal hydraulic gradient, and effective porosity. Average linear groundwater velocity is calculated using the following equation:

$$\bar{v} = \frac{KI}{n_{eff}}$$

where

$\bar{v}$ = average linear groundwater velocity (feet/day)

K = horizontal hydraulic conductivity (feet/day)

I = horizontal hydraulic gradient (dimensionless)

n_{eff} = effective porosity (dimensionless)

As discussed in Section 5.3, the horizontal hydraulic conductivity of the Intermediate Zone and Deep Zone is assumed to be 5 and 50 feet/day, respectively. The effective porosity of the Intermediate Zone and Deep Zone is assumed to be 25 and 30 percent, respectively.

There are two subareas within the Intermediate Zone of the East Landfill area where water quality impacts exceed preliminary screening levels. Exceedances of VOCs (i.e., TCE, etc.) were observed in monitoring wells MW-94-1-I and MW-94-2-I, and exceedances of fluoride were observed in monitoring well MW-51-I. Referencing the average groundwater elevation of 4.45 feet at monitoring well MW-94-2-I, the average Columbia River stage of 4.18 feet, and assuming a distance of 200 feet between these locations yields a horizontal hydraulic gradient of 0.0014 in this area of the Intermediate Zone. Assuming a horizontal hydraulic conductivity of 5 feet/day, a horizontal hydraulic gradient of 0.0014, and an effective porosity of 0.25, the estimated groundwater velocity in the Intermediate Zone near monitoring well MW-94-2-I is 0.028 foot/day, or approximately 10 feet/year.

For the area near monitoring well MW-51-I, the horizontal hydraulic gradient is estimated to be 0.0038 based on the average groundwater elevation of 4.75 feet at monitoring well MW-51-I, the average Columbia River stage of 4.18 feet, and assuming a distance of 150 feet between these locations. Assuming a horizontal hydraulic conductivity of 5 feet/day, a horizontal hydraulic gradient of 0.0038, and an effective porosity of 0.25, the estimated groundwater velocity in the Intermediate Zone near monitoring well MW-51-I is 0.076 foot/day, or approximately 30 feet/year.

There are two subareas within the Deep Zone of the East Landfill area where water quality impacts exceed the preliminary screening levels. Exceedances of VOCs and/or fluoride were observed in monitoring wells MW-94-1-D and MW-94-2-D, and exceedances of fluoride were observed in monitoring wells MW-48-D and MW-51-D. Referencing the average groundwater elevation of 4.38 feet at monitoring well MW-94-2D, the average Columbia River stage of 4.18 feet, and assuming a distance of 200 feet between these locations yields a horizontal hydraulic gradient of 0.0010 in this area of the Intermediate Zone. Assuming a horizontal hydraulic conductivity of 50 feet/day, a horizontal hydraulic gradient of 0.0010, and an effective porosity of 0.30, the estimated groundwater velocity in the Deep Zone near monitoring well MW-94-2-D is 0.17 foot/day, or approximately 60 feet/year.

For the area near monitoring wells MW-48-D and MW-51-D, the horizontal hydraulic gradient is estimated to be 0.00050 based on the average groundwater elevation of 4.64 feet at monitoring well MW-47-D, the average Columbia River stage of 4.18 feet, and assuming a distance of 925 feet between these locations. Assuming a horizontal hydraulic conductivity of 50 feet/day, a horizontal hydraulic gradient of 0.00050, and an effective porosity of 0.30, the estimated groundwater velocity in the Deep Zone near monitoring wells MW-48-D and MW-51-D is 0.083 foot/day, or approximately 30 feet/year.

5.6 Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated at all monitoring well pairs in which transducers and dataloggers were deployed during the period October 5 through October 11, 2007. Vertical hydraulic gradient calculations were made using the average groundwater elevations during this period and the vertical distances between the midpoints of screened intervals of the shallower and deeper wells for each monitoring well pair. Vertical hydraulic gradients were calculated for 10 pairs of Intermediate Zone to Deep Zone monitoring wells, and seven pairs of Deep Zone to Aquifer Zone monitoring wells. Table 5-1 summarizes the vertical hydraulic gradient calculations. All vertical hydraulic gradients were positive, indicating a downward vertical gradient.

For the Intermediate Zone to Deep Zone monitoring well pairs, vertical hydraulic gradients ranged from 0.0030 at monitoring well pairs EVGR-01-I/D and MW-94-2-I/D to 0.73 at monitoring well pair EVGR-02-I/D. With the exception of three monitoring well pairs (i.e., EVGR-01-I/D, MW-51-I/D, and MW-94-2-I/D), vertical hydraulic gradients were greater than 0.10. Vertical hydraulic gradients of this magnitude suggest relatively poor vertical hydraulic communication between the Intermediate Zone and Deep Zone, which is consistent with the fine-grained characteristics of the Intermediate Zone (i.e., silts and clays with some silty sand lenses). The much lower vertical hydraulic gradients observed at monitoring well pairs EVGR-01-I/D, MW-51-I/D, and MW-94-2-I/D suggest fairly good hydraulic communication between the Intermediate Zone and the Deep Zone in the vicinity of these wells, likely due to a decrease in silt and clay content within the Intermediate Zone in these areas.

For the Deep Zone to Aquifer Zone monitoring well pairs, vertical hydraulic gradients ranged from 0.00065 at monitoring well pair MW-51-D/A to 0.017 at monitoring well pair MW-35-D/A. Vertical hydraulic gradients of this magnitude suggest relatively good hydraulic communication between the Deep Zone and the Aquifer Zone, which is consistent with the coarse-grained characteristics of both the Deep Zone and the Aquifer Zone, which are comprised of sands and sands/gravels, respectively.

Table 5-1
Vertical Hydraulic Gradient Calculations[1]

Monitoring Well Pair	Shallower Well Groundwater Elevation (feet NGVD 1929)	Deeper Well Groundwater Elevation (feet NGVD 1929)	Shallower Well Elevation of Screened Interval Midpoint (feet NGVD 1929)	Deeper Well Elevation of Screened Interval Midpoint (feet NGVD 1929)	Vertical Hydraulic Gradient[2] (dimensionless)
Intermediate Groundwater Zone to Deep Groundwater Zone					
EVGR-01-I/D	4.43	4.37	2.48	-17.62	0.0030
EVGR-02-I/D	18.43	4.58	0.89	-18.02	0.73
MW-30-I/D	5.91	4.86	-1.28	-10.14	0.12
MW-35-I/D	8.57	5.03	5.46	-15.82	0.17
MW-46-I/D	7.66	4.30	4.65	-22.44	0.12
MW-47-1-I/D	6.76	4.64	3.02	-14.44	0.12
MW-51-I/D	4.75	4.14	0.85	-19.10	0.031
MW-94-2-I/D	4.45	4.38	-2.00	-25.45	0.0030
SP2-I/D	10.46	4.38	7.20	-23.80	0.20
SP4-I/D	12.47	4.22	8.00	-17.75	0.32
Deep Groundwater Zone to Aquifer Zone					
EVGR-01-D/A	4.37	4.09	-17.62	-74.99	0.005
EVGR-02-D/A	4.58	4.05	-18.02	-103.06	0.006
MW-35-D/A	5.03	4.06	-15.82	-71.41	0.017
MW-46-D/A	4.30	4.07	-22.44	-88.04	0.004
MW-47-1-D/A	4.64	4.07	-14.44	-70.71	0.010
MW-51-D/A	4.14	4.09	-19.10	-96.10	0.00065
MW-94-2-D/A	4.38	4.06	-25.45	-78.91	0.0060

Notes:

Feet NGVD 1929 = feet relative to the North American Vertical Datum of 1929

[1] Based on average groundwater elevation data collected at 15-minute intervals using pressure transducers and dataloggers during the period from 6 pm on October 5, 2007, through 4 pm on October 11, 2007

[2] A positive number indicates a downward vertical hydraulic gradient

5.7 Interactions between Groundwater, the Columbia River, and Power Plant Pumping

As discussed in Section 5.4, it is difficult to draw groundwater elevation contours and identify groundwater flow directions in the Intermediate, Deep, and Aquifer Zones across much of the Site because of the relatively flat horizontal hydraulic gradients, the heterogeneous nature of alluvial materials observed in the Intermediate and Deep Zones, and variations in screened interval depth for the monitoring wells. However, based on the available average groundwater elevation and Columbia River stage data, the following general statements regarding groundwater flow directions can be made:

- In the Intermediate and Deep Zones proximal to the Columbia River (Figures 5-9 and 5-10), the direction of groundwater flow appears to be to the south towards the Columbia River, suggesting that groundwater from these two hydrogeologic units is discharging to the Columbia River.
- There may be an approximately east-west trending hydraulic divide south of monitoring well EVGR-01, with Intermediate and Deep Zone groundwater on the northern portion of the site flowing to the north, away from the Columbia River. Pumping from the two cooling water supply wells at the River Road Generating Plant is a potential cause for this apparent hydraulic divide.
- The Columbia River may be discharging to the Aquifer Zone, potentially induced by pumping from the two cooling water supply wells at the River Road Generating Plant. This discharge would be consistent with the results of the calibrated groundwater flow and contaminant transport model prepared by Parametrix (Parametrix 2004). However, given the very small spatial variation in groundwater elevations within the Aquifer Zone across the entire Site (i.e., 0.06 feet), which is approaching the practical accuracy and precision of water level measurement methods (i.e., approximately 0.02 feet), any discussion regarding groundwater flow directions would be speculative.

Another method to evaluate interactions between groundwater, surface water, and pumping from the two cooling water supply wells at the River Road Generating Plant is a focused review of the groundwater elevation and Columbia River stage data collected during the period October 5 through 11, 2007. These data were used to create hydrographs for the Intermediate, Deep, and Aquifer Zones and are illustrated on Figures 5-12, 5-13, and 5-14, respectively.

Hydrographs for Intermediate Zone monitoring wells (Figure 5-12) show that for those monitoring wells in which the groundwater elevation was in the range of the Columbia River stage tidal changes, groundwater elevations responded to diurnal tidal fluctuations, with one exception. Examples include monitoring wells MW-51-I, MW-94-2-I, EVGR-01-I, and MW-30-I. This indicates that Intermediate Zone groundwater in the areas of these wells is within the zone of influence of Columbia River tidal fluctuations. The single exception to this generalization are the groundwater elevations measured at monitoring well MW-18-I, which do not clearly exhibit any response to Columbia River tidal fluctuations, which is surprising given the proximity of monitoring well MW-18-I to the Columbia River. These data suggest that Intermediate Zone groundwater in the vicinity of monitoring well MW-18-I is not within the zone of influence of the Columbia River tidal fluctuations, and is not in good hydraulic communication with the Columbia River.

For those Intermediate Zone monitoring wells in which the groundwater elevation was above the range of the Columbia River stage tidal changes (i.e., MW-46-I, MW-47-I, MW-35-I, SP-2-I, SP-4-I, and EVGR-01-I), groundwater elevations did not respond to diurnal tidal fluctuations. These data indicate that Intermediate Zone groundwater in the areas of these wells is not within the zone of influence of Columbia River tidal fluctuations. However, this statement should not be interpreted to mean there is poor hydraulic communication between Intermediate Zone groundwater in the areas of these wells and the Columbia River.

Hydrographs for Deep Zone monitoring wells (Figure 5-13) show that groundwater elevations at all of the Deep Zone monitoring wells in which pressure transducers and dataloggers were deployed were all within the range of the Columbia River stage tidal changes. These hydrographs also illustrate that Deep Zone groundwater in the areas of all of these monitoring wells is within the zone of influence of Columbia River tidal fluctuations.

Hydrographs for the Aquifer Zone monitoring wells (Figure 5-14) show a similar response to the Deep Zone monitoring well hydrographs. Groundwater elevations at all of the

Aquifer Zone monitoring wells in which pressure transducers and dataloggers were deployed were all within the range of the Columbia River stage tidal changes, and Aquifer Zone groundwater in the areas of all of these monitoring wells is within the zone of influence of Columbia River tidal fluctuations.

It is worth noting the variations in amplitude of water level response within the Intermediate, Deep, and Aquifer Zone to Columbia River tidal changes. A review of the hydrographs illustrated in Figures 5-12, 5-13, and 5-14 shows that the amplitude of water level response in Deep Zone monitoring wells is approximately equivalent to the amplitude of Columbia River tidal fluctuations for many of the wells. However, the amplitude of water level response in the Intermediate and Aquifer Zone monitoring wells are much lower than the amplitude of Columbia River tidal fluctuations relative to those water level responses observed in Deep Zone monitoring wells. These observations suggest the Deep Zone is in better hydraulic communication with the Columbia River than the Intermediate and Aquifer Zones. Review of the subsurface geologic profiles on Figures 5-1 through 5-8 shows that the Deep Zone is in direct contact with the Columbia River channel sediments, while the top of the Aquifer Zone is well below the deepest portion of the river channel. Therefore, there is a more direct hydraulic connection between the Deep Zone aquifer materials and the Deep Zone has a consequent higher tidal efficiency than the underlying Aquifer Zone.

In order to evaluate potential interactions between groundwater and pumping stresses, personnel from Evergreen and CPU were contacted to identify pumping schedules for on-Site and near off-Site water supply wells during the period October 5 through 11, 2007. Mr. Larry McLellan of Evergreen indicated on-Site production well number 19 was pumped during the month of October 2007, although no pumping schedules are maintained, including rates and pumping times. Mr. McLellan estimated that based on lagoon discharges, approximately 100,000 gallons per day were pumped, with pumping rates ranging between 1,000 and 1,500 gallons per minute (gpm) when the pumps were active. Mr. Dan Charlson of CPU provided pumping schedule data for this period, including individual and total pumping rates for the two River Road Generating Plant cooling water supply wells. On-Site production well number 19 and the near off-Site River Road Generating Plant cooling water supply wells are in the Aquifer Zone.

A focused review of the Aquifer Zone monitoring wells indicates monitoring well EVGR-02-A shows the most pronounced water level responses to what are likely pumping stresses. Figure 5-15 illustrates a hydrograph focused on monitoring well EVGR-02A for the period October 6 through 10, 2007, and includes a second Y axis tracking total pumping from the River Road Generating Plant cooling water supply wells. A review of this hydrograph suggests groundwater elevations in monitoring well EVGR-02-A respond to pumping in these two cooling water supply wells. For example, on the afternoon of October 8, 2007, the PUD wells reached a peak combined pumping rate of 1,485 gpm. A temporally equivalent drawdown response was observed in monitoring well EVGR-02A, which is significant as this occurred during a period when groundwater elevations were generally increasing due to tidal fluctuations. Additional water level responses that may be attributable to PUD pumping can also be identified on Figure 5-15, while other water level responses may be attributable to the undocumented pumping schedule of on-Site production well number 19. These observations indicate that groundwater within the Aquifer Zone at monitoring well EVGR-02-A, and likely other wells in the Aquifer Zone, are within the zone of influence of both on-Site and near off-Site water supply wells.

While the available data suggest that groundwater within the Aquifer Zone is within the zone of influence of both on-site and proximal off-site water supply wells (i.e., River Road Generating Plant cooling water supply wells), as well as the Columbia River, it is still not possible to define directions of groundwater flow within the Aquifer Zone. This is due to the very small spatial variation in Aquifer Zone groundwater elevations across the entire Site, which is likely due to the very high horizontal hydraulic conductivity of the Aquifer Zone (i.e., assumed to be 10,000 feet/day). Should the on-site and proximal off-site water supply wells cease pumping in the future, it is likely that the horizontal hydraulic gradient within the Aquifer Zone would remain very flat. Furthermore, it would likely not be possible to define groundwater flow directions in the Aquifer Zone under this hypothetical future scenario. It should be noted that due to anticipated future increases in local and regional energy demands, it is likely that the River Road Generating Plant will continue to operate and that the associated cooling water supply wells will continue to withdraw water from the Aquifer Zone.

6 GROUNDWATER CONTAMINANT FATE AND TRANSPORT

Previously completed remedial actions have eliminated or significantly reduced many of the groundwater and direct contact pathways for contaminant sources at the Site. Natural attenuation processes control dissolved contaminants in groundwater. These natural attenuation processes, combined with fate and transport modeling, are used in this section to determine the fate and transport of the Site COPCs in groundwater. The primary modeling objectives discussed in this section are twofold: determine the restoration timeframe for site groundwater under a natural attenuation scenario and to determine potential current and future impacts to surface water from transport of Site groundwater.

6.1 Natural Attenuation Processes

The fate and transport of any compound dissolved in groundwater is generally controlled by the following natural attenuation processes: advection, dispersion, adsorption, and degradation. In addition, some compounds such as fluoride and cyanide are attenuated to a form less available to the environment via complex geochemical interactions such as chemical speciation and mineral precipitation. Dilution was not considered in attenuation modeling, in accordance with MTCA requirements.

6.1.1 Advection

Advection is the component of solute transport attributable to mass transport caused by the bulk movement of flowing groundwater. Compounds dissolved in groundwater are carried along by moving groundwater at a rate related to the average linear groundwater velocity. As discussed in Section 5, the estimated groundwater velocities at the Site are relatively low. The estimated average linear groundwater velocity in the Intermediate Zone ranges from 10 feet/year near monitoring well MW-94-2-I to 30 feet/year near monitoring well MW-51-I. The estimated average linear groundwater velocity in the Deep Zone ranges from 30 feet/year near monitoring wells MW-48-D and MW-51-D to 60 feet/year near monitoring well MW-94-2-D.

6.1.2 Dispersion

Dispersion is the process by which dissolved compounds spread during groundwater flow, and is an important mechanism affecting contaminant plume migration and dilution. Dispersion is caused by heterogeneities within the material through which groundwater flows, and occurs from the pore-grain to the field scale. Dispersion results from the variation in flow velocity between pores in the aquifer matrix. It causes dissolved compounds to spread in directions longitudinal and transverse to the axis of a plume (i.e., direction of groundwater flow).

Another component of dispersion is molecular diffusion, which is the process by which dissolved compounds spread from high to low concentrations according to Fick's Law. The diffusion component of dispersion is typically significant only as a plume spreading mechanism in very fine-grained sediment (e.g., clays) where groundwater velocities are very low and concentration gradients are very high. While the groundwater velocities at the Site are relatively low, the contaminant concentration gradients are assumed to be low enough that diffusion is not a significant transport process.

No Site-specific data were collected during the RI for the dispersion parameters affecting the fate and transport of COPCs in groundwater. However, estimates for dispersion parameters for alluvial materials similar to those encountered at the Site are available in the literature. Given the scale of the Site, specifically distances between the source areas and the Columbia River of approximately 600 feet, the longitudinal dispersivity is assumed to be 60 feet (Gelhar et al. 1992), or approximately 1/10th of the estimated plume length.

6.1.3 Adsorption

Adsorption is a reversible process by which dissolved compounds adhere to the surface of the aquifer matrix. Organic compounds dissolved in groundwater are hydrophobic and tend to adsorb to organic material in the aquifer matrix. Both organic and inorganic compounds may have a positive or negative ionic charge, either as a simple ion or as an ionic complex. These ions may adsorb onto positive and negative charge sites of an aquifer matrix. The significance of this process is related to the cation exchange capacity and anion exchange capacity of the aquifer matrix.

The process of adsorption causes dissolved compounds to travel at a rate slower than the average linear groundwater velocity. The travel rate of dissolved compounds can be estimated by calculating the partition coefficient, $K_{d,}$ and retardation factor. A retardation factor of 1 implies that a dissolved compound does not adsorb onto the aquifer matrix, and travels at the same velocity as groundwater. A retardation factor of 2 implies that a dissolved compound adsorbs onto the aquifer matrix, and travels at a rate equal to one-half the velocity of groundwater.

No Site-specific data regarding the K_d and retardation factor for TCE or vinyl chloride were developed; therefore, the following assumptions were used as model input. Fluoride was assumed to migrate conservatively, not adsorbing to the aquifer matrix and having a retardation factor of 1 (although Site data presented in Section 4 indicate some adsorbtion does occur). Based on a review of the TCE fate and transport modeling completed for another site in the region (Parametrix 2004), retardation factors of 1.5 and 2.0 produced equally defensible calibrated fate and transport model results. Based on Parametrix's calibrated TCE transport model, a TCE retardation factor of 1.5 was assumed at the Site. While vinyl chloride likely adsorbs to the aquifer matrix at the Site, the retardation factor of vinyl chloride would be lower than the retardation factor of TCE due to vinyl chloride's chemical properties, as vinyl chloride has a higher solubility and relatively low tendency to adsorb to soil particles (reflected in its partitioning coefficient). In the absence of Site-specific data, the retardation factor of vinyl chloride was assumed to be 1.

6.1.4 Degradation

Degradation is the process by which compounds are decomposed by biotic and abiotic processes. Abiotic processes occur in the absence of organisms (e.g., degradation of many organic compounds by ultraviolet light). Biotic degradation, or biodegradation, is the decomposition of compounds facilitated by enzyme-catalyzed transformation (e.g., reductive dechlorination of many chlorinated solvents). Natural degradation of organic compounds has been well demonstrated and exploited for treatment of a variety of contaminants. Under favorable conditions, TCE and vinyl chloride are degraded by anaerobic bacteria to ethene, which may be further degraded to simpler compounds.

Based on the available data, degradation of fluoride does not appear to be a significant process. Accordingly, the degradation of fluoride was not simulated during fate and transport simulations. Water quality trends based on groundwater samples collected from monitoring wells in the East Landfill area show that TCE and vinyl chloride concentrations trend downward, although the slope is relatively flat since the initial reduction from source control. Figure 2-4 illustrates TCE and vinyl chloride water quality trends in the East Landfill Area, suggesting that degradation of TCE and vinyl chloride is occurring. Further evidence of the degradation of TCE is the formation of cis-1,2-dichloroethene and 1,1-dichloroethene, degradation byproducts of TCE. The source of vinyl chloride, cis-1,2-dichloroethene, and 1,1-dichloroethene in groundwater samples collected at the site is likely associated with the degradation of TCE, probably through reductive dechlorination. This suspected degradation is likely spatially and temporally variable, and modeling of this process was considered technically inappropriate based on the available data, and unnecessary to meet RI/FS objectives.

6.1.5 Cyanide Speciation

The occurrence and distribution of cyanide at industrial sites and mines has been well studied, most notably by Dzombak et al. (2005). These evaluations indicate that the speciation and distribution of cyanide in groundwater at industrial sites is largely controlled by geochemical relationships that are reasonably well understood. Dzombak et al. (2005) have noted that the distribution of dissolved cyanide species at aluminum smelting sites is typically controlled by solid and aqueous iron-cyanide complexes because of the availability of dissolved iron in groundwater at those sites.

Using these relationships, the fate and transport of characteristics of cyanide in groundwater can be reliably predicted under existing conditions. Distribution of cyanide within the Site following remediation takes place in a predictable fashion. The exact distribution of dissolved cyanide species (total or free) in groundwater varies depending on the type of cyanide source material and Site-specific geochemistry. The Site is typical of most other aluminum smelters in that the observed concentrations of iron, pH, and Eh (a measure of oxidation reduction potential [ORP]) indicate iron-cyanide complexes will dominate speciation. According to Dzombak et al. (2005), only 10 percent or less of the cyanide at such sites exists as weak metal-cyanide complexes, of which free cyanide constitutes only a few percent (Table 6-1). These observations concerning cyanide speciation in groundwater at other aluminum smelters are consistent with field data from the Site, which indicate that free cyanide complexes are on average less than 1 percent of the total cyanide concentration at the Site (note that free cyanide concentrations below the detection limit were not included in the calculation of average percent free cyanide from the Site data).

Table 6-1
Common Cyanide Species in Groundwater at Industrial Sites

Classification	Species	Industrial Site Type[a]			
		MGP	**Aluminum Smelting**	**Mining/Heap Leaching**	**Electroplating**
Free cyanide	HCN, CN^-	Trace (<3%)	Trace (<3%)	Moderate (10-30%)	Moderate (20-40%)
Weak metal-cyanide complexes	$Cu(CN)_4^{2-}$ $Zn(CN)_4^{2-}$ $Ag(CN)_2^{-}$ $Ni(CN)_4^{2-}$ $Cd(CN)_4^{2-}$	Low (<10%)	Low (<5%)	Moderate (20-40%)	Moderate (20-40%)
Strong metal-cyanide complexes	$Au(CN)_2^{-}$ $Fe(CN)_6^{4-}$ $Fe(CN)_6^{3-}$ $Co(CN)_6^{3-}$	High (>90%)	High (>90%)	High (30-60%)	High (30-60%)
Other	SCN^-	Low (<10%)	None	None	None

From Dzombak et al. 2005
(a)Cyanide species distribution categories. Trace: <3%, Low: 3 to 10%, Moderate: 10 to 40%, High: 30 to >90%

To understand the occurrence and behavior of dissolved cyanide in groundwater, the stability of solid cyanide-bearing phases must first be understood. The stability of solid cyanide-bearing compounds is strongly influenced by the system pH and Eh (a measure of ORP) and the availability of iron species. Turnbull's Blue, an iron-cyanide solid in which iron exists primarily in the Fe^{+3} state ($KFe^{+2}[Fe^{+3}(CN)_6]$), occurs under anoxic conditions for a wide range of pHs. Table 4-1 provides the concentrations of iron and iron-species in the groundwater. It should be noted that the majority of the iron available in the groundwater is ferric (Fe^{3+}) and the majority of the groundwater is anoxic. Pure Prussian Blue, a solid compound containing iron and cyanide ($Fe_7(CN)_{18}(H_2O)_x$, where $x = 14 \leq x \leq 16$), with iron present primarily as Fe^{+2}, exists under acidic to neutral and anoxic conditions; as pH increases, Prussian Blue coexists with hydrous ferric oxide in the form of a solid solution (co-precipitant), and at high pH, Prussian Blue dissolves.

Observed concentrations of free cyanide at the Site indicate that concentrations decrease as distance is gained from the source area. The precipitation of the iron-complexed cyanides occurs as the groundwater moves away from the source areas. The long-term potential for ecological or human risk issues associated with free cyanide exposure from groundwater are low, as Site concentrations are below the primary preliminary screening levels.

6.1.6 Fluoride Mineral Precipitation

Fluoride is an ion of the element fluorine and is a component of most natural waters. The primary factors that control the concentration of fluoride in natural waters include mineral precipitation and dissolution reactions, and ion exchange with clay minerals. Common fluoride bearing minerals include fluorite (CaF) and a group of phosphate-bearing minerals called apatites.

The initial model results showed that Site groundwater is supersaturated with respect to the mineral fluorapatite, indicating that based on equilibrium thermodynamics, fluorapatite would tend to precipitate from solution. The results indicate that the limiting factor to precipitation of fluoride from the Site groundwater is the availability of the calcium and phosphate ions required for fluorapatite precipitation, based on the equilibrium reaction:

$$Ca5(PO_4)3(F) = 5Ca^{2+} + 3(PO_4^{3-}) + F^{-} \qquad \text{(Equation 2)}$$

Precipitation also occurs during surface water interaction with groundwater, as the appropriate cations and anions are present to support this reaction. Table 4-1 provides the anion and cation chemistry used for this study.

6.2 TCE Fate and Transport Modeling

Contaminant fate and transport modeling of COPCs under natural attenuation processes was performed in a step-wise process. First, a traditional groundwater flow and transport model was developed to simulate the migration of TCE dissolved in groundwater across the Site. The results of this modeling work were used to assess the geochemical reactions between groundwater and surface water as it is discharged at the Site. This section specifically describes the modeling objectives, modeling methods, model structure, and model predictions.

6.2.1 Fate and Transport Modeling Objectives

The primary modeling objective was to predict the time required for natural attenuation of TCE in groundwater to occur. Determination of the maximum breakthrough concentrations of TCE was completed for the Intermediate Zone in the area of maximum detections of these compounds in groundwater samples collected in September 2007. This area corresponds to monitoring well clusters at MW-94-1 and MW-35, where average groundwater elevation information indicates groundwater in the Intermediate Zone is moving to the south-southwest and discharging to the Columbia River.

6.2.2 Transport Modeling Methods

Several model codes and modeling approaches were considered for simulating groundwater flow and TCE transport modeling at the Site. Based on a review of the available hydrogeologic data and discussions with Ecology, it was agreed that development of one-dimensional (1D) groundwater flow and contaminant transport models was technically appropriate.

Groundwater flow modeling was completed using the U.S. Geologic Survey’s modular three-dimensional groundwater flow model code, MODFLOW (McDonald and Harbaugh 1988). MODFLOW is capable of simulating all of the hydrogeologic processes identified in the conceptual hydrogeologic model for the Site. Transport modeling of fluoride, TCE, and vinyl chloride was completed using the Modular Three-Dimensional Transport Model, MT3D (Zheng 1990). Pre-processing and post-processing of hydrogeologic data associated with the groundwater flow and contaminant transport modeling was performed with Groundwater Vistas, which is a graphical user interface program developed by Environmental Simulations, Inc..

6.2.3 Transport Model Structures and Parameters

A two groundwater flow and transport models were developed to simulate the fate and transport of dissolved TCE within the Intermediate Zone. The first model was developed to best fit the reductions in concentration that have been observed since source control activities were completed at the East Landfill. The second model included an increase in natural degradation time (i.e., TCE half-life assumptions) to best characterize the current rate of dechlorination occurring at the Site. The final natural attenuation curve is a synthesis of the two model runs, as described below.

Each model was a one-layer 1D model. The model domains were based on characteristic flowpaths, as illustrated in plan view on Figure 6-1. These flowpaths are considered to be characteristic because they represent groundwater flow from hydraulically up-gradient locations, ultimately ending with discharge of contaminant-impacted groundwater into the Columbia River.

A plan view schematic of the TCE transport model for the Intermediate Zone is also illustrated on Figure 6-2. Constant head boundaries were defined at the up-gradient and down-gradient ends of the model based on the average groundwater elevation and Columbia River stage data collected using pressure transducers and dataloggers during the period October 5 through 11, 2007. The model consists of one row, one layer, and 31 columns with uniform 20-foot column spacing, for a total model domain length of 600 feet. The up-gradient end of the model domain is located 20 feet up-gradient of monitoring well cluster MW-35, and the simulated flowpath moves through monitoring well cluster MW-94-1 before terminating in the Columbia River. The orientation of the model domains originating from MW-35 cluster was selected to represent the greatest potential contribution of TCE from recovering groundwater beneath the East Landfill.

Model-projected contaminant concentrations were monitored at a hypothetical monitoring point 20 feet from the Columbia River and do not account for tidal attenuation effects. It should be noted that given the topography of the river bank, it is not possible to install actual monitoring wells as compliance points this close to the river bank because such wells would be inundated and/or damaged during seasonal high water events.

The following parameters were used as input for the groundwater flow and transport modeling of TCE and vinyl chloride:

- Hydraulic Conductivity – Assumed to be 5 and 50 feet/day for the Intermediate and Deep Zones, respectively, based on Site-specific slug testing and a review of the literature.
- Aquifer Thickness – Assumed to be 25 feet for the Intermediate Zone based on a review of well logs for proximal monitoring wells.
- Constant Head Boundaries – Heads based on average groundwater and Columbia River stage data collected during the period October 5 through 11, 2007. The heads at the up-gradient end of the flowpaths were based on an extrapolation of the gradient between monitoring well cluster MW-35 and the Columbia River
- Hydraulic Gradients – Based on the drop in head along the simulated flowpaths. Referencing average groundwater elevations in monitoring well cluster MW-35 and the Columbia River stage, the hydraulic gradient in the Intermediate Zone was assumed to be 0.0073.
- Effective Porosity – Assumed to be 0.25 for the Intermediate Zone based on a review of the literature.
- Longitudinal Dispersivity – Assumed to 60 feet, or approximately one-tenth of the flowpath lengths (Gelhar et al. 1992).
- Initial TCE concentrations – Based on TCE water quality data collected from monitoring well clusters MW-35 and MW-94-1 during September 2007. Initial TCE concentrations between monitoring well clusters MW-35 and MW-94-1 were set to the concentrations observed at monitoring well cluster MW-94-1, which is down-gradient of the East Landfill. Initial TCE concentrations between monitoring well cluster MW-94-1 and the Columbia River were set to the concentrations observed at monitoring well cluster MW-94-1. It should be noted that the concentrations of TCE observed at the MW-35 and MW-94-2 monitoring well clusters are significantly lower than the concentrations observed at the MW-

94-1 monitoring well cluster. The assumed initial concentrations of TCE applied throughout the East Landfill in the Intermediate Zone are likely biased high. This is a conservative assumption selected to provide an upper bound estimate of model-projected concentrations of TCE reaching the Columbia River.

- Recharge and Leakance – No recharge from the infiltration of precipitation or leakance from the Shallow Zone was simulated. It should be noted that not including recharge or leakane is typically conservative; however, future Site development will likely impede infiltration through the construction of non-porous surfaces.
- Adsorption/Retardation – A retardation factor of 1.5 was used to simulate the transport of TCE. A retardation factor of 1 would simulate no retardation.
- Degradation – Degradation of TCE was simulated stepwise and the half-life of TCE transitioned from 1 year to 15 years.
- Diffusion – Diffusion of TCE in groundwater at the Site is not considered to be a significant process. Accordingly, diffusion was not simulated.
- Tidal Attenuation – Tidal attenuation effects are not considered in the fate and transport model and are discussed below in Section 6.4.

6.2.4 Groundwater Transport Model Predictions

Groundwater transport modeling results were evaluated to predict the maximum breakthrough concentrations of TCE in Intermediate Zone groundwater discharging into the Columbia River prior to the consideration of tidal attenuation effects. Groundwater transport modeling results were also evaluated to predict natural attenuation groundwater restoration timeframes.

An evaluation of groundwater transport model results, as illustrated on Figure 6-3, indicates that TCE in the Intermediate Zone will fall below the MCL for TCE (5.0 μg/L), in approximately 30 years. TCE in the Deep Zone has already decreased to less than twice the screening criteria and will recover before the degradation in the Intermediate Zone is complete. Model output for both the groundwater flow (MODFLOW) and solute transport (MT3D) modeling is presented in Appendix I. A review of the flow model and transport model results indicates mass balance errors were well within technically acceptable levels.

6.3 Fluoride Geochemical Modeling

PHREEQC is a U.S. Geological Survey (USGS) computer program designed to model low-temperature geochemical reactions, such as the equilibrium reactions described above. Among other things, PHREEQC can calculate pH, redox potential, and the composition of solutions in equilibrium with multiple phases. The aqueous model definition, including elements, aqueous species, and mineral phases is exterior to the computer code and is completely user-definable. The model can be used to perform the following:

- Speciation and saturation-index calculations.
- Reaction-path and advective transport calculations involving mixing of solutions, mineral and gas equilibriums, surface complexation reactions, and ion-exchange reactions.
- Inverse modeling, which finds set of mineral and gas mole transfers that account for compositional differences between waters, within specified compositional uncertainties.

PHREEQC was used to evaluate the saturation states of various fluoride-bearing minerals and the potential effect that those minerals may have on determining the ultimate dissolved concentrations of fluoride in site groundwater and in Columbia River surface water. Conceptually, the PHREEQC model was constructed to consider the two distinct water sources at the Site. The calculation was performed in a step-wise fashion, so that fluoride solubility in each water source was considered independently and then again where the two combine, as groundwater is expressed from the riverbank. Site-specific chemical data from each water source was used as input to the model.

The fate of fluoride along the pathway in which groundwater interacts with surface water is controlled by the presence of other ions (such as calcium) for fluoride to react with and form (precipitate) the mineral fluorapatite. The rate at which Site groundwater flows from the Intermediate Zone to the Columbia River is approximately 10 to 30 feet/year and is even less for the Shallow Zone (the zone in which groundwater is locally impacted by fluoride). Using a theoretical, upperbound groundwater concentration of 2,500 mg/L as input into the PHREEQC model, the resulting fluoride concentration in surface water was calculated as 0.25 mg/L, which is within the range of concentration observed up-gradient from the Site. The initial model results showed that both Site groundwater and the Columbia River surface water are supersaturated with respect to the mineral fluorapatite, indicating that based on equilibrium thermodynamics, fluorapatite would tend to precipitate from solution. Based on the groundwater monitoring data collected from shoreline wells over the past 25 years, fluoride concentrations have consistently remained below 700 mg/L and currently average less than 10 mg/L. Therefore, it can be expected that excess fluoride would react to form fluorapatite prior to discharge to the Columbia River.

6.4 Tidal Attenuation Modeling

Tidal fluctuations in groundwater at the Site indicate a strong connection between the Columbia River and groundwater. The propagation of the tidal fluctuations in the Deep Zone and the Aquifer Zone indicate high hydraulic conductivities in both zones with the hydraulic conductivity being higher in the Aquifer Zone. This is consistent with the regional hydrogeologic framework with the Deep Zone being identified with the Columbia River Sand deposits and Aquifer Zone being identified with the Unconsolidated Sedimentary Aquifer or Pleistocene Alluvial Aquifer.

Tidal fluctuations in groundwater can cause natural attenuation of contaminants in upland groundwater near the shoreline due to the influx of surface water into the aquifer during rising tides. A groundwater flow and transport model was used to investigate natural attenuation by simulating the tidal fluctuations and the movement of a conservative tracer over tidal cycles. The analysis showed substantial natural attenuation with upland concentrations at MW-94-2 being reduced by more than 90 percent between the well and the shoreline. Additional documentation of this model is provided in Appendix I.

The results of this model show that concentrations measured at upland, shoreline wells will attenuate by 10 to 11 times before discharging to surface water from tidal effects alone. Other natural processes, such as those discussed above in Section 6.1 will provide additional attenuation of contaminants along the groundwater to surface water pathway.

7 UPLAND AREAS OF CONCERN

Historical operations included the placement and storage of materials (e.g., wastes and process materials) containing COPCs at various locations around the Site. These locations primarily consisted of the undeveloped areas on the west and east sides of the Site, although there are some materials containing COPCs within the footprint of the main primary aluminum facility. Many of these historical contaminant sources have been addressed by earlier remedial actions, as discussed in Section 2. Generally, these remedial actions consisted of removal or isolation of the wastes and affected soils from the environment for protection of human health by direct contact and protection of groundwater to prevent leaching of contaminants.

The RI identified ten source areas at the Site for potential remedial action to ensure protection of human health and the environment. For seven of these areas, Ecology and Alcoa/Evergreen agreed that source removal was appropriate and the maximum practicable remedial action to address waste materials and impacted soil in accordance with WAC 173-340-360(3)(d). Two other areas not included on the list, the Vanexco/Rod Mill Building (Rod Mill) and the SPL Storage Area, were remediated under previous Consent Decrees between Alcoa and Ecology (95-2-03268-4 and 92-2-00783-9, respectively).

The Rod Mill Consent Decree required the long-term maintenance of a cap initially designated as the building floor (constructed of asphalt and/or concrete) and the roof was to be maintained to prevent ponding of precipitation. To facilitate the current sale of the property, the Rod Mill building will be demolished. The new surface (either sand or asphalt) above the asphalt/concrete floor will be regraded to promote positive drainage away from the cap (i.e., the floor) in accordance with the Rod Mill Consent Decree. Ecology approves this action. Groundwater monitoring down-gradient of the Rod Mill was performed for 5 years and was completed in 2001. During this period PCBs were not detected in any of the samples. Ecology approved termination of the monitoring program in 2003. Groundwater monitoring continues at the SPL Storage Area and meets the requirements of that Consent Decree. No further action is required for these two former source areas.

Recently, Evergreen remediated five of the initial Site AOCs through source removal activities under Ecology Enforcement Order 4931(Ecology 2007b). These AOCs include the Transformer/Rectifier Yards, Carbon Plant and Storage Buildings, Plant Emission Control

Systems, Fluoride-Bearing Raw Material Handling Facilities, and the Scrap Metal Recycling Area. The cleanup actions in these areas were performed to address the following potential exposure pathways:

- The potential for direct contact by human and/or ecological receptors with contaminants adsorbed to waste and affected soil or contained within groundwater.
- The potential for contaminants to leach from waste and affected soil into groundwater.
- The potential for dissolved contaminants to migrate from groundwater to surface water at concentrations above levels protective of human health and the environment

The remainder of this section focuses on the upland AOCs with source materials that have been or will be remediated through excavation and off-site disposal. This section does not discuss the Crowley Parcel AOC or the TCE-bearing groundwater at the East Landfill. As previously discussed, these areas will be addressed separately. Section 8 discusses the exposure pathways with respect to the PCB-impacted Sediment AOC.

7.1 Transformer/Rectifier Yards

As discussed in Section 2.1.2, previous remedial actions have been performed to address PCB-impacted soil at the Transformer/Rectifier Yards. To support Site redevelopment, foundations in the vicinity of the Transformer/Rectifier Yards have been removed to 3 feet below the surface. As a presumptive remedial action, all soil within this area with PCB concentrations above 1 mg/kg was excavated and disposed of off-site. Removal of PCB-impacted soil to 1 mg/kg meets the MTCA Method A Unrestricted Use cleanup levels, is protective of groundwater, and requires no further action.

In accordance with Enforcement Order 4931, approximately 10,100 tons of impacted soil over 1.5 acres were removed from the Transformer/Rectifier Yards. The material was disposed of appropriately at Waste Management Inc's Hillsboro Landfill facility and Chemical Waste Management's Arlington Landfill facility. During the course of the remedial activities, soil impacted by mineral oil was also identified. Materials above the Site cleanup level of 4,000 mg/kg were excavated and disposed at an appropriate off-site facility. To document completion of the source removal, over 200 discrete and composite samples were collected to verify that the post excavation surface met required cleanup levels. A formal completion report will be prepared to further document the completion of this remedial work. No additional remedial action is required in this area as the source has been removed from the Site to the maximum extent practicable.

7.2 Dike USTs

As discussed in Section 2.1.1, the Dike USTs were abandoned in place in 1987 at the location noted on Figure 7-1; however, residual product has been subsequently detected in monitoring well T3-3. Sampling of UST well T3-3 also identified TPH in excess of Site cleanup levels for groundwater. The presumptive remedy for this AOC will include removing the tanks, free product (if encountered), and soils exceeding cleanup levels protective of groundwater as defined in Section 9.6. This would be completed upon receipt of the appropriate regulatory approvals necessary for work within the shoreline management zone in accordance with the pending consolidated Consent Decree for the Site. Any additional contaminants encountered during remedial construction would be addressed in accordance with MTCA with Ecology's oversight. No further remedial action would be required upon completion of the source removal activities to meet the general Site RAOs.

7.3 Carbon Plant and Storage Buildings

Materials containing PAHs were historically located within the Carbon Plant and Storage buildings and have limited contact with soil and groundwater. Groundwater data from down-gradient monitoring well clusters EVGR-02 and MW-30 indicate that this area has no significant impact on groundwater quality with respect to PAHs. Elevated concentrations of fluoride in groundwater above the 4 mg/L cleanup level were detected in shallow well MW-30-S, which is located immediately adjacent to the SPL Storage Area and down-gradient of the Carbon Storage building, which is not a source of fluoride. Elevated fluoride concentrations in these wells are associated with the SPL Storage Area and not the removed source formerly located within the Carbon Plant. MW-30-S was designated as an annual monitoring point for the SPL Storage Area by the original 1992 Consent Decree and the current monitoring plan (IT Corporation 2001b) approved by Ecology and continues to demonstrate compliance with the reopeners defined in the Consent Decree. Therefore, no additional remedial action is required for the Carbon Plant and Storage buildings AOC as the source has been removed to the maximum extent practicable. Additional potential RAOs associated with fluoride-impacted groundwater are discussed further in Section 7.8.

To support Site redevelopment, Carbon Plant and Storage buildings were designated to be demolished. During demolition, all source and building materials were removed and disposed of at an appropriate off-site facility. Additionally, the foundations were removed from 0 to 3 feet bgs. PAH-impacted soils detected outside of the Carbon Storage building and soils with concentrations above the cleanup levels presented in Section 9.6 were removed and disposed of at an appropriate off-site facility. In accordance with Enforcement Order 4931, approximately 17,350 tons of waste and impacted soil was excavated from a 4.9-acre-area and disposed of appropriately at Waste Management Inc's Hillsboro Landfill facility and Chemical Waste Management's Arlington Landfill facility. To document completion of the source removal, 45 5-point composite samples (approximately 1 per 0.1 acres) were collected to verify that the post excavation surface met required cleanup levels on a point-by-point basis. A formal completion report will be prepared to further document the completion of this remedial work.

7.4 Plant Emission Control Systems

Source materials located within the Potline and Carbon Plant Emission Control Systems footprints include materials containing fluoride, PAHs, PCBs, and TPH. To support Site redevelopment, a concrete slab serving as an impermeable cap over these areas was removed. In accordance with Enforcement Order 4931, approximately 2,860 tons of waste and impacted soil were excavated from a 0.29-acre-area and disposed of appropriately at Waste Management Inc's Hillsboro Landfill facility and Chemical Waste Management's Arlington Landfill facility. Twenty four discrete verification soil samples (approximately one per every 530 sf) were collected from the main excavation and analyzed for fluoride, PCBs, and PAHs to demonstrate compliance with Site cleanup levels on a point-by-point basis. An additional five soil samples were collected from a deeper excavation beneath the former wet scrubber clarifier and were analyzed for PCBs and PAHs. All PCB samples met the Site cleanup levels; however, two of five samples detected PAHs at concentrations of 21.4 mg/kg and 73.9 mg/kg, above the Site cleanup level of 18 mg/kg.

The residual depths of the two samples exceeding Site cleanup levels were at 12 and 14 feet below ground surface (bgs). These depths coupled with the overall mass removal of PAHs at both the former Wet Scrubber Clarifier and Pond areas, indicate the residual PAHs are of low risk, and as such, further removal was not warranted. Groundwater monitoring well cluster EVGR-02 is located immediately down-gradient from this area and demonstrates that no impacts to groundwater from the PAH-bearing waste materials has occurred. On January 31, 2008, Evergreen received approval from Ecology (Skyllingstad 2008b) to backfill the excavations and no further action would be required in this area to remove PAH-impacted soils. A formal completion report will be prepared to further document the completion of this remedial work. No additional remedial action is required in this area as the source has been removed to the maximum extent practicable. Monitoring well cluster EVGR-02 is located immediately down gradient of this area. Monitoring data collected prior to source removal activities described above also demonstrate that the impacts to groundwater from fluoride-bearing materials were minimal and well intervals are in compliance with Site groundwater cleanup levels.

7.5 Fluoride-Bearing Raw Material Handling Facilities

During the course of former facility operations, fluoride-bearing raw materials (such as cryolite) have come in contact with surface soils within the limited area shown on Figure 7-1. In accordance with Enforcement Order 4931, these fluoride sources and impacted soil above cleanup levels established in Section 9.6 were removed and properly disposed of at an off-site facility. Specifically, an approximate 1.8-acre-area was excavated and 9,100 tons of fluoride-impacted soil was transported to Waste Management Inc’s Hillsboro Landfill facility for disposal. Sixteen 5-part composite verification soil samples (approximately 1 per 0.1 acres) were collected and analyzed for fluoride to confirm compliance with the Site-specific soil REL of 9,000 mg/kg total fluoride. Laboratory analysis confirmed that all verification soil samples met the site-specific cleanup level on a point-by-point basis. Due to permit requirements, the excavation was limited to within 200 feet landward of the shoreline. Additional sampling is currently underway to determine the extent of additional fluoride-bearing materials beyond this regulatory limit. Upon receipt of the appropriate regulatory approvals necessary for work within the shoreline management zone, and confirmation that additional fluoride-materials are present above the Site-specific soil REL, source removal activities will be completed in accordance with the pending consolidated Consent Decree for the Site.

Monitoring well cluster EVGR-02 is located immediately adjacent and down-gradient of this area. Monitoring data collected prior to source removal activities described above demonstrate that the impacts to groundwater were minimal and well intervals are in compliance with Site groundwater cleanup levels. Therefore, in accordance with WAC 173-340-350(8)(a) no further action is required in this AOC upon completion of the supplemental soil sampling to confirm that cleanup levels are met within the AOC.

7.6 Scrap Metal Recycling Area

Materials potentially containing cyanide, fluoride, TPH, PCBs, and metals have impacted the soil beneath the Scrap Metal Recycling Area. In accordance with Enforcement Order 4931, these source materials and impacted soils have been removed and disposed of at an appropriate off-site facility to prevent further impacts to groundwater. Approximately 1,400 tons of material over a 0.16-acre-area were excavated and disposed of appropriately at Waste Management Inc's Hillsboro Landfill facility and Chemical Waste Management's Arlington Landfill facility. Twenty discrete verification soil samples (approximately one per every 350 sf) were collected and analyzed for diesel and oil-range TPH, fluoride, PCBs, and select metals to confirm compliance with Site-specific remediation and cleanup levels defined in Section 9.6. A formal completion report will be prepared to further document the completion of this remedial work.

The Scrap Metal Recycling Area is located immediately adjacent to and up-gradient of the SPL Storage Area. Monitoring wells located down-gradient from this area indicate that groundwater is not impacted by this source area at the perimeter of the Site; therefore, no further action beyond source removal is required for this area to meet the general Site RAOs.

7.7 Soluble Oil Area

Historical documents, summarized in Section 2, indicate that soil and sludge with PCB concentrations above 15 mg/kg were removed in 1990 and that impacted soils above Site cleanup levels may persist. Although the pathway to groundwater was demonstrated as incomplete based on monitoring data, impacted materials with PCB concentrations greater than 10 mg/kg will be removed from this area as a presumptive remedy to prevent direct contact with PCB-impacted material above Site cleanup levels. After removal an appropriate cap will be placed over the area in accordance with MTCA. These actions are also protective of groundwater; therefore, no further remediation beyond source removal is required for this area to meet the general Site RAOs.

7.8 Fluoride-Bearing Groundwater

Fluoride-bearing waste and impacted soils were located at the SPL Storage Area and the following Site AOCs: the Carbon Plant, the Plant Emission Control Systems, the Fluoride-Bearing Raw Material Handling Facilities, and the Scrap Metal Recycling Area. As discussed in Section 2.1.8, Alcoa completed remediation of the SPL Storage Area under a 1992 Consent Decree and Site groundwater samples collected since 2003 demonstrate that the requirements for compliance in the Consent Decree continue to be met. Therefore, further action in the surface and subsurface areas encompassed by the 1992 Consent Decree is not required (refer to Figure 2-3). In addition, the fluoride-bearing soil contained beneath the former SPL Storage Area cap is below the current Site-specific soil REL for protection of groundwater thus meeting the expectations of the current Site RAOs.

In accordance with Enforcement Order 4931 by Ecology to Evergreen, all other sources of fluoride have been removed and disposed of off-site. This action, including the confirmation that all on-Site materials meet soil cleanup levels and RELs for fluoride, achieves the RAOs pertaining to direct contact, protection of groundwater resources, and reduction of on-Site mass of COC-impacted media. Outside of the area designated as the sub-surface Site by the 1992 Consent Decree, only 4 wells (MW-30-S, MW-94-2-I, SP-4-S, and T3-3) exceed the fluoride groundwater cleanup level of 4 mg/L based on data collected prior to the completion of source removal activities.

No wells outside of the SPL Storage Area exceed the Site-specific groundwater REL of 2,500 mg/L established for the protection of surface water resources as discussed in Section 9.5. Because all wells adjacent to the Columbia River are below the groundwater REL, the general Site RAO established for the protection of human health and the environment from potential exposure due to ingestion of surface water affected by COC-bearing groundwater is achieved. The remainder of this section discusses the nature of the fluoride-bearing groundwater beyond the 1992 Consent Decree ‘subsurface site’ in the context of the remaining RAO – protection of human health and the environment from potential ingestion exposure of Site groundwater above the 4 mg/L cleanup level.

MW-94-2-I is located immediately adjacent to and down-gradient of the East Landfill. Any remedial action planned for the East Landfill AOC would also address the limited fluoride-impacted groundwater. For example, a potential pump and treat alternative would also need to reduce fluoride concentrations to below surface water criteria in order to meet Columbia River discharge requirements. Regardless of the alternative selected for the East Landfill, concentrations of fluoride in groundwater down-gradient of this area are below the Site-specific groundwater REL for protection of surface water resources adjacent to the Site; therefore, no specific remedial action is required to address fluoride-bearing groundwater associated with the East Landfill AOC. In addition, so long as the East Landfill remains in place and deed restricted, extraction of this water drinking water purposes is prohibited per WAC 173-160-171, thus further assuring the protection of human health and the environment.

As previously noted, well cluster EVGR-02, located down-gradient from the fluoride-bearing sources areas outside of the SPL Storage Area (e.g., Plant Emissions Control Systems and Fluoride-Bearing Raw Material Handling Facilities), indicate that this area has no significant impact on groundwater quality. Elevated concentrations of fluoride-bearing groundwater were detected in nearby shallow well MW-30-S, which is located immediately adjacent to the SPL Storage Area and down-gradient of the Carbon Storage building, which is not a source of fluoride. Elevated fluoride concentrations in MW-30-S are associated with the SPL Storage Area and have been reducing since installation of the SPL Storage Area cap. Again, so long as groundwater monitoring continues to demonstrate compliance with the 1992 Consent Decree and the SPL Storage Area cap remains in place and deed restricted, extraction of this water drinking water purposes is prohibited per WAC 173-160-171.

The remaining two wells with observed exceedances less than twice the 4 mg/L fluoride groundwater cleanup level are T3-3 and SP-4-S. Well SP-4-S is part of a network of wells installed to monitor the groundwater recovery after the cleanup of the stormwater lagoons as discussed in Section 2.1.3. Well T3-3 was installed to monitor potential groundwater impacts from the dike USTs. It was also located immediately adjacent to the potline building demolition, which likely included the cleanup of a small volume of fluoride-bearing raw material from conveyors used in the manufacturing process. Both of these wells are located in the Shallow Zone.

Given the perched nature of the Shallow Zone, the quality and yield of the regional aquifer, and the availability of alternative sources to the Site; it is extremely unlikely that groundwater would ever be extracted from these areas for use as drinking water. Furthermore, the 1992 CAP sets the expectation that all known, available, and reasonable methods of treatment for fluoride-bearing groundwater were evaluated in the determination of the final remedy set forth by the Consent Decree. Since the filing of the Consent Decree no significant technological advances have been made to methods available to reduce fluoride concentrations to below the MCL. Furthermore, Section 1.3 of the 1992 CAP declared the following conclusions regarding treatment of fluoride-bearing groundwater at the Site:

- "Groundwater pump and treat technologies were not considered appropriate for the site because contaminant loading of the Columbia River from the cyanide/fluoride treatment system would be greater than the present groundwater loading at the site."
- "Also, the effectiveness of a pump and treat system in the most contaminated groundwater zone, the semi-permeable intermediate zone, is very low."

These conclusions are directly applicable to the minor exceedances observed in the two Shallow Zone wells, as these areas contain lower fluoride concentrations than those contemplated by the 1992 CAP. These wells are also located in a similarly low-permeability water-bearing geologic unit that is often perched making groundwater extraction for treatment even less effective.

Because source control of fluoride-bearing waste and impacted soil consist of removal to the maximum extent practicable and given the fact that fluoride-impacted groundwater is generally limited to a shallow perched zone adjacent to the SPL Storage Area, it is appropriate to monitor groundwater recovery in these areas until cleanup levels are met throughout the Site. Natural attenuation in this case is considered an active remedial measure as the expectations set forth in WAC 173-340-370(7) are met. Therefore, no further remedial action – other than continued groundwater monitoring and maintenance of engineered caps and institutional controls – is required at the Site with respect to fluoride in all media.

8 SEDIMENT RISK EVALUATION

8.1 PCB Nature and Extent in Sediments

As previously discussed, sampling efforts were conducted in 1999 and 2000 to characterize the nature and extent of PCBs in sediments adjacent to the Site. Two geostatistical methods were used to evaluate the lateral extent of PCBs at various depths. Initially a Thiessen polygon approach was performed to characterize the distribution of PCBs in the sediment deposit to support an ecological risk assessment described in Section 8.2. The approach was also used to estimate the total PCB mass contained within the deposit for each depth interval (see Table 8-1). Using the equation below, it was determined that approximately 453 pounds of PCBs above upstream background conditions are contained within the Site footprint. A summary spreadsheet of these calculations is provided in Appendix C.

$$M_{PCB} = C_{PCB} \times \rho \times l \times A$$

Where:

M_{PCB} = PCB mass per core interval
C_{PCB} = Sample PCB concentration at each interval
ρ = dry density of sediment
l = length of sample interval
A = Thiessen polygon area represented by each core interval

Table 8-1
Distribution of PCB Mass in Sediment

Core Interval	PCB Mass (lbs)
Surface (0 to 6 inches)	35.9
1 foot below surface	354.4
2 feet below surface	54.3
3 feet below surface	7.2
>3 feet below surface	1.3

The Thiessen polygon approach is the simplest method to evaluate the data on a core depth interval-by-interval basis. As discussed in subsequent sections, the interval-by-interval evaluation was used to support calculations of SWAC) and post-dredge residuals predictions (as documented in Appendix C). However, when more robust data sets are available, such as the one included in this study, design-level assessments are often based on higher order interpolation methods (e.g., inverse distance weighting [IDW] or kriging).

For this project an IDW approach was used to more accurately delineate the lateral extent of PCBs for conceptual design. IDW is an interpolation method in which a neighborhood about the interpolated point is identified and a weighted average is taken of the observed data values within this neighborhood. The weight assigned to each data point diminishes as the distance from the interpolation point to the scatter point increases. This method was applied to each data depth interval to develop a series of gradation plots within the Site area. For the model results shown on Figure 8-1, the gradation contour breaks were designated at various concentration levels that will be used in the development of a dredge and disposal plan for the Site and was used to develop the conceptual dredge plan discussed in subsequent sections of this report.

8.2 Ecological Risk Assessment

The primary potential ecological receptors of concern for exposure to PCBs in the vicinity of the Site are: 1) aquatic species such as Asian clams that are numerically abundant in Columbia River nearshore sediments (McCabe et al. 1997); and 2) piscivorous wildlife species (e.g., mink). Human receptors that may consume Asian clams and other benthic organisms collected from the river are discussed in Section 7.3. Following the RI data collection, an ecological risk assessment was conducted to evaluate risks to piscivorous wildlife from PCBs in sediments adjacent to the Site. The ecological risk assessment was conducted as a cooperative effort between Ecology and Alcoa. The model for bioaccumulation was based on the mammalian predator model from MTCA (Table 749-4; Peredney 2002). By linking the MTCA mammalian predator model with the Gobas and Zhang (1994) bioaccumulation and aquatic food web model, a sediment PCB cleanup level was developed that will ensure protection of wildlife at the Site.

Because mink are a top-level predator of fish and other aquatic species, they may bioaccumulate persistent lipophilic chemicals like PCBs. Otter were not evaluated because mink were determined to be more relevant to the Site area (Peredney 2002). Moreover, otter have a relatively large home range, on the order of 30 river kilometer (rkm), whereas the mink home range is on the order of 1.9 rkm. The Site area has approximately 1.2 rkm of shoreline.

The sediment-to-mink pathway for PCBs associated with the Site is as follows:

- Fish and benthos living near the Site may be exposed to sediment-associated PCBs through direct contact with sediment, porewater, and flux into surface water.
- Piscivorous wildlife may be exposed indirectly though the consumption of prey items containing PCBs.

Based on laboratory and field toxicity data and comprehensive risk assessment studies such as the revised baseline ecological risk assessment for the Hudson River, PCBs in sediment have been shown to potentially impact mink (TAMS 2000). The goal of this risk-based evaluation was to determine sediment concentrations that are protective of mink in the Lower Columbia River.

8.2.1 Exposure Assessment

Risks to mink were evaluated considering potential consumption of three different prey organisms: white sturgeon (*Acipenser transmontanus*), largescale sucker (*Castostomus macrocheilus*), and Asian clams. Typical mink dietary proportions of white sturgeon (17 percent), largescale sucker (17 percent), and Asian clam (16.5 percent) in the mink diet were taken from the Hudson River revised baseline ecological risk assessment (TAMS 2000).

As discussed above, PCB concentrations in the mink prey items were modeled using the steady-state food chain model developed by Gobas and Zhang (1994). Input parameters included chemical specific data, sediment concentrations, environmental properties, food chain component information, and prey organism specific data such as size and lipid content. The area-averaged surface sediment PCB concentration in the Site vicinity of 1.13 mg/kg dry weight was initially input into the model, along with the calculated porewater equilibrium PCB concentration of 1.1 nanograms per liter (ng/L).

Fish size and Asian clam lipid content values used in the model were based on site-specific conditions. Representative weights of mink prey-sized largescale sucker and sturgeon used in the model were 22 g and 25 g, respectively. The lipid content of Asian clams used in the model was 2 percent wet weight (Peredney 2002; Glaser 2002).

Table 8-2 provides a summary of the diet of the sturgeon, sucker, and Asian clams that were used in the Gobas and Zhang (1994) model. PCB uptake by Asian clams was modeled entirely from the sediments.

Table 8-2
Summary of Dietary Fractions of Used in the Bioaccumulation Model

Name	Benthos	Zooplankton	Asian clams	Oligochaetes	Salmon
Asian clams	1.0				
Sturgeon		0.0	0.4	0.4	0.2
Salmon		0.3	0.3	0.4	0.0
Largescale sucker		0.3	0.3	0.4	0.0

Using the above input parameters, the estimated PCB concentrations in Asian clams, sucker, and sturgeon at the Site were calculated at 2.3 mg/kg wet wt 2.9 mg/kg wet wt, and 4.7 mg/kg wet wt, respectively. The modeled Asian clam tissue concentration (4.7 mg/kg wet wt) agreed with independent sampling performed by USACE in the Site area (3.5 mg/kg wet wt; see Section 2.4.2), providing further support for the accuracy of the bioaccumulation model. The estimated dietary dose to mink currently consuming these prey items is approximately 0.138 mg/kg/day.

8.2.2 Effects Assessment

The assessment endpoint evaluated for this assessment was the survival, growth, and reproduction of mink. The toxicity reference value (TRV) used in this risk assessment, a dose of 0.04 mg/kg-day to the mink (Peredney 2002), was based on the Hudson River Revised Baseline Ecological Risk Assessment (TAMS 2000). This TRV is likely to be conservative and probably overestimates the toxicity of PCBs (Glaser 2002).

A hazard quotient (HQ) was calculated using food ingestion rates, proportion of food item in the diet, the area use factor (AUF), and the TRV.

$$HQ = \frac{FIR \times \left[\left(P_{suc} \times C_{suc} \right) + \left(P_{sturg} \times C_{sturg} \right) + \left(P_{corb} \times C_{corb} \right) \right] \times AUF}{TRV}$$

Where:

Variable		Value	Basis for Selection
HQ =	Hazard Quotient	3.5	Calculated
FIR =	Food ingestion Rate (kg food wet wt/kg body wt.-day)	0.132	Tams 2000
P =	Proportion of Food Item in Diet	--	
	P_{suc} (sucker)	0.17	Tams 2000
	P_{sturg} (sturgeon)	0.17	Tams 2000
	P_{corb} (Asian clam)	0.165	Tams 2000
C =	Concentration of PCBs in Diet (mg/kg wet wt)	--	
	C_{suc} (sucker)	2.9	Section 7.1, Gobas model
	C_{sturg} (sturgeon)	4.7	Section 7.1, Gobas model
	C_{corb} (Asian clam)	2.3	Section 7.1, Gobas model
AUF =	Area Use Factor	0.63	Site-specific, see below
TRV =	Toxicity Reference Value (mg/kg/day)	0.04	Tams 2000

The AUF (unitless) for fish was assumed to be 1 under the conservative assumption that all prey tissue burdens were directly attributable to the Site sediments. The AUF for mink was 0.63 and was calculated as the shoreline of the site (1.2 rkm) divided by the male mink home range (1.9 rkm). Based on an average surface sediment concentration of 1.13 mg/kg[3], the calculated HQ was approximately 3.5 (i.e., existing area-weighted surface sediment concentrations would need to be reduced at least 3.5-fold to ensure protection of mink). That is, an area-averaged sediment PCB concentration of 0.32 mg/kg dry wt would be protective of wildlife at the Site.

Uncertainty in this assessment is primarily associated with exposure estimates and the selected TRV and in both cases is due to a conservative application of data. Application of the area-average cleanup value to discrete sample locations would be conservative in that the home range of the prey items reduces their exposure at the Site.

Sediment-associated PCBs are likely not the primary PCB source to the food chain, and thus, to mink. It is likely that the water column is the dominant energy source for Asian clams (Glaser 2002). Modification of the bioaccumulation model to represent a greater water exposure pathway would result in increases to the 0.32 mg/kg dry wt wildlife

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[3] This calculation was performed by Ecology and represents the arithmetic mean of a nearshore subset of the surface grab samples collected by Windward (2001). The Site-wide area-weighted surface concentration is 0.53 mg/kg as documented in Appendix C.

risk-based sediment PCB concentration level. Cleanup level considerations are discussed in more detail in Section 9.

8.3 Baseline Human Health Risk Evaluation

For the purpose of estimating baseline human health risks associated with upper-bound consumption of Asian clams and other organisms from the site area, the measured Site PCB tissue concentration (i.e., 3.5 mg/kg wet wt.) was input into the standard MTCA baseline human cancer risk (BHCR) equation (Chapter 173-340-708 WAC) rearranged as the following:

$$BHCR = \frac{C_{tissue} \times CR \times DF \times CF \times ED \times SF}{ABW \times AT}$$

Where:

Variable		Value	Basis for Selection
BHCR =	baseline human cancer risk	Calculated	--
C_{tissue} =	PCB concentration in tissue, mg/kg wet wt	0.061 to 3.5	Site data
CR =	Upper-bound shellfish consumption rate, g/day	18	Integral et al. 2004[1]
DF =	site-specific diet fraction, percent	25 to 100	Site-specific, discussed below
CF =	correction factor for unit conversion	1,000	MTCA default value
ED =	exposure duration, years	30	MTCA default value
SF =	PCB cancer slope factor, $(mg/kg\text{-}day)^{-1}$	2	MTCA default value
ABW =	average body weight during exposure, kg	70	MTCA default value
AT =	averaging time, years	75	MTCA default value

[1] From EPA's Lower Willamette River Remedial Investigation Work Plan (Integral et al. 2004). Note that while shellfish consumption rates as high as 132 grams/day have been reported for certain regional subpopulations (Craig McCormack, Ecology, personal communication, October 8, 2007), potential shellfish consumption rates are constrained at this site by local shellfish availability; see diet fraction discussion below and Appendix C.

Using the parameters in the above table, the resulting upper-bound baseline BHCR calculated for the Site is 1.8×10^{-4}. The approximate upstream BHCR was also calculated as 1.3×10^{-5} using the upper 90th-percentile concentration (61 µg/kg wet wt, Table 2-6) of PCBs in Asian clams. All parameters in the equations were held constant for the BHCR estimates except for the diet fraction. For the background case, it was assumed that 100 percent of the daily shellfish diet (i.e., 18 grams per day for approximately 30 people) could be harvested from the 4 to 5 miles of habitat located upstream of the Site.

The rationale for the reduced Site-specific diet fraction was based on surveys of available shellfish habitat. Within the 16 acres of nearshore area at the Site that was sampled during the sediment RI, less than 0.35 acres (2 percent) contains sandy substrate at water depths typically suitable for shellfish production and harvesting (see Appendix C for a more detailed description of the survey). Additionally, an investigation of deeper water habitat was conducted that identified an isolated clam bed at the Site. Asian clams were located within a 0.5-acre area buried 12 inches below the sediment surface in approximately 10 to 15 feet of water. At the time of the habitat investigation, average river water levels were approximately 5 feet higher than low water conditions, which indicate that harvesting of the area using common methods (i.e., waders and clam rakes) is relatively infeasible throughout most of the calendar year.

Based on population surveys performed in the Site vicinity by McCabe et al. (1997), the average shellfish (predominantly Asian clams) density within suitable substrate areas of the Lower Columbia River is approximately 80 grams per square meter (grams/m^2) (wet wt; converted from population counts based on Benke et al. 1999). Since Asian clams reach a harvestable size in approximately 2 years, the entire 16-acre site area is capable of supporting a calculated sustained shellfish harvest of no more than 150 grams/day. Assuming further that the sustained Site harvest would be shared among a subpopulation of at least 30 individuals over an exposure period of 30 years (the assumed MTCA exposure duration), the resulting upper-bound site-specific diet fraction is calculated at no more than 25 percent. This value was used in the MTCA risk calculations.

9 CLEANUP STANDARD DEVELOPMENT

This section presents the cleanup levels, remediation levels, and points of compliance (POC) that have been developed for the Site. A cleanup standard defines the POC and concentration of a hazardous substance in media above which the impacted media may pose a risk to human health through the exposure pathway (cleanup level or remediation level). As defined in the MTCA regulation, a remediation level defines the concentration of a hazardous substance in a particular medium above or below which a particular cleanup action component or institutional control may be used. Remediation levels are Site-specific, risk-based values that may be developed using exposure assumptions and other media-specific factors that reflect specific future Site conditions under a given remedial alternative scenario.

9.1 Methodology

Cleanup levels for all Site media were developed following procedures described in the MTCA regulations. The development of sediment cleanup levels under MTCA is established in Chapter 173-340-760 WAC through reference to the SMS (Chapter 173-204 WAC). The sections below describe the methodology used to develop cleanup levels based on SMS and MTCA Method A and Method C procedures, ARARs, and risk-based calculations.

9.1.1 SMS Freshwater Procedures

Section V of the SMS provides guidance for the development of sediment cleanup standards. Although numerical values are provided for cleanups located within the marine waters of Puget Sound, Section 173-204-520(d) WAC states that criteria, methods, and procedures necessary in the development of freshwater sediment cleanup screening levels and minimum cleanup level criteria shall be determined on a case-by-case basis. Sediment cleanup levels presented in Section 9.2 were developed with the consultation of Ecology personnel. The final cleanup level for the Site will be based on protection of human health, benthic aquatic organisms, and wildlife.

9.1.2 MTCA Procedures

The MTCA Cleanup Regulations (Sections 173-340-720, -730, and -740 WAC) establish procedures to develop cleanup levels for groundwater, surface water, and soil. MTCA Method A procedure is applicable to sites with relatively few hazardous substances.

Cleanup levels based on this method for soil and groundwater are derived through selection of the most stringent concentration presented in the following sources:

- Concentrations listed in WAC Tables 173-720-1, -740-1, and -745-1.
- Concentrations established under ARARs
- Concentrations protective of the environment and surface water beneficial uses.

If these sources do not provide an appropriate value, then the cleanup level is based on the natural background concentration or the practical quantitation limit, whichever is higher. For qualifying sites, Method C procedures can be used to develop cleanup levels for specific media and COCs.

MTCA Method C procedures employ a risk-based evaluation of potential human health and environmental exposures to Site COCs. As defined in the MTCA regulation, for a given chemical detected in soil, groundwater, and/or surface water media, Method C cleanup levels must be at least as stringent as established state or federal standards or other laws (i.e., ARARs identified in Section 3.1) developed for human health and environmental protection. Not all chemicals have state or federal standards. If a state or federal standard was available, that ARAR was evaluated to ensure that it was protective under MTCA. If the ARAR was not protective, the cleanup level was adjusted to a lower value to ensure its protectiveness. MTCA Method C risk-based calculations and any deviations from ARAR values are discussed below.

The Method C procedure also requires that a cleanup level for one media must also be protective of the beneficial uses of other affected media. For example, since Site groundwater eventually discharges into the Columbia River, Site-specific groundwater cleanup levels also considered surface water protection requirements. The procedures for developing cleanup levels for groundwater, surface water, and soil are outlined in the MTCA Cleanup Regulations, Sections 173-340-720, -730, and -740 WAC, respectively. Included in these sections are the specific rules for evaluating cross-media protectiveness. Where relevant to the Site, cross-media protectiveness of cleanup levels is discussed below and incorporates the results of the fate and transport studies presented in previous sections of this report.

9.1.3 Risk Evaluations

Baseline risk evaluations to develop potential surface water, groundwater, and soil cleanup levels were performed using standard MTCA risk equations. For sediment, a Site-specific risk evaluation presented in Section 8 was used as the basis for cleanup level development for protection of human health and the environment. For soil, Method C default assumptions for industrial site uses were used in the equations, as described below.

- For surface water, the initial risk evaluation was based on protection of human health from consumption of both shoreline drinking water and fish/shellfish potentially in contact with groundwater releases (e.g., benthic shellfish as may be present in surface sediment). Potential drinking water uses of surface water were also addressed through an evaluation of ARARs. Section 6 evaluated the potential risk associated with the groundwater-to-surface water pathway and concluded that the rate of discharge under current and potential future Site conditions was negligible. However, because the potential for groundwater to reach the Columbia River exists, groundwater cleanup levels were adjusted downward when appropriate.
- For groundwater, the initial risk evaluation was based on protection of human health from drinking water consumption, conservatively assuming withdrawal from hypothetical on-site supply wells. At this time, there is no existing or identified potential future use of groundwater or shoreline surface water at this Site for drinking water consumption purposes. As previously mentioned, the groundwater-to-surface water pathway for fluoride was determined to be incomplete.
- For soil, the initial risk evaluation was based on protection of human health from direct contact with soil, considering long-term industrial site use. For PAHs, PCBs, and fluoride, empirical data was used to evaluate the soil-to-groundwater pathway and demonstrate that no adverse effects were occurring for locations currently meeting direct contact-based cleanup levels. Subsequent calculations were performed using Site-specific K_d determined from laboratory leachate testing and the variable parameter three-phase partitioning model to determine potential remediation levels protective of groundwater resources with respect to

fluoride. Cleanup levels for PAHs were evaluated using the TEF procedure per MTCA regulations.

9.2 Sediment Cleanup Levels

A Site-specific cleanup level was established based on protection of human health and the environment using best professional judgment (BPJ). In addition, the cleanup level selected is both technically achievable and protective. Implementing the selected cleanup level will target approximately 99 percent of the PCB mass (i.e., upon completion of a dredge plan design that includes overdredge allowances) and would immediately reduce risks to human health and the environment.

MTCA addresses sediment cleanup levels by reference to the SMS. Under the SMS, the primary endpoint for sediment quality evaluations is protection of human health and the environment, specifically the benthic community and wildlife, from adverse effects associated with COPCs. Numeric freshwater sediment quality values (SQVs) for a range of chemicals are still under development by Ecology, though interim guidelines have been released based on probable or apparent effects thresholds (AETs) calculated using the available regional database of synoptic chemistry and toxicity test information.

While SMS cleanup levels have been promulgated for sediments in the marine environment, freshwater sediment quality criteria are currently determined on a case-by-case basis (Chapter 173-204-340 WAC). Cleanup standards derived for the Site must consider protection of benthic organisms, as well as the protection of human health and ecological receptors.

Sediment cleanup levels for the Site with respect to benthic organisms were developed using information from several sources, including site-specific studies and other information available from Ecology and EPA. The current interim Ecology (2003b) freshwater SQVs for PCBs consider the potential for localized toxicity to benthic invertebrate organisms and include updates of existing freshwater AETs and evaluations of other SQV measures that may provide improved reliability. Ecology is currently considering potential freshwater toxicity-based SQVs ranging from 62 μg/kg dry weight (lowest AET) to 354 μg/kg dry weight (second lowest AET) as identified in Table 9-1.

Table 9-1
Relevant Site-Specific Cleanup Levels

Parameter	Sediment PCB Concentration (μg/kg)(a)	Basis
Natural Background Level	< 5	Lake Chelan TMDL and other regional studies
Human Health Protection (Target HCR = 10^{-6})	5	18 gms/day shellfish consumption; 50% diet fraction
Practical Quantitation Level	10 to 20	Ecology's Manchester Lab and other lab PQLs
Area Background Level	33	MTCAStat Upper 90 percentile: 10 upstream samples (Section 2.4)
Human Health Protection (Target HCR = 10^{-5})	49	18 gms/day shellfish consumption; 50% diet fraction
Lowest Technically Achievable Concentration	90	BPJ; Dredge & backfill; 8% generated residuals; complete mixing (b)
BPJ Site-Specific Human Health Protection (Target HCR = 10^{-5})	**97**	**18 gms/day shellfish consumption; 25% diet fraction (c)**
Benthos and Fish Risk Threshold	62 to 354	AETs; Michelsen (2003)
Proposed Remedial Action Level	**320**	**Targets ~98% of existing mass for removal(d)**
Wildlife Risk Threshold	320	Site-specific Gobas model
Other Implemented Freshwater Cleanup Levels	500 to 5,000	Average range from similar sites nation-wide
ARARs	Site Specific	SMS (Chapter 173-204-340 WAC)

Notes:

(a) Bold values represent the risk-based cleanup standard established to protect human health and the remedial action level.

(b) This 'lowest technically achievable concentration' is based on the anticipated post-dredging residuals concentrations after a sand backfill is placed to restore pre-construction grades. The post-dredge and residuals estimation methodology is discussed in more detail in Section 9.2.2.

(c) Consistent with WAC 173-340-708(10)(b), modification of the default diet fraction is justified based on the limited availability of potentially harvestable shellfish at the site given local sediment habitat and hydrologic conditions. Engineering or institutional controls are not required to control exposure.

(d) The actual dredge plan, which includes additional overdredge allowances, will target 99% of the existing mass.

HCR = Human Cancer Risk
BPJ = Best Professional Judgment
AET = Apparent Effects Threshold
TMDL = total maximum daily load
PQL = practical quantitation limit
ARAR = applicable or relevant and appropriate requirement

Potential risks to wildlife and human health due to PCB uptake and bioaccumulation were also considered. Section 8.2 discusses the development of a Site-specific wildlife risk threshold of 320 μg/kg using the Gobas and Zhang (1994) food web model. Section 8.3 discusses the estimation of the existing baseline human health risks associated with upper-bound consumption of Asian clams and other organisms from the Site area. The existing upper-bound baseline BHCR calculated for the Site is estimated at 1.8 x 10^{-4}, which is 14 times above the estimated upstream BHCR of 1.3 x 10^{-5}. In addition to the study-specific cleanup levels presented in Table 9-1, human health risk-based threshold concentrations for sediment and tissue were calculated with the following equations:

$$C_{sed} = \frac{C_{tissue} \times TOC}{\%LIPID}$$

$$C_{tissue} = \frac{BHCR \times ABW \times AT}{CR \times DF \times CF \times ED \times SF}$$

Where:

Variable		Value	Basis for Selection
C_{sed} =	PCB concentration in tissue, mg/kg dry weight	Calculated	--
C_{tissue} =	PCB concentration in tissue, mg/kg wet weight	Calculated	--
TOC =	Total organic carbon fraction, %	1	Site average (Section 2.4.1)
%LIPID =	Asian clam lipid content, %	2	USACE 2007 (Section 2.4.2)
BHCR =	baseline human cancer risk	10^{-5} to 10^{-6}	SMS, Case-by-case evaluation
ABW =	average body weight during exposure, kg	70	MTCA default value
AT =	averaging time, years	75	MTCA default value
CR =	Upper-bound shellfish consumption rate, g/day	18	Integral et al. 2004[1]
DF =	site-specific diet fraction, percent	25 - 50	SMS, Case-by-case evaluation
CF =	correction factor for unit conversion	1000	MTCA default value
ED =	exposure duration, years	30	MTCA default value
SF =	PCB cancer slope factor, $(mg/kg\text{-}day)^{-1}$	2	MTCA default value

[1] From EPA's Lower Willamette River Remedial Investigation Work Plan (Integral et al. 2004). Note that while shellfish consumption rates as high as 132 grams/day have been reported for certain regional subpopulations (Craig McCormack, Ecology, personal communication, October 8, 2007), potential shellfish consumption rates are constrained at this site by local shellfish availability; see diet fraction discussion and Appendix C.

The planned sediment remedial action at the Site consists of a design that is permanent to the fullest extent and provides mass removal to the maximum extent practicable as discussed in detail in Section 9.2.2. The project would be constructed with modern, conventional dredging equipment capable of operating safely and effectively under the potentially difficult conditions at the Site (i.e., relatively steep riverbed slopes, dense sediments, and potentially adverse weather conditions). Based on discussions with several experienced sediment remediation contractors, it is anticipated that a mechanical dredge with a hydraulically-articulated arm (e.g., similar to an upland excavator) would be used to remove the sediment. With a closed-bucket setup, this method removes the sediment close to its in situ water content, reducing the volume of water that would require treatment. In addition, this method may also minimize the potential for resuspension; however, even with careful control of operations, dredging residuals will persist. Therefore, dredging residuals should be considered in the planning stages (i.e., during cleanup level development) prior to design and implementation of any remediation project that is primarily based on dredging. Section 9.2.2 specifically discusses the limitations associated with dredging remedies and the calculations performed to determine the lowest achievable cleanup level (90 μg/kg) using the best available technologies applicable to the Site.

9.2.1 Identifying Dredge Residuals

Dredging residuals refer to affected sediments (at concentrations above the action level) found at the post-dredge surface of the sediment profile, either within or adjacent to the dredging footprint. Because there are numerous potential sources of residual sediment contaminants, residuals can be broadly grouped into two categories: 1) undisturbed residuals; and 2) generated residuals.

Undisturbed residuals are affected sediments (at concentrations above an action level) found at and below the post-dredge sediment surface that have been uncovered but not fully removed as a result of the dredging operation. The primary causes of undisturbed residuals include:

- Incomplete dredging based on equipment limitations for sediment which:
  - Directly overlies bedrock or hardpan (i.e., dense sediments)
  - Covers highly uneven surfaces, or debris or boulders that are left in place
  - Is located near piers, piling, or utility crossings that are left in place
- Incomplete characterization of the horizontal and vertical extent of contaminants and/or ability of geostatistical models to adequately characterize the distribution of contaminants
- Inappropriate selection of a target dredge design elevation
- Inaccuracies in meeting targeted dredging elevations
- Development of dredge plans that intentionally do not target complete removal of affected sediments (e.g., due to engineering limitations), which is then factored into the overall design

Generated residuals are post-dredge surface or near-surface sediments (above an action level) that are dislodged or suspended by the dredging operation and are subsequently redeposited on the bottom of the waterbody. The primary sources of generated residuals include:

- Sediments dislodged but left behind by the dredge head that fall to the bottom without being widely dispersed
- Sediment dislodged but left behind by debris-removal operations
- Attempting to dredge sediment in settings that limit the operation of the dredge (e.g., in debris fields)
- Sediment that sloughs into the dredge cut from adjacent undredged areas
- Sediment moved by slope failures caused by the process of dredging
- Sediments resuspended by the dredgehead that quickly resettle
- Sediments resuspended by dredging or other dredging-related activities that resettle within or adjacent to the dredging footprint

At this Site, it is likely that pockets of underlying dense sand may be encountered that may, at times, be difficult for the dredge to penetrate. Other obstructions may be present such as debris or logs, which could further inhibit dredge operations. To offset these conditions, it is anticipated that a dredge plan for the project would be designed with an average 1-foot overdredge allowance to increase the reliability that the target dredge material is effectively removed. Additionally, best management practices (BMPs; such as eliminating multiple bucket bites, prohibiting underwater material stockpiling, and reduced cycle times) would be implemented to reduce the potential for generated residuals to the extent practicable. Ultimately, these limitations will dictate the sediment cleanup levels that can be technically achieved at the Site.

9.2.2 Predicting Dredge Residuals

Although there are no established regulatory methods by which residuals are commonly estimated, significant recent work has been conducted in this area. Using data available from a wide range of well-documented environmental dredging projects, Patmont and Palermo (2007) concluded that a range of 2 to 9 percent of the mass of contaminant dredged typically remains within the site area following dredging, with similar residual percentages observed for both mechanical and hydraulic dredging equipment. The available data suggest that multiple sources contribute to generated residuals, including resuspension and sloughing. The environmental dredging case study information summarized in Patmont and Palermo (2007), when combined with site-specific sampling data, can provide important bounding-level predictions of generated residual concentrations and thicknesses for environmental dredging projects.

The findings of the study serve as the basis for the dredging residual estimates performed for this Site. Specific assumptions considered include:

- Constituent levels in residuals on a site-wide basis are approximate to the site-wide average concentration of COCs characterized prior to dredging. For deep dredge cuts, the average will be biased to the lower interval concentrations that are removed by final dredge passes.
- Generated residuals represent the majority of residuals contaminant mass; undisturbed residuals contribute only a minor amount of residual contaminant mass.
- Generated residuals represent 2 to 9 percent (average 4 percent) of the mass of contaminant that was present in the last dredge cut interval. Higher residual mass will be present at sites where hardpan and debris are present.

For this Site, the process by which dredging residuals were estimated for this project was performed step-wise to represent two scenarios: 1) dredging without subsequent residuals management; and 2) dredging with the subsequent placement of a residual sand layer within the dredge footprint. To support the evaluations, a set of conceptual dredge plans targeting a range of action levels were developed using the data collected by Windward Environmental and USACE (refer to Section 2.4) and a nominal grid system based on Windward's sampling stationing resulting in a total of 20 dredge cells. Data contained within each cell were evaluated to determine pre-dredge surface conditions and the average target dredge concentrations. The thickness of the generated residuals deposit was estimated, assuming that a range of 2 to 9 percent of the total dredged sediment mass would not be fully removed from, and would redeposit within, the dredge footprint. The thickness of a generated residuals layer is expected to range from 1 to 5 inches locally depending upon the thickness of the dredge cut; however, the Site-wide average is expected to be less than 1.5 inches.

Theoretical post-dredge confirmation sample concentrations were estimated for each dredge cell by calculating a depth-weighted average of the predicted generated residuals and the observed data (from the pre-characterization studies) for the interval below the dredge cut. Site SWACs were then calculated using these theoretical confirmation sample data for a range of target action levels (200, 320, 500, and 1,000 µg/kg) and residual percentages (2, 5, and 9 percent). For areas outside of the dredge footprint, the pre-dredge surface concentrations were included in the SWAC. Copies of the detailed spreadsheets used for these calculations are provided in Appendix C.

Because hardpan and debris are likely to be encountered at the Site, it is anticipated that the upper and lower-bound residuals will range from 5 to 9 percent with an average of 8 percent of the total dredge mass. For the dredge scenario with no residuals management, the average lower-bound SWAC is predicted to be on the order of 315 µg/kg. Based on data collected from similar sediment remediation projects, follow-up dredge passes are typically less effective when dense substrate and debris is present. In these cases, sand placement is often used to manage thin, low density deposits of residuals. The benefit of using a nominal 12-inch post-dredge sand backfill at this Site was evaluated using the method described above.

The SWAC estimation for the dredge and residuals management backfill scenario was performed for a conservative case under which the 12-inch backfill layer would completely mix with the underlying residual sediment deposit. The resulting relationship between the estimated SWAC and overall PCB mass removal versus a range of prospective action levels is illustrated on Figure 9-1. Based on experience gained at sites where similar dredge and habitat backfill actions were completed (e.g., Duwamish River [WA], Fox River [WI], and Grasse River [NY]), it is expected that only the bottom 6 inches will likely mix with the underlying residuals layer; however, the full mixing scenario was considered in this evaluation to assess the potential upper bound range of in situ SWAC values. It is likely that actual post-construction confirmation sampling performed at the Site will yield results lower than the predictions in Figure 9-1. However, because residuals typically do not deposit uniformly across a site, an upper bound case was considered where 5 to 9 percent of the dredged mass may redeposit.

This calculation yields a lowest technically achievable concentration of 90 µg/kg dry wt for the post-dredge and residuals management backfill condition (see Table 9-1). Without the residuals management backfill, the lowest technically achievable concentration would increase to approximately 315 µg/kg.

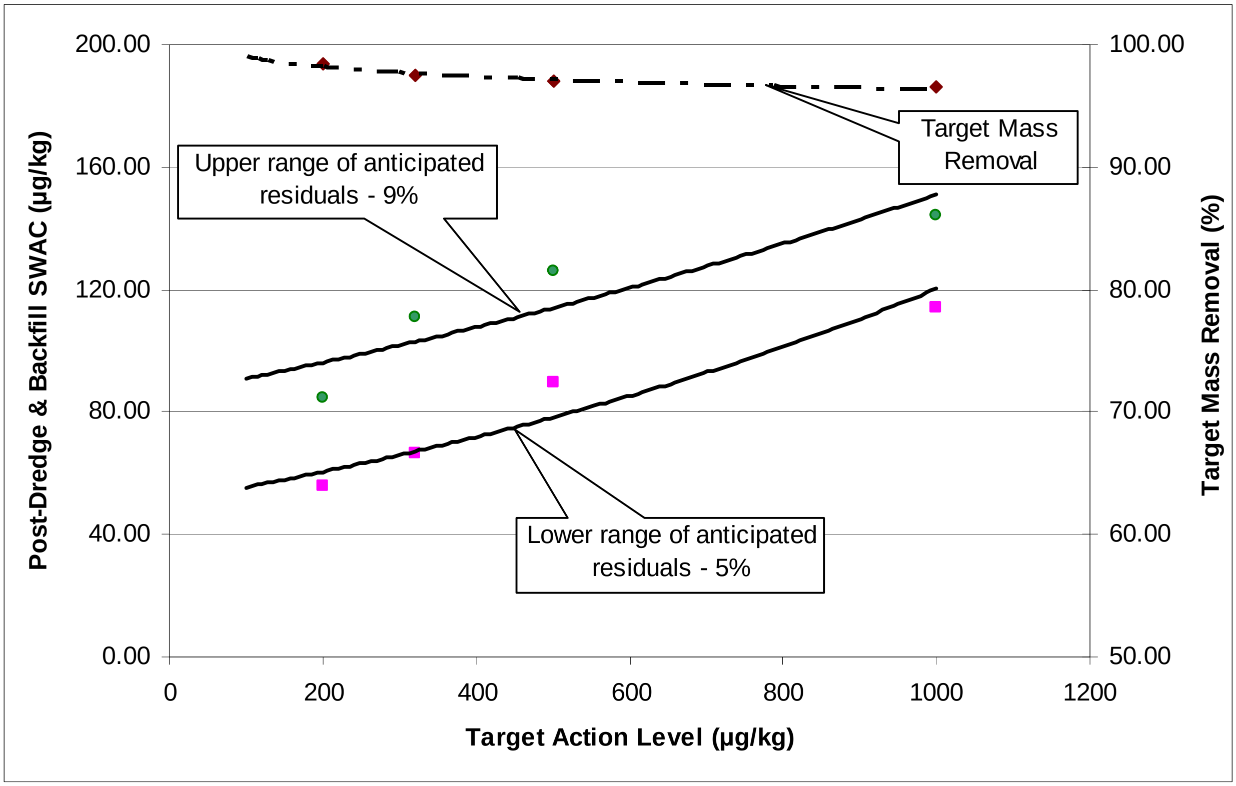

Figure 9-1
Relationship between Target Action Level, Estimated SWAC, and Mass Removal

The results of the residuals analysis provide an evaluation of the lowest technically achievable cleanup levels for a dredging remedy with and without residuals management. The 90 µg/kg value presented in Table 9-1 is based on a scenario in which a nominal 12-inch sand layer would completely mix with underlying Site sediment and migrating sediment from upstream sources. Because approximately 95 percent of the PCBs deposited at the Site are distributed in surface sediments, required dredge cuts will likely be designed to 1 foot. Accordingly, generated residuals will likely redeposit in very thin, low-density layers on the order of 1 to 2 inches. Based on data collected from other sediment remediation sites, it is impracticable to target such layers with subsequent dredging passes and little success, if any, is often observed.

Based on a BPJ assessment of the anticipated post-dredge Site conditions, it is recommended that a residuals management backfill layer be implemented as a necessary component to the remedial action. Furthermore, based on the analysis of predicted post-dredge SWAC ranges, it is recommended that a technically feasible, Site-specific cleanup level of 97 μg/kg be adopted for the project. A 97 μg/kg cleanup level would be protective of benthic organisms and wildlife (i.e., it is lower than cleanup levels adopted at other sites with similar conditions and receptors) and satisfies the Site-specific risk reduction goal for protection of human health.

9.3 Sediment Remedial Action Level

Based on BPJ with sediment dredging projects, it expected that dredging residuals will persist, as discussed in Section 9.2.2. For projects that are designed to fully remove the affected sediment to the maximum extent practicable, thus pushing the practical operational limits of the best available remedial technologies, it is appropriate to consider a Remedial Action Level (RAL) in which other alternatives (e.g., enhanced natural recovery) may be used to achieve cleanup goals.

To evaluate the effectiveness of a removal remedy based on a RAL, an evaluation of target mass removal as a function of RAL was performed. Section 8.1 discusses the distribution of the total PCB mass contained within the Site area using a Thiessen polygon approach. To determine the target mass removal for a range of RALs, Thiessen polygons were again used to evaluate the PCB mass contained within each depth interval at each sample location exceeding a given RAL. The target PCB mass removal (i.e., excluding considerations of residuals and over-dredging allowances) corresponding to three RALs (320, 500, and 1,000 μg/kg) is shown graphically on Figure 9-1. From this figure it is evident that RALs as high as 1,000 μg/kg would target greater than 96 percent of the total PCB mass deposited at the Site. It is likely a final dredge plan based on a 1,000 μg/kg RAL would ultimately result in additional mass removal. The target mass removal associated with the 320 μg/kg RAL is approximately 98 percent.

Examination of the RAL and mass removal/SWAC relationships reveals the marginal benefit of targeting lower RALs (i.e., the rate at which PCB mass removal and the SWAC declines is diminished with lower RALs; see Figure 9-1). This is due in part to anticipated dredging residuals (averaging 8 percent of the dredged PCB mass), and also to the similarity of the predicted SWAC to upstream background sediment concentrations. Furthermore, targeting lower dredging RALs would significantly increase the volume of sediment to be removed and disturbed increasing the potential for short-term water quality impacts and down-stream migration of suspended material. Thus, targeting a lower RAL (and a larger associated dredge volume) would result in low incremental environmental benefit relative to overall risk reduction.

The Site-specific cleanup level selected in the previous section is based on protection of human health and the environment using BPJ. As noted in Table 9-1, cleanup levels protective of benthic organisms and wildlife range from 62 μg/kg to 354 μg/kg; generally above the 97 μg/kg cleanup level. Selection of a RAL up to 354 μg/kg would provide an action level for which a dredging remedy is both technically achievable and protective. Therefore, a Site-specific RAL set at 320 μg/kg dry weight would target approximately 99 percent of the PCB mass (i.e., upon completion of a dredge plan design that includes overdredge allowances) and would immediately reduce risks to human health and the environment. For areas with concentrations below the RAL and above the cleanup level, enhanced natural recovery (i.e., placement of a minimum 6-inch sand layer) will be used.

9.4 Sediment Point of Compliance

Surface sediments within the biologically active surface water habitat zone are typically represented by samples collected across the top 10 cm (0 to 0.3 feet) below the mudline. A site-specific evaluation of the depth of the biologic zone has not been completed for this Site; however, based on observations during the RI it is likely that the zone is 10 cm or less. Therefore, use of a default 0 to 10 cm POC in the sediment cleanup standard should provide an additional level of protectiveness at the Site.

9.5 Groundwater Cleanup and Remediation Levels and Conditional POC

As previously discussed, future Site uses will continue to be industrial, there are no plans to extract water from the shallow water-bearing layers, and existing water supply regulations effectively preclude this potential site exposure pathway within portions of the Site. However, consistent with MTCA procedures for determining potable water sources, potential drinking water uses were considered in the initial development of groundwater cleanup levels. Because the site has few groundwater contaminants, Method A was used to develop cleanup levels for the Site AOCs identified in Section 7.

Final cleanup levels were selected as the most stringent of the Method A WAC 173-720-1 Table values and ARARs. The ARARs for groundwater in this case include the federal Drinking Water Standards and Health Advisories (USEPA 2002) and the State Primary Drinking Water Regulations (Chapter 246-290 WAC). The ARARs for surface water in this case include the federal CWA and Chapter 173-201A WAC. The groundwater cleanup levels for each COC and the basis for selection are listed in Table 9-2.

Table 9-2
Groundwater Cleanup Levels

Chemical of Potential Concern	Groundwater Cleanup Level	Protection Basis
Fluoride (dissolved)	4 mg/L	State Drinking Water MCL
TPH Diesel Range	500 µg/L	MTCA Method A Standard Value
TPH Mineral Oil	500 µg/L	MTCA Method A Standard Value

As defined in the MTCA regulations, the standard POC for groundwater extends from the uppermost level of the saturated zone to the lowest depth that could be potentially affected by Site releases. It is anticipated that it would not practicable to meet the some or all groundwater cleanup levels throughout the Site within a reasonable timeframe. Therefore, compliance with groundwater cleanup levels would be measured at Conditional POC wells located along the shoreline, down-gradient from the respective source areas in accordance with WAC 173-340-720(8)(c).

While most of the fluoride-bearing groundwater at the Site is covered by the 1992 Consent Decree for the SPL Storage Area, a few minor exceedances (less than two times the cleanup level) were observed in Shallow Zone wells SP-4-S and T3-3. These two wells are located where cleanup activities have been completed with Ecology's oversight and the sources have been completely removed to the maximum extent practicable. In the alternatives evaluation of the 1992 CAP for the SPL Storage Area determined that treatment of low level fluoride-bearing groundwater was impracticable, particularly when present in the seasonal Shallow Zone. The concentrations of fluoride observed in these wells also complies with the conditions of the 1992 Consent Decree. Therefore, it is appropriate to establish a groundwater remediation level (REL) that is protective of surface water resources and above which, treatment of fluoride-bearing groundwater may be considered.

Concentrations of fluoride in surface water up-gradient of the Site were monitored between 1992 and 2002 and ranged from 0.08 mg/L to 0.48 mg/L, averaging 0.24 mg/L. This data was collected as part of the requirements of the 1992 Consent Decree. As part of this RI, a surface water sample was collected and fluoride concentration of 0.127 mg/L was reported. The fate of fluoride along the pathway in which groundwater interacts with surface water was discussed in Section 6.2. The rate at which Site groundwater flows from the Intermediate Zone to the Columbia River is approximately 10 to 30 feet/year and is even less for the Shallow Zone. Based on this data, a mathematical simulation of the chemical reaction that occurs as fluorapatites precipitation can be performed to calculate a surface water concentration for a range of fluoride concentrations. Using a theoretical, upper-bound groundwater concentration of 2,500 mg/L (fluoride), the calculated fluoride concentration in surface water is 0.25 mg/L, which is within the range of concentration observed up-gradient from the Site. Therefore, a fluoride groundwater REL of 2,500 mg/L will be established and monitored at the conditional point of compliance in well clusters along the shoreline.

9.6 Soil Cleanup and Remediation Levels

The current and future Site use plans include industrial storage and light industrial operations, and meet the requirement of a “traditional industrial use” under the MTCA regulations (Section 173-340-745 WAC). Thus, industrial use is the appropriate basis for development of Site-specific soil cleanup levels under MTCA Method C. Soil cleanup levels were developed for fluoride, PAHs, TPH, and PCBs by considering the following potential exposure/risk pathways:

- Human health protection from direct soil contact
- Human health protection from soil-to-groundwater pathway exposure
- Human health protection from soil-to-air pathway exposure
- Terrestrial ecological protection

9.6.1 Direct Soil Contact Pathway Exposure

Future development plans at the Site include grading of the existing site with a minimum of 12 inches of clean fill and asphalt pavement; therefore, direct contact exposures to soil will be minimized. The primary potential pathway for direct contact would occur during earthwork operations and other activities required for Site development. Accordingly, cleanup levels were initially derived using WAC Equations 173-340-745-1, -745-2, and -745-3 for non-carcinogenic, carcinogenic, and petroleum COCs, respectively. No modifications were made to the standard parameters for these equations. However, because the TSCA regulation for PCBs lists more restrictive cleanup levels than those derived under Method C, the initial PCB cleanup level was adjusted downward from 66 mg/kg to 10 mg/kg. This value is also consistent with the Method A concentration for Industrial Use scenarios.

The POC for direct contact with soils extends from the ground surface to the reasonable estimated depth of potential future soil excavations (e.g., to accommodate deep foundations or similar facilities), which can extend to 15 feet bgs or deeper [see WAC 173-340-740(6)(d)]. As set forth in WAC 173-340-740(6)(f), for MTCA cleanup actions that involve containment of hazardous substances (such as the East Landfill), soil cleanup levels will typically not be met at the standard POC in soils shallower than 15 feet bgs. In these cases, the cleanup action consisting of engineered caps, such as the East Landfill cap, may be determined to comply with cleanup standards, provided that:

- The selected remedy is permanent to the maximum extent practicable using the procedures in WAC 173-340-360 (see Section 13)
- The cleanup action is protective of human health and the environment
- The cleanup action is demonstrated to be protective of terrestrial ecological receptors under WAC 173-340-7490 through 173-340-7494, as described herein
- Institutional controls are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system (see Sections 12 and 13)
- Compliance monitoring under WAC 173-340-410 and periodic reviews under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system (see Sections 12 and 13)

- The types, levels, and amount of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances are specified in the draft CAP (development of which is pending).

9.6.2 Soil-to-Groundwater Pathway Exposure

Cleanup levels based on Method C direct contact must also be adjusted as necessary to ensure groundwater resources are protected. However, when empirical data exists that indicates that current groundwater impacts are not occurring and sufficient time has elapsed for migration from source areas to the point of measurement to reinforce that demonstration, then cleanup levels derived for direct contact would not require adjustment. Furthermore, current site conditions must be representative of future development scenarios, as is the case at this Site (i.e., impervious areas will be maintained and potentially expanded).

For PAHs, source control work is planned to remove the remaining on-Site material subject to infiltration. Section 4 discusses the groundwater collected during several years of monitoring, which demonstrates that Site groundwater is currently in compliance with Method A cleanup levels. Therefore, the PAH cleanup level was not adjusted downward for protection of groundwater resources.

A similar source control effort is planned for residual fluoride-bearing waste at the Site. In 1992, the primary source of fluoride (SPL) was removed from the Site and the residual underlying soils were capped with an impermeable liner pursuant to a Consent Decree. Since this remedial action, fluoride concentration in groundwater has been declining. The groundwater concentrations adjacent to and down gradient from the remaining source areas outside of the SPL area are marginally above the fluoride groundwater cleanup level of 4 mg/L. Upon removal of the residual waste and affected soil, it is expected that groundwater will attenuate to below the cleanup level. However, data generated from Site-specific laboratory leaching tests and evaluated in the MTCA Equation 173-340-747-1 (below; the standard 3-phase partitioning model) indicate that a concentration of approximately 9,100 mg/kg in soil would be protective of groundwater resources. Therefore, a soil REL of 9,000 mg/kg will be established and implemented during source control activities outside of the SPL area.

$$C_S = C_w\left(UCF\right)DF\left[K_d + \frac{\left(\theta_w + \theta_a H_{cc}\right)}{\rho_b}\right]$$

Where:

Variable		Value	Basis for Selection
C_S =	Soil concentration, mg/kg	Calculated REL	--
C_w =	Groundwater cleanup level, µg/L	4,000	Section 8.5
UCF =	Unit conversion factor (1 mg/1,000 µg)	0.001	MTCA default value
DF =	Dilution factor, unitless	20	MTCA default value
K_d =	Distribution coefficient, L/kg	114	Site-specific[1]
θ_w =	Water-filled soil porosity, ml water/ ml soil	0.3	MTCA default value
θ_a =	Air-filled soil porosity, ml air/ ml soil	0.13	MTCA default value
H_{cc} =	Henry's law constant, unitless	0	MTCA default value
ρ_b =	Dry soil bulk density, kg/L	1.5	MTCA default value

[1] The site-specific K_d value used to calculate a fluoride concentration in soil protective of groundwater resources was taken as half the average value presented in Table 4-8. The reduction was made to account for variability in the laboratory generated data.

Soil concentrations established under Method A are conservative and are typically protective of groundwater resources. Because the PCB cleanup level was adjusted downward for compliance with TSCA, it also meets the requirements of Method A. Therefore, no further adjustment of the PCB cleanup level is required.

9.6.3 Soil-to-Air Pathway Exposure

For COCs that readily evaporate (such as diesel and solvents), the inhalation of vapors arising from impacted soil must be considered. Under Method C, the vapor pathway must be evaluated whenever a volatile substance is expected on site. On this Site, diesel and residual range organics are present; however, the pathway is considered incomplete whenever the TPH concentration is less than 10,000 mg/kg for diesel range constituents. For residual range TPH, the pathway is considered incomplete when the existing concentrations are approximate to the cleanup level derived for protection of groundwater resources. TPH cleanup levels for this Site have been set under such conditions and are therefore protective of the soil-to-air pathway.

9.6.4 Terrestrial Ecological Protection

As previously stated, the Site will be redeveloped for industrial uses and impacted soil will be covered with a minimum of 12 inches of clean fill or other improvements such as buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to the soil. Based on future Site conditions and using the exposure analysis procedure under WAC 173-340-7492 (2)(a)(ii), a simplified terrestrial ecological evaluation was not required. Therefore, cleanup levels were not further adjusted for protection of terrestrial ecological resources, although all exposed areas (i.e., where institutional controls would not be placed or a remedial action conducted) meet the criteria in WAC Table 173-340-749-2.

The final cleanup levels and REL for Site soils are summarized in Tables 9-3 and 9-4.

Table 9-3
Soil Cleanup Levels

Chemical of Potential Concern	Soil Cleanup Level	Protection Basis
Fluoride	210,000 mg/kg	Direct Contact
PAHs[1]	18 mg/kg	Direct Contact
PCBs[2]	10 mg/kg	Direct Contact and Groundwater
TPH Diesel Range	2,000 mg/kg	Direct Contact and Groundwater
TPH Mineral Oil	4,000 mg/kg	Direct Contact and Groundwater

[1] Cleanup level developed for potentially carcinogenic PAHs based on the approved MTCA TEF procedure
[2] A cleanup level of 1 mg/kg will be adopted for areas designated for Unrestricted Use

Table 9-4
Soil Remediation Level

Chemical of Potential Concern	Soil Remediation Level	Protection Basis/Remedial Action
Fluoride	9,000 mg/kg	Groundwater – Excavate Soils above REL

10 APPLICABLE FEDERAL, STATE, AND LOCAL LAWS

Many environmental laws may apply to a cleanup action. In addition to meeting MTCA cleanup standard requirements as described in Section 9, a cleanup action must meet cleanup standard requirements and environmental standards set in applicable laws. The cleanup action must also comply with elements of other applicable environmental reviews and permitting requirements. Though a cleanup action performed under formal MTCA authorities (e.g., a Consent Decree) would be exempt from the procedural requirements of certain state and local environmental laws, the action must nevertheless comply with the substantive requirements of such laws (RCW 70.105D.090; WAC 173-340-710). Potentially applicable federal, state, and local laws that may impact the implementation of remedial actions at the Site are summarized below.

10.1 Federal Requirements

Potential federal requirements are specified in several statutes, codified in the U.S. Code (USC), and regulations promulgated in the Code of Federal Regulations (CFR), as discussed in the following sections.

The Clean Water Act (33 USC Section 1251 et seq.) requires the establishment of guidelines and standards to control the direct or indirect discharge of pollutants to waters of the United States. Section 304 of the CWA (33 USC 1314) requires the EPA to publish water quality criteria, which are developed for the protection of human health and aquatic life. Federal water quality criteria are published as they are developed, and many of them are included in Quality Criteria for Water 1986, EPA 440/5-86-001, May 1, 1986 (51 FR 43665), commonly known as the "Gold Book." Publications of additional criteria established since the Gold Book was printed are announced in the Federal Register. Federal water quality criteria are used by states, including Washington, to set water quality standards for surface water. These standards are relevant and appropriate for possible actions at the Site. Federal water quality criteria (along with related state standards) have been incorporated into the cleanup standards summarized in Section 9.

- **Discharges of Pollutants into Navigable Waters** are regulated under Sections 401 and 404 of the CWA (33 USC 1341 and 1344), 40 CFR Part 230 [Section 404(b)(1) guidelines], 33 CFR Parts 320 (general policies), 323 and 325 (permit requirements), and 328 (definition of waters of the United States). These requirements regulate the excavation of shoreline materials and the placement of fill material (including caps) below the ordinary high water elevation of waters of the United States. The 401/404 regulations are implemented by the USACE and EPA. Under the Section 404(b)(1) guidelines, 40 CFR 230.10(b), no discharge shall be allowed if it:

1. Causes or contributes to violations of water quality standards, pursuant to Section 401 of the CWA, after consideration of local dilution and dispersion
2. Violates any applicable toxic effluent standard or discharge prohibition under Section 307 of the CWA
3. Jeopardizes the continued existence of any endangered or threatened species, or contributes to the destruction or modification of any critical habitat for such species
4. Violates any requirement imposed by the Secretary of Commerce to protect sanctuary areas

The guidelines in 40 CFR 230.10(c) also provide that no discharge will be authorized that contributes to significant degradation of the waters of the United States. Where there is no practicable alternative to a discharge, 40 CFR 203.10(d) requires the use of appropriate mitigation measures to minimize potential adverse impacts of the discharge on the aquatic ecosystem. The term “practicable” is defined in 40 CFR 230.3(q) to mean “available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.” Examples of specific steps that may be taken to minimize adverse impacts are set forth in 40 CFR Part 230, Subpart H. As discussed above, Section 401 and Section 404 requirements of the CWA may be applicable to an environmental project addressing potential groundwater discharges to protected surface waters or to a shoreline cleanup project if sediment removal and/or capping are implemented.

Cleanup actions at the Site may be performed under the terms of a MTCA Consent Decree between Ecology and the performing parties. Actions performed under such a Consent Decree typically qualify for a USACE Nationwide Permit 38 (NWP 38; Cleanup of Hazardous and Toxic Waste). Nevertheless, federal consultation under the Endangered Species Act, Section 401 Water Quality Certification, and other substantive requirements must still be met by the action. Ecology would be responsible for issuing the final approval for the cleanup project, following consultation with other state and local regulators. The USACE would separately be responsible for issuing approval of this project under NWP 38, following

Endangered Species Act consultation with the federal services (National Marine Fisheries Service [NMFS] and U.S. Fish and Wildlife Services [USFWS]), and also incorporating Ecology's 401 Water Quality Certification.

- **NPDES Waste Discharge Permit** is required for discharge of pollutants to waters of the United States pursuant to Section 402 of the CWA. The cleanup of the Site will generate waste water that will be either discharged to the local sanitary sewer system or to surface water. Discharge of pollutants to surface water requires a permit under Section 402 of the CWA to ensure compliance with state water quality standards. NPDES permits are obtained from Ecology.
- **Memorandum of Agreement between EPA and USACE** (mitigation under CWA Section 404(b)(1)) sets forth policy and procedures for developing mitigation for compliance under Section 404, but does not alter any of the requirements under this section. These guidelines for mitigation include, in order of importance: avoidance, minimization, and compensatory mitigation.

TSCA (15 USC s/s 2601 et seq. (1976)) enables the EPA to require manufacturers and processors of chemicals to test and report potential health and environment hazards of chemicals which might create an unreasonable environmental or public health hazard. The EPA also has the power to track industrial chemicals in the United States and regulate intrastate and interstate commerce under this act. Chemicals which the EPA deems to be an unreasonable risk may be prohibited from use in the United States. TSCA specifically regulates polychlorinated biphenyls (Title I Section 6 (e)), asbestos (Title II), indoor radon gas (Title III), and lead based paint (Title IV). Additionally, TSCA regulations supplement other Federal statues such as the Clean Air Act. TSCA regulated materials such as PCBs, asbestos, and lead based paint are located on the Site.

RCRA addresses the generation and transportation of hazardous waste, and waste management activities at facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a "cradle to grave" management and permitting system for hazardous wastes. RCRA regulates "solid wastes" that are hazardous because they may cause or significantly contribute to an increase in mortality or serious illness, or that pose a substantial hazard to human health or the environment when improperly managed. In Washington State, RCRA is implemented by Ecology under the State's Dangerous Waste Regulations, Chapter 173-303 WAC.

One objective of RCRA is to minimize both the generation and land disposal of hazardous waste by encouraging process substitution, materials recovery, recycling and reuse, and treatment (see RCRA Section 3003). To further this objective, EPA has set various goals for the Waste Minimization National Plan, including reducing the generation and mobility of hazardous wastes and establishing treatment standards as part of several rulemakings under the Land Disposal Restrictions (LDR) in 40 CFR Part 268.

With the potential exception of solid materials removed from PAH or PCB areas, soil, water, or sediment removed from the Site are not expected to be designated as hazardous wastes. As a part of the hazardous waste designations, the waste must be evaluated to determine if it will meet current land disposal restrictions, prior to selection of off-site disposal facilities.

The Federal Clean Air Act (42 USC 7401 et seq.;) regulates emissions of hazardous pollutants to the air. Controls for emissions are implemented through federal, state, and local programs. The Clean Air Act is implemented in the state of Washington through the Washington Clean Air Act (RCW 70.94).

Endangered Species Act (16 USC 1536 (a) – (d); 50 CFR Part 402) Section 7(a) grants authority to and imposes requirements upon federal agencies regarding endangered or threatened species of fish, wildlife, or plants (listed species) and habitat of such species that has been designated as critical. Federal agencies must confer with NMFS and USFWS on any action that is likely to jeopardize the continued existence of listed Chinook salmon or bull trout stocks, respectively, or any other proposed species, or result in the destruction or adverse modification of any critical habitat important to these species. The conference/consultation process is directed at making a biological opinion regarding the proposed action. The opinion evaluates whether or not the action will jeopardize the continued existence of a species, or result in the destruction or adverse modification of critical habitat, and may include modification to the action that would avoid the likelihood of adverse effects to listed species or their critical habitat. Formal or informal consultation with NMFS and USFWS will be required prior to implementation of those cleanup remedies that trigger a federal action, such as a Section 404 permit (see above).

USFWS Mitigation Policy (46 FR 7644) establishes guidance for USFWS personnel involved in making recommendations to protect or conserve fish and wildlife resources.

The Fish and Wildlife Coordination Act (16 USC 661 et seq.) is a federal law requiring consultation with fish and wildlife agencies on activities that could affect fish and wildlife.

Protection of Wetlands, Executive Order 11990 (Appendix A 40 CFR Part 6) requires that federal agencies avoid adversely impacting wetlands wherever possible, minimize wetland destruction, and preserve the value of wetlands. Appendix A of 40 CFR Part 6 provides EPA procedures for managing floodplains and protecting wetlands.

National Historic Preservation Act (36 CFR 800) requires that when proponents seek a federal approval, the responsible federal agency must consult with the State Historic Preservation Officer and the federal Advisory Council on Historic Preservation to determine if the project would affect cultural or historic sites on, or eligible for, the National Register of Historic Places.

10.2 Washington State and Local Requirements

MTCA (Chapter 70.105D RCW) authorized Ecology to adopt cleanup standards for remedial actions at sites where hazardous substances are present. The processes for identifying, investigating, and cleaning up these sites are defined and cleanup standards are set for groundwater, soil, surface water, and air in Chapter 173-340 WAC. The cleanup of contaminated sediments is governed by the SMS process. In addition to MTCA, other potential state requirements are specified in several statutes, codified in the RCW, or are regulations promulgated in the WAC.

Washington SMS (Chapter 173-204 WAC) establishes numerical values for chemical constituents in sediments and biological standards for SQS and CSL. The SMS sets forth a sediment cleanup decision process for identifying contaminated sediment areas and determining appropriate cleanup responses. The SMS governs the identification and cleanup of contaminated sediment sites and establishes two sets of numerical chemical criteria against which surface sediment concentrations are evaluated. The more conservative SQSs provide a regulatory goal by identifying surface sediments that have no known adverse effects on human health or biological resources. The SQS is Ecology's preferred cleanup standard, though Ecology may approve an alternate cleanup level within the range of the SQS and the Minimum Cleanup Level, if justified by a weighing of environmental benefits, technical feasibility, and cost. Site-specific sediment cleanup levels are presented in Section 9.2.

The SMS rule was reviewed and approved by the U.S. Environmental Protection Agency Region 10, pursuant to Section 303 of the CWA. The SMS rule provides the regulatory framework for Ecology to monitor sediment quality in the state of Washington, requiring adherence to specific criteria for discharge source control and cleanup of contaminated sediments. Therefore, the SMS is also a Federal ARAR by CWA reference.

Washington State Clean Air Act (RCW 70.94; WAC 173-400, 403). The Federal Clean Air Act is implemented in the state of Washington through the Washington Clean Air Act (RCW 70.94). The regional air pollution contract authorities, activated under the Washington Clean Air Act, have jurisdiction over regulation and control of the emission of air contaminants and the requirements of state and federal Clean Air Acts in their districts.

State Environmental Policy Act (SEPA) (RCW 43.21C; WAC 197-11) is intended to ensure that state and local government officials consider environmental values when making decisions. The SEPA process begins when an application for a permit is submitted to an agency, or an agency proposes to take some official action such as implementing a MTCA CAP. Prior to taking any action on a proposal, agencies must follow specific procedures to ensure that appropriate consideration has been given to the environment. The severity of potential environmental impacts associated with a project determines whether an Environmental Impact Statement (EIS) is required.

Washington Water Pollution Control Act (Chapter 90.48 RCW; Chapter 173-201A WAC) provides for the protection of surface water and groundwater quality. Chapter 173-201A WAC establishes water quality standards for surface waters of the state. Consistent with the requirements of Chapter 90.48 RCW, Ecology issues a water quality certification for any activity, including MTCA cleanup actions, which may result in a discharge to state water. As outlined above, shoreline excavation, dredging, and/or capping actions typically constitute a "discharge" under this state regulation. The need for mitigation resulting from these activities has been further defined by the Washington State Legislature (see the section below entitled "Compensatory Mitigation Policy for Aquatic Resources").

Washington Shoreline Management Act (Chapter 90.58 RCW; Chapter 173-14 WAC) and regulations promulgated therein establish requirements for substantial developments occurring within water areas of the state or within 200 feet of the shoreline. Clark County has set forth requirements based on local considerations. Local shoreline management plans are adopted under state regulations, creating an enforceable state law.

Washington Hydraulics Code (Chapter 75.20 RCW; Chapter 220-110 WAC) establishes requirements for performing work that would use, divert, obstruct, or change the natural flow or bed of any salt or fresh waters. Mitigation is required for projects that directly or indirectly harm fish. Consistent with the requirements of Chapter 75.20 RCW, the Washington Department of Fish and Wildlife (WDFW) issues a Hydraulic Project Approval (HPA) for any project that will use or change the natural flow of any waters of the state. Shoreline excavation, dredging, and/or capping actions would likely require a HPA under this state regulation. In addition, WDFW typically requires that impacts to wetlands or aquatic resources occurring as a result of cleanup actions be mitigated on the project site and with a similar habitat type. The need for mitigation resulting from these activities has been further defined by the Washington State Legislature (see the section below entitled "Compensatory Mitigation Policy for Aquatic Resources").

Washington Solid Waste Management — Reduction and Recycling Act (Chapter 70.95 RCW; Chapter 173-350 WAC), and regulations promulgated therein, establishes a comprehensive statewide program for solid waste handling, and solid waste recovery and/or recycling to prevent land, air, and water pollution and conserve the natural, economic, and energy resources of the state of Washington.

Washington Hazardous Waste Management Act (Chapter 70.105 RCW; Chapter 173-303 WAC), and regulations promulgated therein, is the state equivalent of RCRA requirements for designating certain solid wastes as "dangerous waste." Under this Act, materials designated as hazardous waste must be monitored until they are properly disposed of or undergo a process to become non-dangerous waste. Hazardous materials transported from the Site must be tracked, sampled, and monitored under the regulations developed. This Act also governs and establishes regulations for hazardous waste treatment, storage, transfer, and disposal facilities. Some materials on the Site are considered hazardous waste and this act will regulate the transportation and off-site disposal these materials.

Washington Department of Fisheries Habitat Management Policy, POL 410, includes the following provisions:

- Achieve no net loss of productive capacity of the habitat of food fish and shellfish resources of the state.
- Create productive capacity of habitats that have been damaged or degraded by natural causes or as a result of human activities.
- Improve the productive capacity of existing habitat and create new habitat.

In addition, in-water actions will need to address the requirements of an HPA, including seasonal fisheries closures and water quality and habitat protection.

Compensatory Mitigation Policy for Aquatic Resources (Chapters 75.20 and 90.48 RCW). In 1997, the Legislature added new sections to Chapters 75.20 and 90.48 RCW to establish a clear state policy relating to the mitigation of wetlands and aquatic habitat for infrastructure development and the cleanup of aquatic resources. Compensatory mitigation is defined to include mitigation that occurs in advance of a project's planned environmental impacts, either on or off the project site, and that may provide different biological functions from the functions impacted by the project. The policy encourages mitigation proposals that are timed, designed, and located in a manner to provide equal or better biological functions and values compared to "traditional" on-site, in-kind mitigation proposals. In addition, the policy provides that the state shall not require mitigation for sediment dredging or capping actions that result in a cleaner aquatic environment and equal or better habitat functions and values, if the actions are taken under a state or federal cleanup action.

Water Resources Act (Chapter 90.54 RCW) establishes fundamental water resource policies for preservation of Washington State water resources.

State Aquatic Lands Management Laws, Washington State Constitution Articles XV, XVII, and XXVII (RCW 79.90 through 79.96; WAC 332-30), are intended to provide a balance between:

- Encouraging direct public use and access
- Fostering water-dependent uses
- Ensuring environmental protection
- Utilizing renewable resources

The Washington DNR has the authority to lease state-owned aquatic lands. Washington DNR has the responsibility to consider the natural values of the land before leasing it, and Washington DNR has the authority to withhold land from leasing if Washington DNR determines the land has significant natural values.

Growth Management Act (Chapters 36.70A; 36.70.A.150; and 36.70.A.200 RCW) (GMA) requires counties and cities to classify and designate natural resource lands and critical areas (which include "waters of the state"). Additionally, the state's fastest growing cities and counties must adopt comprehensive plans and development regulations regarding land use within their jurisdiction. In particular, each plan must identify land within the jurisdiction that is useful for public purposes, and include a process for citing essential public facilities, including solid waste handling facilities.

State Historic Preservation Act (Chapter 27, 34, 44, and 53 RCW) is a state law to ensure that cultural resources, such as historical and archaeological sites, are identified and protected.

11 REMEDIAL ACTION OBJECTIVES

This section defines the remedial action objectives (RAOs) for each of the source areas identified in the conceptual site model. As discussed in Sections 7 and 8, ten source areas at the Site were identified for potential remedial action for the protection of human health and the environment. The locations of these AOCs are shown in Figure 7-1. Based on discussions with Ecology prior to the demolition of the facility, the presumptive remedy of source removal was selected as the maximum practicable remedial action to address waste materials and impacted soil located within the former manufacturing facility boundaries in accordance with WAC 173-340-360(3)(d). Other former source areas, such as the Vanexco/Rod Mill Building and the SPL Storage Area have been remediated under previous Consent Decrees with Ecology. RAOs specific to the remaining AOCs not being addressed by presumptive remedy are defined in Section 11.2.

11.1 Presumptive Remedy AOCs

As required by Ecology in Enforcement Order 4931 to Evergreen, five of the initial Site AOCs were remediated prior to completion of this RI/FS through source removal activities (as discussed in Section 7). The required remedial actions consisted of the removal of COC-impacted soil, waste, and raw materials. Two additional areas include presumptive remedies to address potential source control issues and will be completed upon receipt of the appropriate regulatory approvals. The remainder of this section describes the RAOs applicable to these areas and summarizes the activities required to demonstrate achievement of the objectives.

In general the RAOs for the Site as they pertain to various COCs include:

1. Protection of human health and the environment from direct contact with COC-impacted media (i.e., soil, waste, raw materials, sediment, and groundwater)
2. Protection of groundwater resources from direct contact with COC-impacted media (i.e., soil, waste, and raw materials)
3. Protection of human health and the environment from potential exposure due to ingestion of surface water affected by COC-bearing groundwater discharging from the Site into the Columbia River
4. Protection of human health and the environment from potential exposure due to ingestion of Site groundwater

5. Reduction of on-site volume or mass of impacted-media containing Site COCs

The presumptive remedies described in Section 7 were developed in accordance with MTCA 173-340-360(3)(d) to achieve the applicable RAOs stated above and were designed to remove source materials to the maximum extent practicable. Selection for these remedies is based on the expectation that soil cleanup levels defined in Section 8.6 would be achieved at a standard point of compliance thus warranting no further action in accordance with WAC 173-340-350(8)(a). Upon completion of source removal within these AOCs, it is anticipated that subsequent groundwater monitoring would indicate compliance with cleanup levels defined in Section 9.5.

11.2 AOC-Specific RAOs

Of the initial 10 AOCs, three require additional evaluation and the development of remedial alternatives to determine the most permanent and cost-effective solution as required in WAC 173-340-350, -360, and -370. They include the Crowley Parcel, the East Landfill, and the PCB-impacted River Sediments. In addition, various sources of fluoride-bearing materials were historically stored on site (as discussed above) and may have impacted Site groundwater prior to removal. Although current groundwater monitoring data indicate that groundwater is not impacted by fluoride outside of areas addressed by the 1992 Consent Decree for the SPL Storage Area, Section 11.2.4 discusses compliance with the relevant provisions of MTCA, thus demonstrating the continued appropriateness of the selected remedy. In general, this section summarizes which of the RAOs defined in Section 11.1 have been achieved and any AOC-specific refinements necessary to develop remedial alternatives that are protective of human health and the environment, use active remedial measures, and are permanent to the maximum extent practicable.

11.2.1 Crowley Parcel AOC

Although several remedial actions have been conducted on the Crowley Parcel, recent soil and groundwater sampling indicate the presence of PAHs, VOCs, and TPH as gasoline, diesel, and heavy oil. Additional remedial actions will likely be required to achieve acceptable cleanup levels. A separate FS was conducted by Crowley Marine's consultant SLR International Corporation (SLR). This document is provided in Appendix B. The Crowley Parcel AOC will not be addressed further in this FS.

11.2.2 East Landfill AOC

In 2004, an engineered, low-permeability cap was constructed to control sources of PAH- and TCE-bearing waste and impacted soil contained within the East Landfill in accordance with the requirements of Agreed Order DE-03-TCPIS-5737. The purpose of the engineered cap was to protect human health by preventing direct contact with waste and eliminating precipitation and run-off infiltration through waste – preventing further impacts to groundwater. The remedial action, performed under the IAWP, was selected and designed to be consistent with the final clean-up of the Site. The IAWP was developed based on the findings of an earlier Focused FS (Hart Crowser 1994b), which evaluated the 'Soil Direct Contact' and 'Groundwater Contact' exposure pathways. The Focused FS developed and evaluated 8 alternatives including natural attenuation, on-site containment, hot spot removal and off-site disposal, in situ stabilization of hot spots, installation of a cutoff trench, and pumping and treating of groundwater. The alternatives were developed to address both TCE and PAH-bearing wastes contained within the East Landfill.

Evidence of the effectiveness of the remedial work performed under the 2003 Agreed Order as a final action is demonstrated in the groundwater monitoring data generated since construction of engineered cap. Post-source control groundwater monitoring down-gradient and in the vicinity of the East Landfill indicates that concentrations of TCE have significantly decreased, particularly:

- Maximum concentrations in the Intermediate Zone have declined by 85% from 4,200 μg/L to less than 650 μg/L
- Maximum concentrations in the Deep Zone have declined by 99% from 2,400 μg/L to less than 10 μg/L

Although TCE levels persist above the groundwater cleanup level, these reductions in the concentrations of TCE and the production of degradation products (e.g., vinyl chloride) demonstrate that:

- Natural attenuation/degradation of TCE is occurring
- The landfill is no longer impacting groundwater as the source of TCE has been effectively isolated

The need for further groundwater remediation at the East Landfill AOC is being addressed separately in a focused remedial alternatives evaluation. Treatment technologies applicable to the development of alternatives to deal with TCE-beargin groundwater beneath the East Landfill are identified in this FS. Screening of the technologies would occur in subsequent documents.

11.2.3 PCB-Impacted Sediment AOC

Sediments of the Columbia River adjacent to the Site are impacted with PCBs at levels that pose a potential threat to human health and the environment. The planned remedial action at the Site to address affected sediment includes a design that is permanent, provides mass removal to the maximum extent practicable, and addresses public concerns. To further evaluate the benefit of the removal alternative, an additional FS alternative will developed that considers in situ containment of sediments above the RAL. These alternatives are compared and contrasted against the MTCA and SMS threshold criteria listed in Section 13.2. These alternatives are designed to meet the RAOs discussed in Section 8 to protect human health, benthic aquatic organisms, and wildlife. Specifically, the preferred remedy must achieve the Site-specific sediment cleanup level as measured on a SWAC-basis.

12 EVALUTION OF REMEDIAL TECHNOLOGY ALTERNATIVES

This section identifies and evaluates remedial technologies relative to their ability to achieve the RAOs defined in Section 11. Remedial technologies appropriate to address fluoride-impacted groundwater are also considered. Technologies are evaluated based on the MTCA threshhold criteria of relative cost, effectiveness, and implementability prior to assembly into Site-specific remedial action alternatives. The evaluation of AOC-specific remedial alternatives is discussed in Section 13.

12.1 General Response Actions

Cleanup technologies are typically organized under General Response Actions (GRAs) that represent different conceptual approaches to remediation. At the Site, six GRAs have been identified to address the various affected media:

- Institutional controls
- Monitored natural attenuation/recovery
- Enhanced natural attenuation/recovery
- In situ containment
- In situ treatment
- Removal and Disposal

Under WAC 173-340-350(8)(b), a preliminary screening of technologies is appropriate to eliminate remedial components that are not technically possible at the site, prior to assembling remedial alternatives. In addition, the rule allows preliminary screening of technologies that clearly do not meet the minimum requirements of WAC 173-340-360 (e.g., threshold requirements) and are clearly disproportionate under WAC 173-340-360(3)(e).

The remedial technology identification and screening process begins by identifying available technologies that do not address Site COCs or are not able to be implemented for technical reasons. These technologies are eliminated at this initial screening stage. Retained technologies are evaluated further and for each affected medium (soil, groundwater, and sediment), cleanup technologies under the same GRA are evaluated relative to one another on the basis of the following three criteria:

- **Effectiveness:** The effectiveness criterion evaluates the technology for its protectiveness and reduction in contaminant toxicity, mobility, or volume. Both short-term and long-term effectiveness are evaluated. Short-term effectiveness addresses the construction and implementation periods. Long-term effectiveness evaluates the technology after the action is in place.

- **Implementability:** The implementability criterion evaluates the technology for technical and administrative feasibility. Technical feasibility refers to the ability to construct, operate, maintain, and monitor the action during and after construction and meet technology-specific regulations during construction. Administrative feasibility refers to the ability to obtain permits for offsite actions and the availability of specific equipment and technical specialists.
- **Cost:** The cost criterion is used to compare different technologies. Typically, the full cost of a given technology cannot be determined at this screening level; however, knowledge of typical technology costs obtained from vendors, cost-estimating guides, prior projects, and engineering judgment are used to determine the relative cost of a technology compared with similar technologies.

The evaluation of applicable remedial technologies for each GRA is described below for soil, groundwater, and sediment media. Note that some technologies are classified under multiple GRAs and may be screened differently depending on the intended use. For example, while groundwater pumping can be applied with the objective of either hydraulic containment or removal of contaminants from an aquifer, it is generally more effective as a hydraulic containment measure for typical sites.

Technologies that pass the screening evaluation are assembled into remedial alternatives. When two or more similar technologies are available, or process options are identified within a given technology, a single technology/process option is typically carried forward. For example, various proven and equivalent treatment methods may be available to support a pump and treat alternative to address VOC-impacted groundwater, such as ex situ air stripping or activated carbon filtration. Typically when one of more equally effective technologies are available, the most implementable and cost-effective technology/process option is brought forward in the alternative. Selected technologies/process options, specified as ‘retained’, are typically proven technologies so that all remedial alternatives consist of reliable technologies that can be evenly compared. Alternate process options ultimately may be selected for a cleanup action during the remedial design phase, based on design-level evaluation of similar options.

12.2 Institutional Controls

Institutional controls are measures undertaken to limit or prohibit activities that may interfere with a cleanup action or result in exposure to hazardous substances. They may be physical restrictions, such as fences, or legal restrictions, such as use limitations recorded on the property deed.

Examples of institutional controls potentially applicable to this Site include the following:

- Fences and warning signs to control access to the Site or specific areas on the Site
- Deed restrictions recorded regarding the extraction and use of groundwater
- Deed restrictions recorded regarding the future land use and zoning of the property
- Commercial fishing bans
- Health advisories regarding specific activities, such as restrictions on fish consumption and swimming
- Use restrictions and monitoring requirements to prevent disturbance of caps or other engineered controls

All of the above institutional controls are potentially effective at preventing exposure to hazardous substances either as stand-alone measures or as part of a remedial action with engineering controls, are easy to implement, and can be implemented at relatively low cost. Therefore, they have been retained for further consideration.

12.3 Monitored Natural Attenuation/Recovery

Monitored Natural Attenuation/Recovery refers to the strategy of allowing naturally occurring physical, chemical, and biological processes to reduce contaminant concentrations over time. Some natural processes (e.g., sorption of hydrophobic organic contaminants to organic carbon in soil) act as containment mechanisms; others (e.g., biodegradation of contaminants by native bacteria) act as in situ treatment mechanisms. These natural processes can occur in all matrices at a site including water, sediments, soil, and tissue.

In WAC 173-340-200, MTCA defines natural attenuation as, “a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of hazardous substances in the environment.” As discussed in Section 6, these processes may include: natural biodegradation; dispersion; dilution; sorption; volatilization; and, chemical or biological stabilization, transformation, or destruction of hazardous substances. MTCA further states that, “A cleanup action that includes natural attenuation and conforms to the expectation in WAC 173-340-370(7) can be considered an active remedial measure.”

The remainder of this section discusses the natural attenuation/recovery processes specific to the East Landfill and PCB-Impacted Sediment AOCs.

12.3.1 Groundwater Natural Attenuation Processes

VOCs breakdown in the environment through a variety of processes depending upon site conditions and affected media. The primary processes typically include volatilization (i.e., evaporation) and biodegradation in anaerobic and (to a lesser extent) aerobic environments. The anaerobic process is also referred to as reductive dechlorination as the parent VOC (in this case, TCE) is degraded to a non-toxic chemical. Reductive dechlorination occurs when other anaerobic bacteria present in the contaminated media take electrons from organic compounds (the "electron donors") and produce H_2. The dechlorinating bacteria use the electrons in the H_2 to replace chlorine atoms. If site media contain sufficient organic electron donors, this process can proceed until all of the chlorine atoms are removed, and TCE is dechlorinated completely to ethene, a harmless end-product.

Monitored Natural Attenuation (MNA) of VOCs has been implemented as a successful remedial alternative for sites where source control or removal activities have been completed. Sources of Site TCE-bearing wastes have been isolated from the environment through a combination of removal (at North and North 2 Landfills) and isolation capping (at the East Landfill). Groundwater data collected beneath the East Landfill indicate that concentrations of TCE have reduced significantly (over 85 percent) since the construction of the cap over the East Landfill and no TCE exceedances of cleanup levels are observed in groundwater beneath the North and North 2 Landfills.

Groundwater monitoring indicates that the process continues to occur through the production of TCE degradation products such as vinyl chloride. MNA will be used in the development of groundwater remedial alternatives, as the occurrence of such process has already been documented at the Site.

12.3.2 Sediment Natural Recovery Processes

Because sediments are usually both an important sink for chemicals and a potential exposure pathway to organisms, the focus of natural recovery is often on contaminated sediments and the mechanisms that affect them. Monitored natural recovery (MNR) usually includes the following primary mechanisms that affect the surface of the sediment bed:

- Mixing of incoming clean sediment from the water column with site sediment containing chemicals, causing dilution of the chemical concentrations
- Burial of site sediments containing chemicals by incoming clean sediment from the water column
- Degradation of organic compounds within sediments
- Reduction of chemical mobility and/or toxicity by conversion to less toxic forms and/or forms that are more highly adsorbed to site sediments
- Diffusion/advection of chemicals to the water volume (i.e., loss to the water column)
- Transport of sediments containing chemicals and dispersion over wider areas at lower concentrations

As a GRA, MNR provides monitoring to document the presence and effectiveness of natural processes removing or containing Site contaminants (i.e., PCBs). Monitoring of Compliance with the cleanup level may be performed using chemical and/or biological testing. The SMS/MTCA also requires that Ecology review cleanups no less than every 5 years in those cases where impacted media has been left in place without active remedial measures, to ensure the remedy remains protective. Generally, MNR is allowed to occur over a given timeframe and is expected to achieve specified goals within that timeframe. It also includes contingency planning procedures in case sufficient natural recovery is not observed. Such contingency planning might involve a range of activities from additional monitoring to implementing more active remedial technologies. Potential technologies applied under MNR include:

- Characterization and predictive modeling of natural attenuation/recovery processes
- Performance monitoring of sediment to verify model predictions

MNR was evaluated for Site sediments; however, due to physical constraints (the Site is not in a significant sediment accretion zone) MNR is not considered as a practical option for the purposes of this project and was not carried forward as a potentially applicable technology.

12.4 Enhanced Natural Attenuation/Recovery

The natural degradation and recovery processes described in the previous section may be enhanced to shorten restoration timeframes for Site COCs. The following sections discuss the potential enhancements that could be used to reduce the time required to meet various RAOs.

12.4.1 Groundwater ENR

Groundwater data collected at the East Landfill demonstrate that natural attenuation of TCE has been occurring as is evident through the production of degradation products such as vinyl chloride. However, since the initial reduction in TCE concentration after construction of the engineered cap, the degradation rate has been variable. Enhancing the existing Site conditions with agents such as zero-valent iron or anaerobic bacteria work to promote reduction conditions which drive the dechlorination process may be a feasible technology option to potentially speed up groundwater recovery.

Enhanced in situ anaerobic bioremediation involves the delivery of an organic substrate into the subsurface for the purpose of stimulating microbial growth and development, creating an anaerobic groundwater treatment zone, and generating hydrogen through fermentation reactions. This creates conditions conducive to anaerobic biodegradation of VOCs dissolved in groundwater. In some cases, organisms may need to be added, but only if the natural microbial population is incapable of performing the required transformations. Further enhancement could be provided by the introduction of zero-valent iron (ZVI) to assist in maintaining reducing conditions. At some sites, where aerobic conditions are present, air sparging (a technology that introduces air into the affected matrix) may be appropriate; however, since the concept is to enhance the natural processes leading to degradation, conversion to aerobic degradation would not be an enhancement at the Site since natural anaerobic degradation processes are successfully reducing levels of TCE.

Implementation of ENA at the Site may work as a reasonable cost alternative that stimulates the anaerobic degradation of TCE, while maintaining the integrity of the source control cap. An ENA alternative would likely not target the entire zone of VOC-impacted groundwater, but could be positioned down-gradient from the East Landfill to treat groundwater as it migrates towards the Columbia River. Use of ENA in this configuration would help to decrease the mass of TCE entering the river, while having the benefit of reducing potential risks to human health and the environment. In addition, for sites where degradation is occurring naturally and concentrations are close to qualitative risk-based criteria (refer to Section 11.2.2), ENA may offer a more cost-effective method to address groundwater impacts in comparison to complete in situ treatment of TCE. Because the intent is to enhance the natural processes, the potential challenges associated with maintaining conditions favorable for in situ treatment to occur (such as a controlled reducing environment) are minimized. Therefore, groundwater ENA has been retained for further evaluation in the FS.

12.4.2 Sediment ENR

Enhanced natural recovery (ENR) relies on MNR processes but enhances the natural recovery rate with the placement of a nominal 6-inch (15 cm) layer of clean, fine to medium grained sand over sediments that exceed a cleanup level. Placement of this thin layer on the existing sediments facilitates attainment of the cleanup level within the top 10 cm biologically active zone by providing a source of material at sites with low sedimentation rates. Compared with thicker sediment caps, application of thin-layer placement technologies is typically associated with less short-term environmental impact, as existing sediment-dwelling benthos populations are able to migrate through the 6-inch layer with relatively little mortality. ENR would likely provide a cost effective alternative to address low level impacted media at the Site and is retained for further consideration.

12.5 In Situ Containment

In situ containment involves confining hazardous substances in situ through placement of physical barriers or hydraulic controls to disrupt the exposure pathway between a source or affected medium and a receptor. Use of in situ containment technologies typically results in minimal short-term releases of hazardous substances during construction and can provide an effective method of reducing the potential for exposure at a lower cost than other GRAs, such as treatment or removal. The main disadvantage is that containment technologies do not typically result in a reduction in contaminant mass, volume, or toxicity. Potentially applicable in situ containment technologies for soil, groundwater, and sediment are described below.

12.5.1 Soil/Waste Capping

A common method of controlling exposure to wastes and soils containing elevated concentrations of COCs (i.e., above cleanup levels) is to place an engineered cap over the materials. The long-term cap integrity can be maintained through the selection of appropriate capping materials to resist potentially erosive forces, the use of fencing to inhibit entry into the capped area, and implementation of appropriate institutional controls. Where practicable, the placed clean cap materials necessary to achieve adequate cap thickness may be separated from underlying potentially impacted materials with a marker (e.g., geotextile fabric) indicating the cap boundary.

Process options for soil/waste capping include:

- **Permeable Soil Capping**: Placing clean soil on the surface provides a barrier that prevents exposure to underlying soil but allows stormwater to infiltrate. Permeable soil caps implemented without additional measures (e.g., hydraulic controls) would not address the soil-to-groundwater/surface water pathway for soils beneath the cap. Cap thicknesses of 1 to 2 feet are typical in this application, potentially varying based on specific land uses and the presence of existing clean cover materials. These caps are often vegetated to prevent erosion of the protective layer. This type of cap is applicable to areas where PCB-affected soils between 1 mg/kg and 10 mg/kg are contained on site and managed with institutional controls.

- **Low-Permeability Capping**: A low permeability cap, constructed of low permeability soil such as clay or an engineered material such as geosynthetic membranes, asphalt, or concrete, could also be constructed. This cap would not only prevent exposure to underlying soils, but would also minimize stormwater infiltration through potentially impacted materials, thereby reducing mobility of contaminants located in the unsaturated soil zone. Engineered materials could also be used in areas requiring a durable surface, such as high-traffic areas. This type of cap is highly effective in protection exposure from direct contact with COC-bearing media and prevents migration of COCs from waste and soil to groundwater.

Two previous source areas that are being managed on site per previous Consent Decrees (i.e., the Vanexco/Rod Mill and the SPL Storage Area), were successfully capped with low-permeability caps. In addition, an engineered, low-permeability cap was placed over the East Landfill in 2004 and post-construction monitoring well data demonstrates its effectiveness as maximum TCE concentrations have been reduced by approximately 85 percent. As part of the final remedy selection for the East Landfill AOC, the benefits of the low-permeability cap will be re-evaluated in accordance with WAC 173-340-360(3). In addition, PCB-affected sediment with concentrations less than 10 mg/kg will be placed in the North and North 2 Landfills, thus requiring a permeable soil cap. Therefore, both technology options have been retained for further consideration.

12.5.2 Groundwater Containment

Various technologies are generally available to control the movement of groundwater. Groundwater containment may be used to limit the spread of a contaminant plume into adjacent areas of groundwater or to control the discharge of groundwater into an adjacent wetland or surface water. The East Landfill engineered cap controls infiltration of rainwater through waste and prevents migration of COCs to groundwater. Groundwater at the Site within affected-groundwater bearing zones beneath the East Landfill flows toward the Columbia River and discharges at a rate which produces negligible VOC concentrations in surface water adjacent to the Site. However, because some mass will migrate into the Columbia River through non-point groundwater discharge before Site-COCs are completely attenuated, technologies to minimize the potential exposure pathway could be considered.

Groundwater containment technologies may also have applicability in conjunction with a treatment technology to enhance the performance of a remedial action to restore groundwater quality. For example, a vertical groundwater flow barrier could be used with a pump and treat alternative to reduce the inflow of river water to groundwater containment wells. This would have the benefit of reducing the size and cost of operating a groundwater treatment system. The following sections discuss the various methods used to isolate impacted groundwater and the feasibility of effectively implementing the technologies at the Site as stand-alone or support technologies.

12.5.2.1 Vertical Barriers

The mobility of dissolved-phase contaminants in groundwater can be controlled at some sites by installing impermeable vertical barriers across the groundwater flow path. Ideally, the base of a vertical barrier should be keyed into a low permeability layer, such as homogeneous silt or clay aquitard, to form an effective containment barrier. At the Site, the deeper geologic units have higher permeability than the affected groundwater. The Intermediate Zone is underlain by the more permeable Deep Zone, which is, in turn, underlain by the more permeable Aquifer Zone. Vertical barriers would be ineffective at the Site because of the absence of low-permeability soil layers in which to key a vertical barrier. Without a low-permeability layer, COC-bearing groundwater would migrate around or under any vertical barrier installed and would effectively lengthen the timeframes required for natural attenuation processes to reduce TCE concentrations at the Site.

Typical process options include subsurface walls constructed of interlocking, sealed sheetpile sections; grouted columns; or bentonite slurry. These walls would need to extend to a minimum of 70 feet bgs, which is at the limit of constructability of such structures using standard construction methods. Not withstanding the issues associated with the lack of an aquitard key for the bottom of the barrier, construction at the Site between the East Landfill and the Columbia River would be also be difficult due to the close proximity to the sloping riverbank and limited clearance between the landfill liner and the shoreline revetment system. Groundwater extraction wells would also be required to collect groundwater that may mound behind the barrier as it flows in the direction of the Columbia River. This water would subsequently require either on-site treatment or off-site disposal at a permitted facility. In order to avoid installation of extraction wells, the vertical barrier would need to be extended around the entire landfill in order to deflect water migrating from areas up-gradient of the East Landfill toward the Columbia River. Costs of construction of a barrier to completely encircle the landfill would be in excess of tens of millions of dollars – and still not provide full groundwater containment without the low-permeability soil needed for an effective system.

In light of the technical challenges associated with implementing this technology at the Site, the benefit associated with options should also be considered prior to use in a remedial alternative. The overall need for an impermeable vertical barrier at the Site to prevent groundwater migration is low as the short-term risk to human health and the environment from exposure to surface water adjacent to the East Landfill, as discussed in Section 11.2.2, is also low. A vertical barrier alone would not provide any benefit in terms of reduction of TCE mass or treatment of the COC and would not achieve cleanup levels and, therefore, would not meet the threshold requirements under WAC 173-340-360(2)(a).

Therefore, because of the low anticipated effectiveness of this technology at this Site, impermeable vertical barriers as a containment technology have not been retained for further consideration. This screening is further supported by WAC 173-340-350(8)(b) as the costs are clearly disproportionate to the environmental benefits.

12.5.2.2 Groundwater Pumping for Containment

Migration of contaminants dissolved in groundwater may be contained by pumping groundwater from extraction wells or trenches to create a capture zone. The implementability of this technology to completely capture affected groundwater is complex at sites with heterogeneous soils, such as at the East Landfill AOC. The groundwater extraction rate that would be needed to achieve containment at the Site is likely high because of induced flow of river water into the extraction wells. In addition, the geologic units located below the Intermediate Zone (i.e., the primary affected water-bearing geologic unit) are more permeable; therefore, it would be technically infeasible to prevent migration of groundwater from lower layers into the containment extraction wells dramatically increasing the throughput and size of the system. Ideally, extraction wells or trenches would be constructed in the center of the landfill. To avoid compromising the integrity of the East Landfill engineered cap, the containment wells could be constructed at the edge of the cap, but considerable inflow of river water to the wells would occur. The engineered cap prevents direct contact with contaminants and infiltration of precipitation through waste. If the integrity of the cap is compromised, it is likely concentrations of VOCs dissolved in groundwater would increase, as the potential for rain and surface water to migrate through waste and impacted-soil previously isolated by a continuous cap would also be increased.

Groundwater pumping is applicable as a part of a treatment scheme and is discussed in Section 12.7.2. However, groundwater pumping would have limited effectiveness as a containment GRA. Additionally, the restoration timeframe associated with reducing groundwater concentrations beneath the East Landfill to below cleanup levels could be increased in the event the cap is compromised and infiltration through waste occurs. Protection of the East Landfill cap is critical for continued source control for protection of human health with respect to direct contact with Site COCs (including TCE and PAHs) and for long-term protection of groundwater quality. Groundwater pumping for containment alone has not been retained for further consideration; however, groundwater pumping will be retained as an integral part of a pump and treat system.

12.5.3 Sediment Capping

Sediment containment technologies can reduce potential exposure to human and ecological receptors by preventing direct contact with affected sediments and reducing the flux of chemicals into the water column. Capping is a demonstrated remedial technology for containing chemicals in sediments and preventing or reducing the exposure and mobility of those sediment chemicals from their existing location. It is one of the most commonly evaluated and implemented remedial technologies for affected sediments (Palermo et al. 1998a). Exposure potential can be reduced by placing a layer of clean material above potentially affected sediments. Field experience and cap monitoring results have shown capping is technically and operationally feasible and can provide an opportunity for effective and economical sediment remediation, without the risks involved in removing contaminants by dredging (Palermo et al. 1998a and b; Sumeri 1996).

An isolation sediment cap is a designed system that is intended to isolate the chemicals underlying the cap by placing a thicker layer of sand and/or clean sediment and can range from approximately 1 foot to several feet thick, depending on the particular site. This primary isolation layer may be augmented by layers of other materials for various purposes, such as providing habitat or erosion controls on the cap surface (e.g., spawning gravels, cobble, quarry spall, or riprap). Regardless of the particular design, the primary objectives of cap design are:

- Stabilizing the sediment and preventing resuspension, contaminant mobilization, and sediment transport
- Chemically isolating the affected sediment and reducing contaminant flux into the water column
- Physically isolating the affected sediment from benthic organisms (Palermo et al. 1998b).

A sediment cap at the Site would be designed to effectively contain and isolate affected sediments from the overlying point of exposure/compliance. The cap would be designed to be thick enough and of sufficient grain size to maintain its integrity under reasonable worst-case environmental and land use conditions. The engineering basis for sediment isolation cap design is unique for each application and depends on site-specific conditions and project objectives. Several factors are considered in a cap design, such as:

- Amount of erosion protection required to secure the cap in place
- Cap thickness required to prevent the activities of benthic organisms from mixing affected sediment layers with cap material layers (i.e., bioturbation)
- Cap thickness and permeability required to effectively reduce the migration of contaminants (flux) to the water column via advection and diffusion

Design of cap thickness is normally based on a combination of laboratory tests, mathematical models of the various processes involved (e.g., contaminant flux, bioturbation, consolidation, and erosion), field experience, and monitoring data. Surface layers of a sediment cap system would likely be constructed of clean sand or available clean sediment, and could be placed by a number of mechanical and hydraulic methods. An armoring layer may be designed, where necessary, to protect the cap from erosional forces such as wind/wave action (e.g., fetch-generated wind waves or vessel wake), currents (e.g., seasonal high flow), anchor dragging, and fishing activities.

Sediment capping is a proven technology to prevent exposure to affected sediments and could be easily implemented at the Site. It is important to note that capping is often conducted in combination with other technologies such as dredging. In addition, capping can be used in areas where residual contamination remains after dredging either in the area of original concern or in adjacent areas if residuals have dispersed. Subject to a balancing of environmental benefits and cost, caps have the potential to be inexpensive remediation technologies to achieve cleanup levels and therefore have been retained for further consideration for containment of affected sediment.

12.6 In Situ Treatment

A common approach to site remediation is the application of in situ technologies that address contaminant occurrences in the subsurface without removing large volumes of impacted materials. In situ treatment technologies can potentially reduce the concentration, mobility, and/or toxicity of COCs. They can also minimize potential releases of hazardous substances and the amount of waste generated. The disadvantage of many in situ treatment technologies is that their effectiveness is often limited by subsurface conditions (e.g., heterogeneous soil layers) that limit the ability to contact the contaminated zones with injected materials. In addition to proven in situ technologies, there are a number of innovative treatment technologies at various levels of development that may be potentially applicable to the Site. In general, to the extent that in situ treatment technologies for Site COCs have been successfully demonstrated at the field scale, they were considered further in this FS. Potentially applicable, demonstrated in situ treatment technologies to address VOCs in soil, waste, and groundwater and PCBs in sediment are described below.

12.6.1 In Situ Soil/Waste Treatment Options

As previously stated, all on-Site sources of COC-bearing materials have either been excavated and disposed of at an off-site facility or controlled and managed on-site through the construction of an engineered cap. For those areas that are managed on site, groundwater monitoring and cap inspection is performed routinely to ensure the integrity and effectiveness of the engineered controls. Two of the previous source areas (i.e., the Vanexco/Rod Mill and the SPL Storage Area) are in compliance with the requirements of the Consent Decrees lodged in 1992 and 1995. In 2004, a low-permeability cap was constructed to control sources of PAH- and TCE-bearing waste and impacted soil contained within the East Landfill in accordance with the requirements of Agreed Order DE-03-TCPIS-5737. The purpose of the engineered cap was to protect human health by preventing direct contact with waste and preventing precipitation infiltration through waste and migration of mobile contaminants to groundwater.

TCE and PAHs are the primary COCs contained within the East Landfill. Post-construction monitoring well data demonstrates the cap's effectiveness to isolate the waste as maximum TCE concentrations have been reduced by approximately 85 percent and PAH concentrations range from non-detect to an order of magnitude below the groundwater cleanup level Therefore, continued protection of the East Landfill cap is integral to the on-site management of wastes in this area and treatment technologies which require installation vertically through the landfill would significantly compromise the effectiveness of the source control cap.

Common in situ treatment approaches to treating VOC-bearing wastes include soil vapor extraction (SVE), bioventing, steam stripping, and conductive or radio-frequency heating. These technologies have been successfully implemented on other sites; however, their use at the East Landfill may not be compatible with the need to maintain existing cap which addresses multiple COCs including VOCs and PAHs. For in-situ treatment to be technically feasible and cost-effective, the lateral and vertical extent of the TCE-bearing wastes within the landfill must be well defined. This is not as critical for remedial alternatives that rely upon placement of large area caps or removal of source material with follow-up confirmation sampling. Conducting an investigation to better define the subsurface extent of contamination would require breaking through the geomembrane layers of the engineered cap. The heterogeneous nature of the waste in the East Landfill would require many investigative borings to collect enough samples for adequate definition of the zone of contamination. The presence of recycled concrete and other large obstructions in the waste may prevent boring penetration to the desired sample locations. Additional breaches of the landfill cap would also be required to install vapor extraction wells. Depending upon the permeability of the waste, a tightly-spaced network of extraction or injection wells could be required, which would increase the risk of incidental infiltration caused by improperly sealed well ports through the geomembrane. For these reasons the use of in situ treatment for waste has not been retained as a viable technology for alternatives that include in situ waste containment as a GRA.

12.6.2 In Situ VOC-Impacted Groundwater Treatment Options

This section presents a wide range of situ technologies with a demonstrated level of effectiveness in degrading VOCs in groundwater. Emerging or experimental technologies that have only been evaluated with limited success in treating TCE in laboratory were not considered. In general, in situ treatment technologies have a shared technical limitation, which is related to hydrogeological conditions in the subsurface zone of groundwater contamination. The success of all in situ treatment methods depends upon achieving complete contact of the introduced chemicals or bacteria with the contaminated subsurface soil and groundwater. Most technologies require multiple subsurface applications of introduced materials to be effective at completely degrading a source are to below cleanup levels. Remedial investigations completed to date indicate that the Intermediate Zone soil consists of heterogeneous, silt and sand layers resulting in a non-uniform, low-permeability geologic unit. The follow sections discuss the applicable in situ technologies potentially appropriate to treat VOC-impacted groundwater at the Site.

12.6.2.1 Bioremediation

Bioremediation involves adding amendments to the subsurface that support microbial degradation of contaminants. Anaerobic bacteria have been used to dechlorinate contaminants in groundwater and soil. The bacteria and an electron-donor material are injected into the contaminant plume, where the bacteria metabolize the chlorinated hydrocarbons (that is, the bacteria use enzymes to break the chemical bonds in the contaminant molecules to recover the energy stored in the bonds). Zero-valent iron (ZVI) has also been used successfully in various applications to dechlorinate contaminants such as TCE in groundwater. The process works through the injection of nanoparticles coated with ZVI into the groundwater. Various options for introducing the amendments include phased direct injections, injections into existing or expanded monitoring well networks, and recirculation well networks (discussed in more detail below) have been used to maximize the mixing of reagents and groundwater; however, for this Site directional or horizontal wells would be required to maintain the integrity of the engineered cap during injection events. Based on successes at similar nearby sites, in situ treatment of TCE in groundwater is potentially applicable for affected groundwater in the East Landfill and has been retained for consideration.

12.6.2.2 Air/Bio-sparging

Air or bio-sparging is an in-situ technology that reduces concentrations of VOCs that are adsorbed to soils and dissolved in groundwater. This technology involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone. Because the technology relies on transference of COCs from one media to another (i.e., groundwater to vapor), air sparging is most often used together with SVE, but it can also be used with other remedial technologies. When air sparging is combined with SVE, the SVE system creates a negative pressure in the unsaturated zone through a series of extraction wells to control the vapor plume migration. The extracted groundwater and vapor would be treated in an above ground treatment system. The combined air sparging/SVE system would be required at the East Landfill to ensure that escaping vapor would not collect beneath the landfill cover, which could potentially exert enough pressure to damage the geomembrane cap. In general, air sparging is most applicable to sites where the groundwater contamination is primarily in the upper portion of the water table and smear zone as transformed vapor may remain captured in low-permeability deeper zones, such as the Intermediate Zone.

Application of air sparging at the East Landfill AOC has two primary drawbacks in comparison to the in situ bioremediation method described above. Groundwater monitoring data collected since the construction of the engineered cap demonstrate that degradation of TCE is occurring through reductive dechlorination, an anaerobic process. Air sparging would work against the natural system as, depending upon the oxygen injection rate, the process simulates either direct volatilization or aerobic biodegradation. After the air sparging system is shut down, if cleanup levels are not attained, the natural anaerobic processes may or may not resume to degrade the remaining mass dissolved in groundwater. Thus in situ biodegradation would likely have a greater overall benefit to the long-term degradation of TCE in comparison to a process which relies upon aerobic processes.

The second drawback to air sparging over in situ anaerobic degradation is the fact that contaminants are not destroyed upon the initial application, but transferred to a secondary media (i.e., vapor). In situ anaerobic biodegradation destroys the contaminant producing non-toxic by-products. Because a comparably effective technology exists, at similar costs to implement, air sparging has not been retained as a technology for FS evaluation at this time. In the event a pilot test conducted during design of an anaerobic biodegradation treatment indicates that the Site may be more amenable to aerobic methods, then air sparging could be considered during design.

12.6.2.3 Recirculation Groundwater Recovery Wells

Recirculation groundwater recovery wells (RGRW) are designed to establish a subsurface circulation system whereby groundwater is continuously pumped from one portion of the well and injected back out into the aquifer from another portion of the well. Each well has its own circulation system and the wells are designed so that the circulation cells of adjacent wells overlap with each other. RGRW systems can be designed so that groundwater is treated in situ in the well casing by air stripping which required subsequent treatment of the affected vapors. Alternatively a portion of the extracted groundwater can be pumped to an aboveground treatment system where amendments to promote biodegradation are added, which are reinjected into the aquifer and circulated through the groundwater at each well. RGRW systems are constructed of a network of vertical wells. In order to effectively treat the entire source area at the East Landfill, it would require installing several well clusters through the geomembrane cap, which would significantly compromise the effectiveness of the source control cap. In lieu of the availability of other in situ treatment options, RGRW is less practicable because of the need for vertical installation. Alternatively, RGRW systems have been used to capture groundwater as it migrates away from a source zone, much like an interceptor wall. However, as discussed in Section 12.5.2, the overall need for a barrier to prevent groundwater migration is low as the short-term risk to human health and the environment from exposure to surface water adjacent to the East Landfill is low. Therefore, RGRW will not be considered further in the FS.

12.6.2.4 Bioremediation Process Options

In addition to direction injection of amendments to promote biodegradation of COCs, two process options are available for introduction of the amendments that build upon the containment options discussed in Section 12.5.2: permeable reactive barriers (PRB) or funnel-and-gate systems.

- Permeable Reactive Barrier: A PRB is installed across the flow path of a groundwater plume, allowing the water portion of the plume to passively move through the wall. These barriers allow the passage of water while prohibiting the movement of contaminants by employing such agents as zero-valent metals, chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others. As groundwater moves through the PRB, it reacts with the amendments to produce chloride and non-toxic chemicals (i.e., reductive dechlorination occurs).
- Funnel-and-Gate Systems: Funnel-and-gate systems are a modification to the PRB, in that the primary area of the barrier is constructed of low-permeability materials (such as a sealed sheetpile or slurry wall) to serve as a funnel to the permeable ‘gate’ which is impregnated with reactive materials to promote dechorination. Much like the vertical barriers discussed in Section 12.5.2, the

impermeable portions of the wall require a low-permeable geologic layer to key into in order to ensure the affected water will migrate through the reactive zone and not around the wall.

While PRBs and funnel-and-gate systems rely on well-known processes, several drawbacks limit their effectiveness. For example, as the treatment zones age they may lose their reactive capacity, requiring replacement of the reactive medium. In addition, permeability of the reactive zone may decrease due to precipitation of metal salts and biological activity, which results in the plugging of pore spaces that groundwater migrates through. As the pore spaces are reduced, the potential for affected groundwater to migrate around the barrier increases.

In addition to concerns regarding the effectiveness of the technology, implementability must also be considered. At the East Landfill AOC, a PRB would need to be installed between the landfill and the shoreline armoring. Both the landfill cap and the shoreline armoring are anchored into the subsurface soil for stability. The average distance between these anchor points is approximately 20 to 25 feet. Because the PRB would need to extend to a depth of 65 feet bgs or greater in order to intersect the water of the Intermediate Zone while partially keying into the underlying Deep Zone, large construction equipment would be required to excavate the barrier trenches. Based on discussions with contractors who specialize in this type of construction, they concluded that access issues would prevent them from safely installing the barrier and that disturbance of the engineered cap would be required – thus making PRBs impracticable at the Site.

Given that it may be difficult to control the flow of groundwater through the PRB in the long-term, the inability to construct the technology without compromising the integrity of the engineered cap, and that other viable in situ options are available to treat the COC source directly, PRBs have not been retained for further consideration in the FS.

12.6.2.5 ElectroChemical Remediation

ElectroChemical Remediation technology is an innovative technology for destroying organic contaminants in situ by applying an alternating current across electrodes placed in the subsurface. In theory, the applied voltage creates redox reactions that destroy contaminants. The primary advantage of this technology is that it can treat soil (both within the unsaturated- and saturated-zone) and groundwater. The disadvantages are that it has produced mixed results at the field level. Therefore, this technology has not been retained for further consideration since it is not a proven technology at the field scale.

12.6.3 In Situ Sediment Treatment Options

In situ treatment options for sediments are attractive when implementable because they generally alleviate the need for a removal GRA, thus reducing the potential impacts to surface water quality and reducing costs associated with moving and manipulating sediments. Subsurface investigations are critical to the success of these treatment processes and necessary to gain an adequate understanding of the potentially complex depositional history that exist at many contaminated sites. Furthermore, bench-scale and pilot-scale testing is required in nearly all situations to confirm the effectiveness of the selected technology to the site-specific COCs and field conditions. Finally, extensive monitoring programs are necessary to assess the success of the treatment, which also contribute to the overall remedial cost. Given Ecology’s desire to remediate the Site as quickly as possible, alternatives based on technologies requiring additional studies prior to implementation are not feasible and in situ sediment treatment technologies will not be retained for further consideration.

12.7 Removal and Disposal

The removal and disposal GRA includes removing contaminant source material or impacted media from its existing location and treating the material to destroy or immobilize the contaminants or disposing of the material in a new location that minimizes the mobility, exposure, or impacts to human health and the environment. Removed impacted soil, waste, groundwater, and sediments are treated and/or disposed of either on site or at an off-site, permitted disposal facility. In some cases, beneficial use options may exist such as the use of relatively clean dredged sediment as backfill on Brownfield reclamation sites. This GRA has the advantage of providing (where practicable) the greatest removal of contaminants from a site. The main disadvantages include the potential for short-term releases of hazardous substances during removal operations and technical limitations to removing materials below the groundwater table. Potentially applicable technologies for removal and disposal of impacted materials are presented below.

12.7.1 Soil/Waste Excavation

Excavators, backhoes, and other conventional earth moving equipment are the most common equipment used to remove impacted soil and waste from upland areas. Dry excavation of soil below the groundwater table may also be facilitated through the installation of temporary cofferdams and the subsequent lowering of the groundwater table. Dry excavation is a proven method; however, costs associated with dewatering and groundwater drawdown can be excessive and fluids from dewatering would require disposal or treatment prior to discharge. Therefore, dry excavation is retained for removal of waste and upland soils above and just below the groundwater table for the AOCs with a presumptive remedy of source removal. For the East Landfill AOC, sources have been controlled by the installation of a low-permeability, engineered cap in 2004. The subsequent groundwater data collected confirm that the remedial action was effective and is facilitating natural attenuation of impacted groundwater below the landfill. However, in accordance with WAC 173-340-360 and -430, to further demonstrate that this remedial action is an appropriate final action, soil and waste excavation will also be retained to evaluate permanence of East Landfill remedial alternatives that consider the use of on-site containment of TCE-impacted materials beneath an engineered cap.

12.7.2 Groundwater Pumping for Removal

Impacted groundwater can be removed and treated in certain conditions. Low permeability soil formations, highly heterogeneous soil formations, high contaminant concentrations, and contaminants with low water solubility complicate groundwater pumping and can render effective removal of contaminants infeasible. More detailed characterization of the hydrogeologic conditions beneath the East Landfill would be required in order to verify if conditions at the Site are favorable for removal of contaminants by groundwater pumping. One complicating factor is the proximity of the source areas to the Columbia River and the absence of a low permeability layer (discussed in Section 12.5.2) that would be necessary to install an effective barrier between the river and groundwater recovery systems. In the absence of a barrier, the influx of river water would limit the effectiveness of groundwater pumping and make the system very inefficient for removing contaminants. Specifically, a pump and treat system would need to be designed to capture not only the affected groundwater contained with the relatively low-permeability Intermediate Zone, but also the clean surface water infiltrating from the river along the shoreline and through underlying, permeable soil layers.

Technologies for extracting groundwater include:

- **Vertical Wells:** Vertical wells can be installed with carefully placed screen sections to maximize removal of groundwater from targeted zones. The main disadvantage of vertical wells is the potential for incomplete capture of fluids in heterogeneous soils as well as limited radius of influence in low permeability soils. The radius of influence of vertical wells is insufficient to capture groundwater in the existing capped areas without installing wells through the caps. Despite the limitations, vertical wells are a well demonstrated technology for groundwater extraction as well as injection of treated water or injection of reagents for in situ treatment; therefore, vertical wells have been retained for further consideration.
- **Horizontal or Angled Wells**: Directional drilling techniques have been used at cleanup sites to install non-vertical wells that provide access to areas where the surface is inaccessible to drilling rigs. As with vertical wells, horizontal wells have application for groundwater extraction as well as for injection of treated groundwater or reagents for in situ treatment. Horizontal wells have the advantage of providing much greater length of well screen for a single well than a vertical well. Also, since horizontal well screens are placed near the bottom of the saturated formation rather than through the saturated zone, they are less likely to be pumped dry than vertical wells, even in moderately low permeability formations. The primary disadvantage to horizontal wells is that they are expensive to install compared to vertical wells. Horizontal wells have been retained for consideration as an alternative to vertical wells in capped areas.

- **Trenches**: Trenches generally allow more effective capture of groundwater than individual vertical wells by providing an expanded zone of influence (capture). Trenches are typically the preferred method for groundwater collection at sites with heterogeneous subsurface soils and a shallow groundwater table. Ideally, the trench would be placed in the center of the source area which is located beneath the engineered cap; however, protection of the East Landfill cap is integral to continued source control. Section 12.6.2.4 discusses the impracticability of constructing a PRB between the shoreline and landfill. Construction of trench for collection of groundwater would have the same technical challenges and the construction methodology would be similar if not identical. Therefore, trenching has not been retained for further evaluation.

12.7.3 Sediment Dredging

Removal of affected sediments has been widely applied to contaminated sites. Dredging is the general terminology used to describe the removal of sediments with overlying water present, and can be conducted using various techniques generally classified as either hydraulical or mechanical. Removal and disposal of affected sediments has been performed by both methods within the Portland, Oregon, metropolitan region and elsewhere. There are other types of dredges that combine mechanical and hydraulic capabilities or are designed for special purposes, but their use is fairly limited (Stuber and Day 1994), and they are not discussed here.

12.7.3.1 Mechanical Dredging

Mechanical dredges excavate material by using some form of bucket to carry dredge material up through the water column. Mechanical dredges can be classified into ladder, dipper, or bucket dredges. Bucket dredges, specifically clamshell dredges, are the most common type of mechanical dredges. They are typically used in areas where hydraulic dredges cannot work because of the proximity of piers, docks, etc., or where the disposal area is too far from the dredge site for it to be feasible for a hydraulic dredge to pump the dredge material (Hayes and Engler 1986). Mechanical dredges are typically used on projects where dewatering and water quality are an issue. They may be used to excavate most types of material except for the most cohesive consolidated sediments and solid rock.

At the Site, the most appropriate mechanical dredge would be a clamshell bucket and may be operated from a crane, derrick mounted, or a hydraulic-arm excavator from a barge. Mechanically removed sediment retains a density comparable to its in situ density; however, production rates are relatively low compared to hydraulic dredging methods. The material is usually placed in barges or scows for transportation to the disposal area or offloading facility. Although the dredging depth is practically unlimited, because of production efficiency and accuracy, clamshell dredges are usually used in water not deeper than 100 feet. The clamshell dredge usually leaves an irregular, cratered bottom (Herbich and Brahme 1991; Cleland 1997). Water quality impacts are more evenly dispersed throughout the water column in mechanical dredging than in hydraulic dredging, which in turn may result in reductions in water quality through releases of contaminants associated with sediment particles. Potential transfer of contaminants from the dredging area to adjacent water bodies may be minimized in certain applications through the use of best management practices (BMPs) such as specially designed environmental buckets, restricting dredge bucket speed though the water, and removal of residuals from bucket after dumping.

12.7.3.2 Hydraulic Dredging

In hydraulic dredging, sediments are directed into the suction end of a hydraulic pipeline by various methods (e.g., rotating cutterhead) and transported up the water column to the discharge end of the pipeline. The slurry that discharges out of the pipeline has a variable percent solids content by weight. The percent solids can be as low as 2 to 5 percent, but on average is 10 to 15 percent resulting in large volumes of water when compared to mechanical dredging.

Hydraulically operated dredges can be classified into four main categories: pipeline (plain suction, cutterhead, dustpan, etc.), hopper (trialing section), bucket wheel, and side casting (Herbich 2000). Hydraulic dredges are self-contained units that handle both phases of the dredging operations. They not only dig the material but dispose of it either by pumping the material through a floating pipeline to a placement area, or by storing it in hoppers that can be subsequently emptied over the disposal area.

In a hydraulic dredge, the material to be removed is first loosed and mixed with water by cutterheads or by agitation with water jets and then pumped as a slurry (Herbich 2000). Water quality impacts are typically focused on the lower water column at the dredge site and at the discharge end.

At the Site, the most appropriate hydraulic dredge to accomplish dredging and delivery of affected sediments to the disposal site would be a cutterhead dredge. The hydraulic pipeline cutterhead suction dredge is the most common hydraulic dredge used in the United States and is generally the most efficient and versatile. With this type of dredge, a rotating cutter at the end of a ladder excavates the bottom sediment and guides it into the suction. The excavated material is picked up and pumped by a centrifugal pump to a designated disposal area through a 6- to 44-inch pipeline as slurry. The typical cutterhead dredge is swung in an arc from side to side by alternately pulling on port and starboard swing wires connected to anchors through pulleys mounted on the ladder just behind the cutter. Pivoting on one of the tow spuds at the stern, the dredge “steps” or “sets” forward (Herbich and Brahme 1991; Cleland 1997).

Drawbacks associated with hydraulic dredging must be considered. Hydraulic methods produce dredged product that contains approximately 2 to 20 percent solids by weight. This material, once brought upland, must be dewatered prior to transport off site. The volume of water generated is significantly greater than that produced by mechanical dredging methods. The dewatering fluid, which will likely consist of water and PCBs, must either be disposed of or treated on site prior to discharge back to the Columbia River. Because of water quality control requirements and the limited space available in the on-site landfills, hydraulic dredging would require an area to be setup to treat the excess water released as the sediments settle. Costs associated with processing and disposal of this additional waste product are high. For these reasons, only mechanical dredging technologies were retained for further consideration in-water sediment removal.

12.7.4 Disposal Process Options

Depending upon the media and contaminants present, a number of potential disposal technologies are available. This section focuses on technologies for disposal of soil, sediment, and groundwater that are commercially available, are proven, and have been successfully implemented on similar sites. Technologies considered experimental or in stages of demonstration, which would require extensive bench and/or pilot-scale studies prior to implementation at this Site, were not considered.

12.7.4.1 Off-Site Landfill Disposal

A portion of the impacted soils and sediments from the Site may be transported to an off-site, permitted upland disposal facility. Solid waste landfills in Washington are regulated primarily by the Washington Solid Waste Handling Standards (WAC 173-350) and RCRA Subtitle D. Dangerous and PCB wastes are regulated by Washington Dangerous Waste Regulations (WAC 173-303), RCRA Subtitle C, and TSCA. Some of the materials requiring disposal as part of remedial activities may be characterized as hazardous waste, although most of the materials are expected to be non-hazardous solid waste. Off-site landfill disposal provides for secure, long-term containment of hazardous and non-hazardous solid wastes. Therefore, landfill disposal has been retained for further consideration.

12.7.4.2 On-Site Confined Disposal

Excavated soils and dredged sediments meeting applicable cleanup levels could potentially be placed on-site and consolidated at the North and North 2 Landfills. On-site confined disposal can be cheaper than off-site confined disposal, but may require institutional controls or long-term on-site management of impacted materials to control future exposure to contaminants. This disposal technology has been retained for further consideration contingent on design-level evaluation of its implementability and cost. An example of the application of this disposal process option includes the placement of dredged sediments with PCB concentrations less than the industrial cleanup level of 10 mg/kg beneath a vegetated soil cover or asphalt pavement. This GRA process option also provides an additional environmental benefit by reducing impacts associated with transporting materials off-site (i.e., emissions reduction) and also reserves valuable landfill facility space for those wastes that cannot be placed elsewhere.

12.7.4.3 Beneficial Use

Excavated soils or dredged sediments may potentially be beneficially used on-site if they meet applicable cleanup levels. Impacted soils and sediments could be treated to achieve cleanup standards and then beneficially used on-site. An example of a beneficial use process option includes the use of dredged sediment with PCB concentrations less than the unrestricted use cleanup level of 1 mg/kg as bulk fill at the Site. When appropriate, on-site beneficial use is the most preferred and likely the least costly method of soil and sediment disposal. On-site beneficial use of clean sediment also employs Ecology's most preferred cleanup component in terms of long-term effectiveness under WAC 173-340-360(3)(f)(iv). Therefore, on-site beneficial use has been retained for further consideration.

12.7.4.4 Groundwater Disposal

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

- **Discharge to Sanitary Sewer:** In this disposal option, groundwater is discharged to the local sanitary sewer system. Pre-treatment of groundwater may not be required if concentrations of COCs meet discharge criteria. Water containing high concentrations of solids (e.g., from construction dewatering) would likely need to be passed through a settling tank or filter to meet discharge requirements. Fees for disposal of groundwater to the sanitary sewer are based on the volume discharged, and periodic chemical and physical monitoring of discharges are typically required. Allowable discharge volumes may be limited, particularly in the wet season. Because this option may be required to support other groundwater treatment alternatives, it has been retained for further consideration.

- **Discharge to Surface Water:** Extracted groundwater may also be discharged to surface water, although this discharge option would likely require an NPDES permit. Water discharged to surface water would have to meet strict water quality requirements and would likely require treatment before discharge. However, no discharge fee (besides permitting fees) would be incurred. This technology has been retained for further consideration.
- **Reintroduction to Groundwater:** Extracted groundwater may also be discharged on-site to groundwater via infiltration galleries or injection wells. Impacted groundwater would likely require treatment before discharge via this method. This is often the preferred method of disposal for water generated during construction at large sites, when practicable. Sediments dredged from the Columbia River will require dewatering prior to final on-site placement. Infiltration of dewatering fluid is a cost-effective method of treatment; therefore, this technology has been retained for further consideration.

12.7.5 Ex Situ Treatment Process Options

12.7.5.1 Ex Situ Groundwater Treatment

Ex situ groundwater treatment occurs in an aboveground treatment system. Ex situ treatment of dissolved contaminants in groundwater would be a component of an extraction well hydraulic containment system. Potentially applicable treatment technologies for groundwater are described and evaluated below. For each technology discussed, the target COC is also noted. That is, various ex situ technologies are available to treat VOC-affected groundwater, while the secondary treatment options for fluoride are limited to the two options presented. Groundwater would not need treatment for a particular COC if it meets discharge requirements (e.g., if minimally impacted groundwater is extracted as a containment measure). Disposal options for groundwater are discussed in Section 12.6.4.

- **Activated Carbon Adsorption (VOCs):** Adsorption of dissolved organic contaminants onto activated carbon is one of the most widely used water treatment technologies. In this technology, impacted groundwater is passed through a bed of granulated activated carbon, and hydrophobic organic compounds in solution adsorb onto the carbon until the carbon becomes saturated. Advantages of activated carbon adsorption include its proven effectiveness for site COCs, particularly for achieving high treatment efficiencies. Disadvantages include the need to periodically replace the activated carbon and regenerate or dispose of the used carbon. Because of its proven effectiveness, this treatment technology has been retained for further consideration in combination with groundwater removal technologies.

- **Air Stripping (VOCs):** In air stripping implemented as an ex situ technology, impacted groundwater and air are typically passed counter-currently through a tower, and volatile contaminants (such as TCE) transfer from the water to the air. The contaminant-laden air is usually treated by activated carbon and then discharged to the atmosphere. Air stripping can be a cost-effective stand-alone treatment method or can be used to reduce contaminant concentrations in water prior to a final treatment step, such as activated carbon, thereby reducing the use of activated carbon. However, for sites where groundwater dissolved iron concentrations are greater than 0.3 μg/L to 1 μg/L fouling of the system can occur. Site groundwater that would be extracted as part of a potential pump and treat alternative has iron concentrations that range from 0.1 μg/L to 20 μg/L. Under these conditions additional maintenance and cost can be expected to operate such a system. Methods to minimize fouling (which add cost) often include groundwater pretreatment through addition of sequestering agents and biocides or ozone and other strong oxidizing agents; and, increasing or controlling the volume of water treated by the system. Increasing input volumes is problematic at the Site as pumping rates would need to be kept low in order to reduce the volume of groundwater extracted from deeper, more permeable geologic layers and surface water from the adjacent Columbia River. Therefore, this technology, as an ex situ option, has not been retained for further consideration given that an equivalent, more cost-effective and readily implementable option (i.e., activated carbon adsorption) is available.
- **Advanced Oxidation Processes (VOCs)**. A number of technologies exist that involve adding chemicals that directly oxidize organic contaminants in water. Process options include ozonation, hydrogen peroxide (with or

without catalysts such as Fenton's Reagent or ultraviolet light), and permanganate. These technologies can effectively destroy organic chemicals, but treatment costs are generally significantly higher than treatment by activated carbon. Therefore, this technology has not been retained for further consideration.

- **Biological Treatment (VOCs)**. In biological treatment, contaminated groundwater is passed through a biological reactor in which a contaminant-degrading microbial culture is maintained, generally by adding nutrients and oxygen and controlling temperature, pH, and other parameters. Process options include bioslurry reactors and fixed-film bioreactors. Biological treatment has the potential for providing a low-cost treatment method for site COPCs, but would have to be demonstrated in bench-scale and/or pilot tests. Bioreactors are generally most cost effective for large-scale groundwater treatment systems. Potential pump and treat activities at this Site would be limited to the East Landfill and must be compatible with future redevelopment plans restricting the size of a treatment system. Therefore, this treatment technology has not been retained for further consideration.
- **Mineral Precipitation (Fluoride):** Mineral precipitation is the process by which dissolved COCs react with other cations and anions to dissolve and form stable minerals. The treatment of fluoride by mineral precipitation occurs via a process similar to the geochemical reactions described in Section 6.2. However, based on Alcoa's experience at other remediation sites, the use of mineral precipitation alone as a treatment method in full-scale pump and treat systems is ineffective to reduce fluoride concentrations in groundwater to below the 4 mg/L cleanup level. Therefore, has not been retained for further consideration.
- **Reverse Osmosis (Fluoride):** Reverse osmosis is a water treatment technology that is commonly used to treat drinking water. Water with high solute or contaminant concentrations is forced through a semi-permeable membrane to a region of lower concentration by the application of pressure. Thus, the water is moved against the concentration gradient and the contaminant concentrations are effectively reduced. Reverse osmosis is generally more expensive than other methods because pre-treatment is often

required to filter suspended particles. However, this method can effectively treat site COCs, such as fluoride, to the required cleanup levels whereas other methods, such as mineral precipitation, would not achieve the cleanup levels. Because of its proven effectiveness in removing fluoride to the 4 mg/L cleanup level, reverse osmosis has been retained for consideration as a treatment technology to support other process options.

12.7.5.2 Ex Situ Sediment Treatment

Several ex situ treatment options may be applicable for the final disposition of affected sediment at the Site including biological, chemical/physical, and thermal methods. In particular, several physical and thermal methods have proven effective in immobilizing or destroying PCBs adsorbed to sediment; however, costs for small projects are typically 5 to 10 times greater than landfill disposal options. Therefore, ex situ treatment process options for PCB affected sediment were not retained for further consideration.

12.8 Summary of Retained Cleanup Technologies

Technologies applicable to the PCB-impacted Sediment AOC were evaluated using the threshold criteria. As previously stated, screening of technologies applicable to the TCE-bearing groundwater at the East Landfill will occur in a separate document. Based on the detailed evaluation discussed in the above sections, in accordance with WAC 173-340-350(8)(b) and -360(2), the following technologies meet the minimum MTCA threshold requirements and were retained for use in developing remedial alternatives.

- ENR of sediment
- Sediment capping
- Soil capping (permeable and low-permeability)
- Soil excavation
- Mechanical sediment dredging
- Off-site landfill disposal of soil, waste, and dredged sediment
- On-site confined disposal of dredged sediment
- Beneficial use of dredged sediment

13 EVALUATION OF REMEDIAL ALTERNATIVES

This section describes the remedial alternatives assembled from the retained remedial technologies to achieve the RAOs defined in Section 11. This section also provides a comparative evaluation of the various remedial alternatives, to support selection of a preferred cleanup action in accordance with MTCA requirements. MTCA identifies specific criteria against which alternatives are to be evaluated, and categorizes them as either "threshold" or "other" criteria. All cleanup actions must meet the requirements of the threshold criteria. The other MTCA criteria are considered when selecting from among the alternatives that fulfill the threshold requirements. The remedial alternatives are evaluated against the threshold criteria in Section 13.2, and against the other MTCA criteria in Section 13.3.

Although this section is organized to specifically address MTCA evaluation criteria, cleanup action requirements under other ARARs (as summarized in Section 10) are also incorporated into the discussion as appropriate. For example, the guidelines in 40 CFR 230.10(c) regulating discharges to waters of the U.S. were considered in evaluations of short-term risks (e.g., potential for contaminant releases during construction) and the effectiveness over the long term (e.g., potential for long-term discharges to surface water).

The remedial alternatives described in Section 13.1 include process options that have been left intentionally broad at the FS level. Selection between specific remedial process options requires a detailed evaluation that is appropriately performed in the remedial design phase. Detailed analysis of remedial process options, potentially requiring focused treatability testing, would be accomplished during the remedial design phase. For example, the specific method of ex situ treatment to support a pump and treat alternative may be modified during remedial design; however, for the purposes of this alternative the most technically- and cost-effective method was selected for the purposes of evaluating remedial alternatives again the criteria set forth in WAC 173-340-360(3)(e).

13.1 Summary of PCB-Impacted Sediment AOC Alternatives

As discussed throughout this RI/FS, the planned sediment remedial action at the Site includes a design that is permanent and provides mass removal to the maximum extent practicable. In order to comparatively evaluate the benefit of the anticipated removal alternative, an additional FS alternative was developed that considered in situ containment of sediments above the RAL. Because an active remedial measure has been pre-selected for the PCB-Impacted Sediment AOC, the typical No Action alternative was not developed. Details regarding the two alternatives are discussed in following sections and Table 13-1 provides a summary of the GRAs used in each alternative.

Table 13-1
Summary of PCB-Impacted Sediment AOC Remedial Alternative Components

Remedial Alternative	Probable Cost	Institutional Controls	MNR	ENR	Containment	Removal & Disposal	Treatment	Reuse & Recycling
PIS-1	$8M	No	No	Yes	No	Yes	No	Yes
PIS-2	$4M	Yes	No	Yes	Yes	No	No	No

Notes:
1. A typical 'No Action' alternative was not considered for this AOC as an active remedial measure was pre-selected.
AOC: Area of Concern
MNR: Monitored Natural Recovery
ENR: Enhanced Natural Recovery

13.1.1 Alternative PIS-1: Sediment Removal with ENR

The Sediment Removal Alternative (PIS-1) includes excavation/dredging, dewatering, and disposing of impacted sediments; backfilling sand excavation/dredging and over a select portion of adjacent sediments to manage residuals, restore pre-construction grades, and enhance natural recovery; and providing shoreline protection at the Site. Specifically, the alternative would remove approximately 56,000 cy of sediments above the 320 μg/kg RAL and the placement of approximately 60,000 cy of sand. It is anticipated that a portion of the work could be completed during seasonal low river stages from the shore. BMPs such as silt fencing and sand berms would be used as necessary to prevent erosion into the Columbia River and to keep work areas reasonably dry.

During the acceptable in-water, environmental work window (November 1 through February 28), dredging and backfill activities would commence. Turbidity monitoring would occur throughout construction and BMPs would be employed to prevent excessive sediment resuspension and other environmental impacts. Dredging of the hotspot (i.e., material subject to TSCA disposal regulations) would occur first followed by the remaining areas designated for off-site disposal. Material subject to TSCA disposal requirements would be transferred on-site and dewatered prior to being loaded into lined roll-off containers prior to shipment to the presumed off-site disposal facility in Arlington, Oregon. The fluid from dewatering would either be treated on-site and disposed using the existing stormwater system, or it would be transported to an off-site regulated facility for disposal.

Non-TSCA dredge sediment designated for off-site disposal as solid waste may be handled in two ways. Sediment treated as solid waste may be transferred and dewatered on-site using the equipment used to process the TSCA material (after appropriate decontamination procedures are employed) prior to transfer by truck to an upland facility. Alternatively, the material may be transferred by barge, without prior dewatering other than the initial decanting of accumulated free water within the barge, directly to a transfer facility upstream of the Site on the Columbia River.

The next segments to be removed would target the sediment to be disposed of on Site in the North and North 2 Landfills (i.e., sediment less than 10 mg/kg PCBs). This material would be transferred on site and placed within the North and North 2 Landfills footprint where it would be allowed to passively dewater prior to final compaction and covering with a 1-foot soil layer and vegetation. Finally, sediment retained for beneficial use (i.e., sediment less than 1 mg/kg PCBs) would be dredged last, transferred on Site, and stockpiled. The stockpile would be located away from the shoreline and covered to prevent transport of the material back to the affected area prior to final placement as on-site fill.

Upon completion of the work, confirmation sampling would be performed to ensure compliance with the 97 μg/kg cleanup level. Samples would be collected and analyzed individually. The results would then be evaluated on a SWAC basis. In the event compliance is not demonstrated, additional ENR material would be placed and samples re-collected. No additional dredging would be performed.

13.1.1.1 Alternative PIS-2: In Situ Containment of Sediment with ENR

In this remedial alternative, an isolation cap composed of a sand layer beneath an armoring layer would be placed over the affected sediments that are above the RAL (320 μg/kg) at the Site. Capping forms a surface barrier to physically isolate the affected sediments from the aquatic environment. The cap would be designed to effectively contain and isolate the affected sediments from the overlying water column and benthic habitat and prevent contaminant migration through the cap into the surrounding water body. The armor layer would consist of sufficient thickness and grain size to resist long-term erosive forces from mechanical scour, wave action, or burrowing organisms. For sediments above the cleanup level, but below the RAL, an ENR layer consisting of a minimum 6 inches of sand would be placed.

Pending remedial design, the isolation cap would consist of two layers: approximately 1 foot of sand and 2 feet of quarry spall armoring. The 1-foot sand layer (comprised of minimum 6 inches with an allowable overplacement for construction of 6 inches) would be used for the chemical isolation layer to effectively isolate the underlying affected sediments. For this evaluation, it is assumed that imported sand would be required for the capping material. The 2-foot fine gravel/quarry spall armoring layer (comprised of minimum 12 inches of material with an allowable overplacement for construction of 12 inches), would be included at the top of the cap to prevent erosion from wind and vessel-generated wave action, as well as the potential for future propeller wash effects.

For the ENR layer, it is anticipated a total of 1 foot of material may be placed, as the ENR layer design would include a 6-inch overplacement allowance. In addition to local upland sources, ENR material could potentially be obtained from a clean sediment source, such as from regular maintenance dredging operations on the Columbia River, which occurs annually along various reaches of the river. Regardless of the selected sand source, regular QA/QC testing would be performed to ensure compliance with established cleanup levels.

Both the isolation cap and ENR layer would likely be placed using one of four different placement methods, or a combination of these methods:

- Directly placing the cap material at the mudline using a dredge rehandling bucket; the rehandling bucket would grab cap material from a haul barge and lower the material through the water column before opening slightly above the mudline

- Hydraulically spraying the cap material off of the deck of a flat deck barge over the remediation area
- Cracking open a split-hull barge full of cap material while slowly moving it across the remediation area
- Placing the cap material by rehandling cap material from a haul barge into a tremie tube that would extend through the water column to deposit the cap material slightly above the mudline

In each case, the construction method would minimize disturbance of the in situ sediments, as the methods described all entail low-energy placement. In all cases, the armoring layer would be placed using a rehandling bucket to deposit the armor material by opening the bucket at or near the surface of the newly placed cap. All material placement would commence downslope where applicable. All cleanup areas of the Site would be monitored during construction to document compliance with turbidity standards and other permit requirements. Upon completion of the construction, bathymetric surveys would be performed to confirm that the minimum placement thicknesses are achieved and, if necessary, surveys would be verified via core collection. Long-term monitoring and maintenance of the cap would be performed. No dredging or PCB mass removal would occur under this alternative.

13.2 Minimum Requirements for Cleanup Actions

WAC 173-340-360(2) defines the minimum requirements that all remedial alternatives must achieve in order to for selection as a final cleanup action at a site. In this WAC section, MTCA identifies specific criteria against which alternatives are to be evaluated, and categorizes them as either “threshold” or “other” criteria. All cleanup actions must meet the requirements of the threshold criteria. The other MTCA criteria are considered when selecting from among the alternatives that fulfill the threshold requirements.

13.2.1 Threshold Requirements

The threshold MTCA requirements for a selected cleanup action are as follows:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws

- Provide for compliance monitoring

Together, the Site-specific cleanup levels and POCs are referred to as cleanup standards. The overall protectiveness that a cleanup alternative provides depends on its ability to meet cleanup standards for Site COCs. All alternatives are expected to ultimately achieve compliance with cleanup standards and ARARs, although the estimated time required to accomplish such compliance may vary among the alternatives.

Of the proposed alternatives (for each AOC), No Action alternatives generally do not meet threshold requirements because they do not include monitoring to verify compliance with cleanup levels. The remaining alternatives all achieve the threshold requirements, as these alternatives protect human health and the environment, would result in compliance with cleanup levels, and provide for appropriate protection and compliance monitoring. More detailed assessments of restoration timeframes and other relevant MTCA considerations are provided below.

13.2.2 Other MTCA Requirements

Other requirements for evaluating remedial alternatives for the selection of a cleanup action include:

- Use of permanent solutions to the maximum extent practicable [WAC 173-340-360(3)]
- Provide for a reasonable restoration timeframe [WAC 173-340-360(4)]
- Consider public concerns (facilitated by public notice of this RI/FS)

The primary test to determine if a remedial alternative uses permanent solution to the maximum extent practicable is the disproportionate cost analysis. Essentially this analysis ranks the costs and environmental benefits of each of the remedial alternatives against seven criteria to determine the most practicable ‘permanent’ alternative to evaluate and compare the other alternatives to. In the event that two or more alternatives are equally permanent, Ecology shall select the less costly alternative provided the other criteria defined above are met. The disproportionate cost analysis criteria include:

- Protectiveness

- Permanence
- Effectiveness over the long term
- Management of short-term risks
- Technical and administrative implementability
- Consideration of public concerns
- Cost

MTCA also provides specific guidelines for determining a reasonable restoration timeframe. The following factors are to be considered:

- Potential risks posed by the site to human health and the environment
- Practicability of achieving a shorter restoration timeframe
- Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
- Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor migration of hazardous substances from the site
- Toxicity of the hazardous substances at the site
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions

For the PCB-Impacted Sediment AOC, similar evaluation criteria are specified under the SMS ARAR. This comparative evaluation of remedial alternatives was based on quantitative analysis where possible, and included preliminary FS-level cost estimates. For criteria that could not be accurately quantified, a qualitative analysis was performed.

13.3 Evaluation of PCB-Impacted Sediment AOC Alternatives

As discussed in previous sections, an in-water remedy that provides the most permanent and greatest mass removal to the maximum extent practicable will be implemented at the Site. The following section summarizes the evaluation of the Removal (PIS-1) and In Situ Containment (PIS-2) Alternatives, which further evaluate the benefits of dredging at the Site.

13.3.1 Protectiveness

For this Site, both sediment alternatives are expected to provide similar restoration timeframes on a Site-wide basis, as the Alternative PIS-1 is expected to meet the cleanup standard immediately upon construction of the remedy. Typically, dredging alternatives experience a slight lag in cleanup level compliance in comparison to isolation cap remedies as dredging residuals often persist for a short time after the initial remedial action. However, because this project incorporates a sand backfill component to restore pre-construction habitat grades, it is expected that dredging residuals would be managed through attenuation. Both alternatives also include ENR components within identical footprints; therefore, the restoration timeframe would be consistent within those areas. Both alternatives equally satisfy the criteria for a reasonable restoration timeframe and are expected to achieve cleanup levels within months of the start of the remedial action.

13.3.2 Permanence

The permanence of a cleanup action is measured by the degree to which it permanently reduces the toxicity, mobility, or volume of hazardous substances. For example, treatment actions that destroy contaminants (thereby reducing toxicity, mobility, and volume) are considered under MTCA as more permanent than containment actions (which only reduce the mobility). Upon dredging, the sediment would be removed from the affected area and contained upland through a combination of disposal process options. Alternative PIS-2 does not reduce the mass of materials within the deposit, but it does reduce the toxicity and reasonably prevent mobility. The toxicity and volume of PCBs addressed by the Alternative PIS-2 would be reduced over the long term by natural attenuation, although the degradation rate would likely be reduced under anaerobic conditions. Therefore, the Alternative PIS-1 provides a higher degree of permanence in comparison to Alternative PIS-2.

13.3.3 Effectiveness Over the Long Term

Long term effectiveness includes the degree of certainty that the alternative would be successful, the reliability of the alternative during the restoration timeframe, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage remaining hazardous substances. MTCA ranks the following types of cleanup action components in descending order of relative long-term effectiveness:

- Reuse and recycling (and waste minimization under SMS)
- Destruction or detoxification
- Immobilization or solidification
- On-site or off-site disposal in an engineered, lined, and monitored facility
- On-site isolation or containment with attendant engineering controls
- Institutional controls and monitoring

Both Alternatives are effective in managing long-term risk. However, the Alternative PIS-1 relies upon higher ranking, preferred MTCA cleanup action measures, such as beneficial use and off-site disposal, in comparison to Alternative PIS-2, which is composed of in situ isolation and long-term monitoring. In addition, Alternative PIS-2 is subject to unknown future conditions such as changes in hydraulic conditions (i.e., dam flow) and site uses (e.g., potential shoreline development to provide deep water berths). Therefore, the Alternative PIS-1 provides a preferred longer-term benefit.

13.3.4 Management of Short-Term Risks

Management of short-term risks (a.k.a. short-term effectiveness) is the degree to which human health and the environment are protected during construction and implementation of the alternative. The Alternative PSI-1 is likely to have the greater short-term risk associated with water quality impacts; however, due to the coarse nature of the target sediment increased turbidity is expected to be minimal. The upland transfer of sediment for final disposal may also have a potential short-term impact through the potential for spills. BMPs, such as control of dredging rate and spill guards for conveyor systems, are typically employed to address and minimize short-term impact concerns associated with dredging. Therefore, Alternative PSI-2 provides a slightly greater short-term risk management benefit as the alternative provides for minimal disturbance of the affected sediment.

13.3.5 Technical and Administrative Implementability

Evaluating an alternative's technical and administrative implementability includes consideration of the following:

- Potential for landowner cooperation
- Whether the alternative is technically possible
- Availability of necessary facilities, services, and materials
- Administrative and regulatory requirements
- Scheduling
- Size and complexity of the alternative
- Monitoring requirements
- Access for construction and monitoring
- Integration of existing operations with the remedial action

Both alternatives are technically feasible and satisfy the implementability criteria to a high degree; however placement of cap materials in deep water presents a slightly greater challenge to the contractor.

13.3.6 Consideration of Public Concerns

The Draft RI/FS Report will be made available for public review and comment. The degree to which each alternative considers public concerns would be evaluated after public comments are received.

13.3.7 Cost

Estimated costs for the sediment remedial alternatives are summarized in Table 13-1. Cost estimates include design, Ecology oversight, and capital and long-term operation and maintenance costs, but do not include legal costs. Cost estimates are FS level (+50/-30 percent). In general, Alternative PSI-2 is a lower cost solution to achieve the goals of the remedial action. However, Alternative PSI-1 costs are not substantially greater when considerations of future site development are considered. That is, Alternative PSI-1 would not restrict potential long-term development options such as berth construction, which under the Alternative PSI-2 scenario, future redevelopment may require cap removal or placement of additional armoring to ensure stability, thus incurring future capital costs. Therefore, selection of Alternative PSI-2 would likely only provide a short-term cost benefit. Ultimately, costs are a minor consideration because the decision has been made to remove the PCB-impacted sediment to the maximum extent practicable.

13.3.8 Provision for a Reasonable Restoration Timeframe

Both alternatives equally satisfy the SMS criteria for a reasonable restoration timeframe and are expected to achieve cleanup levels within months of the start of the remedial action.

14 RECOMMENDED CLEANUP ACTION ALTERNATIVES

The preceding sections present and evaluate various Site-wide remediation alternatives that represent a wide range of remedial technologies and process options for each of the AOCs. When viewed together, the relative benefits and tradeoffs associated with implementation of different alternatives are apparent.

14.1 PCB-Impacted Sediment AOC Alternative

Alternative PIS-1 – Sediment Removal with ENR was selected as the preferred remedy to address the PCB-impacted sediment because it provides the greatest overall environmental benefit in terms of permanence, long-term risk reduction to human health and ecological receptors, maximum mass removal, reasonable restoration timeframe, and appropriate management of short-term impacts. The remedy also meets the intent of other MTCA goals in taking advantage of beneficial use opportunities.

The alternative includes a combination of dredging to the maximum extent practicable using the RAL defined in Section 9 the placement of a sand backfill to manage dredge residuals, and the placement of an ENR cap layer over the areas that marginally exceed the cleanup level. Construction of the in-water work could potentially undermine the adjacent bank. Prior to dredging, deleterious materials, such as debris and visible industrial waste would be removed and disposed of at an appropriate off-site landfill facility. The remaining bank would be evaluated and oversteepened areas would be regraded and erosion protection would be placed. Existing vegetation would be preserved to the greatest extent possible. This work would occur prior to the in-water work.

During the acceptable environmental work window (November 1 through February 28), dredging and backfill activities would commence. Turbidity monitoring would occur throughout construction and BMPs would be employed to prevent excessive sediment resuspension and other environmental impacts. Dredging of the hotspot (i.e., material subject to TSCA disposal regulations) would occur first followed by the remaining areas designated for off-site disposal. Material subject to TSCA disposal requirements would be transferred on-site and dewatered prior to being loaded into lined roll-off containers prior to shipment to an off-site disposal facility. The fluid from dewatering would either be treated on-site and disposed using the existing stormwater system, or it would be transported to an off-site, regulated facility for disposal. Dredge sediment designated for off-site disposal as solid waste may be handled in two ways. Sediment treated as solid waste may be transferred and dewatered on-site using the equipment used to process the TSCA material (after appropriate decontamination procedures are employed) prior to transfer by truck to an upland facility. Alternatively, the material may be transferred by barge, without prior dewatering other than the initial decanting of accumulated free water within the barge, directly to a transfer facility upstream of the Site on the Columbia River.

The next segments to be removed would target the sediment to be disposed of on Site in the North and North 2 Landfills (i.e., sediment less than 10 mg/kg PCBs). This material would be transferred on site and placed within the North and North 2 Landfills footprint where it would be allowed to passively dewater prior to final compaction and covering with a 1-foot soil layer and vegetation. Finally, sediment retained for beneficial use (i.e., sediment less than 1 mg/kg PCBs) would be dredged last, transferred on Site, and stockpiled. The stockpile would be located away from the shoreline and covered to prevent transport of the material back to the affected area prior to final placement as on-site fill.

Upon confirmation that the minimum required dredge elevations are achieved, backfill would be placed to restore all dredged areas to pre-construction grades. Placement of the 6-inch ENR layer would be sequenced with this work. Confirmation samples would be taken after placement of the ENR layer and backfill to evaluate compliance with the cleanup level on a SWAC basis. During the confirmation sampling event, additional samples would be collected from the upstream reach of the Columbia River to characterize material that may potentially migrate to the Site in subsequent years. In the event the Site is not in compliance, additional ENR material would be placed and the area resampled. As discussed in Section 9.2, initiation of supplemental dredging would not effectively manage dredging residuals; therefore, additional dredging is not practicable and would not be required. In addition, the selected remedial alternative targets the removal of affected sediment to the greatest extent practicable and little remaining mass would likely be present to remove. Upon attainment of the cleanup levels, no additional long-term monitoring would be required as Site sediment would no longer pose a risk to human health or the environment.

As described in Section 2, a significant amount of source control work has been completed at the Site. Any remaining source control issues that exist along the shoreline would be addressed prior to the in-water construction. The current Agreed Order in place for the East Landfill closure requires periodic monitoring (i.e., visual inspection) of the shoreline revetment. As part of the new Consent Decree, it is anticipated that these inspections would continue. In the event shoreline erosion is identified during a monitoring event, appropriate contingency actions would be taken.

14.2 Dike USTs and Soluble Oil Area

The presumptive remedy for the Dike USTs and Soluble Oil Area consists of removal and off-site disposal of the COC-impacted soil, waste, and raw materials. The contaminated material will be removed until the remaining soil meets the Site soil cleanup levels.

The presumptive remedy for the Dike USTs will include removal of the tanks, free product, and impacted soils exceeding the Site cleanup levels. Materials removed from the Site will be disposed of at an appropriate off-site landfill. Removal of the source materials is protective of groundwater and meets the general Site RAOs.

Impacted materials with PCB concentrations greater than 10 mg/kg will be removed from the Soluble Oil Area and disposed of at an off-site location. This presumptive remedy will prevent direct contact with PCB-impacted material above Site cleanup levels. After removal, an appropriate cap will be placed over the area in accordance with MTCA regulations. These actions are protective of groundwater; therefore, no further remediation beyond source removal is required for this area to meet the general Site RAOs.

Selection of these remedies is based on the expectation that soil cleanup levels defined in Section 9 will be achieved at a standard point of compliance, thus warranting no further action in accordance with WAC 173-340-350(8)(a). Upon completion of source removal activities within these AOCs, it is anticipated that subsequent groundwater samples collected from excavations would indicate compliance with cleanup levels defined in Section 9 and no further action would be required.

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