Cleanup Action Plan
Occidental Chemical Corporation, Inc.

605 East Alexander Ave., Tacoma, Washington
Facility Site ID: 1212, Cleanup Site ID: 4326/4330
Dangerous Waste Permit ID: WAD009242314

Hazardous Waste and Toxics Reduction Program
Southwest Regional Office
Washington State Department of Ecology
Olympia, Washington
December, 2023

Document Information

This document is available on the Department of Ecology's Occidental Chemical Corporation, Inc. cleanup site page.[1]

Related Information

- Facility Site ID: 1212
- Cleanup Site ID: 4326/4330
- Dangerous Waste Permit ID: WAD009242314

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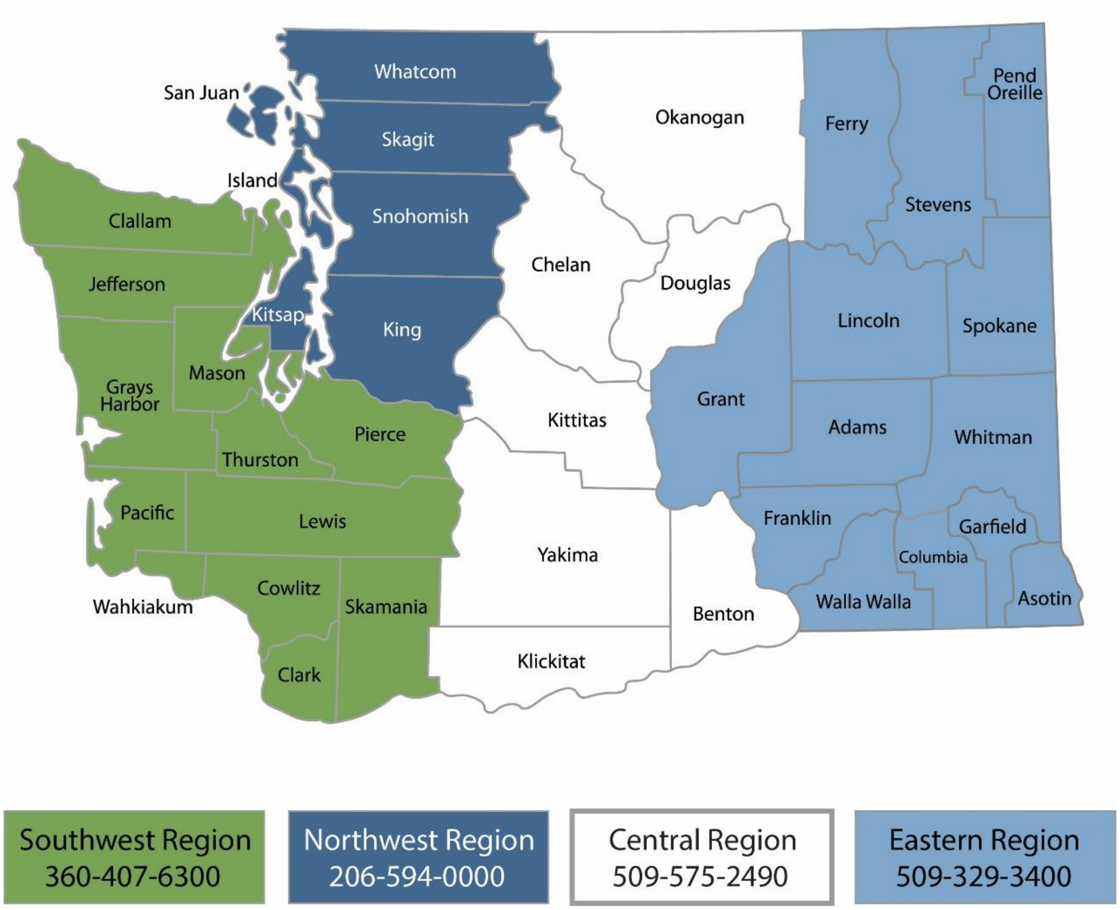
[1] https://apps.ecology.wa.gov/cleanupsearch/site/4326
[2] https://ecology.wa.gov/About-us/Accountability-transparency/Our-website/Accessibility

Department of Ecology's Regional Offices

Map of Counties Served



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List of Acronyms and Abbreviations

AOC	Administrative Order on Consent, as amended in USEPA Docket No. 10-97-0011 CERCLA
ADP	Anthropogenic Density Plume
ALC	Aquatic Life Criteria
AAPTF	Alexander Avenue Petroleum Tank Facilities
ARARs	Applicable, Relevant and Appropriate Requirements
ARF	Army Reserve Facility
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
Bluffs	Puget Sound Bluffs

BML	below mud line
CAP	Cleanup Action Plan
CB/NT site	Commencement Bay Nearshore/Tideflats Superfund site
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
CLARC	Cleanup Levels and Risk Calculation
COC	contaminant of concern or contaminants of concern
CPOC	Conditional Points of Compliance
CRA	Conestoga Rovers & Associates (now GHD)
CSL	Cleanup Screening Level
CSI	comprehensive supplemental investigation
CSM	Conceptual Site Model
CULs	cleanup levels
CVOC	chlorinated volatile organic compound or chlorinated volatile organic compounds
°C	degrees Celsius
DCA	Disproportionate Cost Analysis
dCAP	draft Cleanup Action Plan
DDD	dichlorodiphenyldichloroethane
DDT	dichloro-diphenyl-trichloroethane
DHC	Dehalococcoides
DMMP	Dredged Materials Management Program
DNAPL	dense non-aqueous phase liquids
DOSH	Washington State Department of Labor & Industries (L&I) Division of Occupational Safety and Health
DDE	dichlorodiphenyldichloroethylene
Ecology	Washington State Department of Ecology
EDR	engineering design report
EHEPA	ecological health exposure pathway assessment
EPA	United States Environmental Protection Agency (or USEPA)
ERH	electrical resistance heating
FS	approved Feasibility Study
ft	feet
gpm	gallons per minute
HCB	hexachlorobenzene
HCBD	hexachlorobutadiene
HHEPA	human health exposure pathway assessment
Hylebos	Hylebos Waterway
ICs	Institutional Controls
IQRPE	independent qualified registered professional engineer
ISB	in situ bioremediation
ISCO	in situ chemical oxidation
Kd	soil adsorption coefficient
Mariana	Mariana Properties, Inc.
µg/L	micrograms per liter

μg/m³	micrograms per cubic meter
mg/L	milligrams per liter
MLLW	mean lower low water level
MSP	Mass Reduction by Strategic Groundwater Pumping
MTCA	Model Toxics Control Act
NAAQS	National Ambient Air Quality Standards
NaCl	sodium chloride (salt)
NAVD 88	North American Vertical Datum of 1988
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
NTU	nephelometric turbidity unit
O&M	operation and maintenance
OCC	Occidental Chemical Corporation
Occidental	Occidental Chemical Corporation
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene or perchloroethylene
PDCE	physical direct contact exposure
PLP	Potentially Liable Person
PMI	Port Maritime & Industrial
POC	Points of Compliance
PQLs	practical quantitation limits
PTW	principal threat waste
RAGs	Remedial Action Goals
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	remedial investigation
ROD	Record of Decision
s.u.	standard units of pH
SCR	Site Characterization Report (or Remedial Investigation [RI] Report)
Si	silica
Site	former Occidental Chemical Corporation (OCC) facility located in Tacoma, Washington
SSL	soil screening levels
SVE	soil vapor extraction
SVOC	semi-volatile organic compound or semi-volatile organic compounds
SWMU	solid waste management unit
TCE	trichloroethene or trichloroethylene
TCVOC	total chlorinated volatile organic compound or total chlorinated volatile organic compounds
UIC	Underground Injection Control
U.S.C.	United States Code
US Navy	United States Navy
VC	vinyl chloride
VI	vapor intrusion

VOC	volatile organic compound or volatile organic compounds
WAC	Washington Administrative Code
Waterway	Hylebos Waterway
WISHA	Washington Industrial Safety and Health Act
WMU	waste management unit or waste management units
WQC	Water Quality Criteria
WQS	Water Quality Standards
yrs	years

EXECUTIVE SUMMARY

The Department of Ecology (Ecology) selected a remedy for the former Occidental Chemical Corporation (OCC or Occidental) Site (Site) in this Cleanup Action Plan (CAP). The sources of contamination were the release of solvents and other chemicals from manufacturing operations, and the breakdown of contaminants in the environment. The proposed remedy includes early actions to remove sources of contamination. The remedy also includes extraction and treatment of contaminated groundwater that has migrated beyond the site property boundary. These measures are designed to both remove and contain contamination in order to protect groundwater. A video showing the remedy is available here.

Early Removal Actions to Address Potential Sources of Vapor Intrusion

This remedy includes a series of early actions. The selected remedy features a sequence of actions that remove shallow contamination from groundwater and soil by dewatering the groundwater in soils about 10 feet below surface using shallow extraction wells. The area targeted contains solvents that are treated by the currently operating groundwater treatment plant. Once dewatered, the exposed soils will be treated using soil vapor extraction (SVE). OCC will continue the action until performance standards specified in this CAP are met. If performance standards are not met within a specific time frame additional treatment will be implemented.

The SVE system may include vertical and horizontal pipes, gravel beds, and/or trenches and will be developed and specified during the design phase. Horizontal drilling is an option to access some locations. Groundwater from the dewatering system and vapors from the SVE system are treated using the onsite groundwater treatment facility. Continued periodic monitoring must occur to verify that the system is achieving the performance standards identified in this CAP.

The OCC office building at 605 E. Alexander Avenue will be removed or mitigated within three years of the implementation of the soil and soil vapor early action source treatment, unless early-action source treatment continues and soil vapor concentrations in the vicinity of the office building are meeting or approaching the cleanup levels. Once the early removal action is complete, continued monitoring is required.

Volatile Organic Compound (VOC) Source Area Mass Reduction by Strategic Groundwater Pumping

To address the existing plume of contamination in the shallow and deep groundwater that has travelled beyond the site property boundary the remedy includes extracting shallow and deep groundwater that contain high chlorinated volatile organic compound (CVOC) concentrations. The design of the system at this stage will focus on reversing the direction of the plume to bring contamination back towards the property while reducing contamination. This strategy will remove mass at a higher rate than hydraulic containment alone. The extracted groundwater will be conveyed to a new groundwater treatment plant to be built in a new location on the Site. If necessary, wells will be moved to specific locations to avoid problem areas where high pH and high dissolved silica concentrations cause problems with pumping. When OCC is unable to continue strategic groundwater pumping at specific locations in the remedy design, the remedy will transition to the next phase of hydraulic containment.

Hydraulic Containment

The hydraulic containment element of the cleanup action will control Site groundwater within specified hydraulic control boundaries. The hydraulic containment system must impose an inward hydraulic gradient and perform to a specific set of performance standards. These requirements must be maintained irrespective of aquifer conditions within the control boundaries, including high pH and high dissolved silica concentrations. If it becomes technically infeasible to maintain hydraulic containment at the required performance standard an equivalent level of containment must be achieved and maintained using an alternative technology or approach. These alternative approaches are identified specifically as contingencies in this CAP and are to be implemented using an adaptive management approach with active Ecology oversight.

Vertical Barrier Wall Adjacent to the Hylebos Waterway

To achieve containment of shallow groundwater containing high pH and other sources of contamination a vertical barrier wall will be constructed. The vertical barrier wall will be approximately 2,200 feet long and approximately 70-75 feet deep. Methods for protecting the wall from corrosion will be identified during the design phase. The design will address sea level rise and any identified impacts from climate change or seismic events expected or predicted for the lifespan of the barrier wall.

Cover

A cover will be constructed over the Site property including specific areas with elevated VOC concentrations in shallow soil (i.e., greater than 500 mg/kg) on adjacent properties to prevent potential direct contact with shallow soil contamination. The sloped area between the vertical barrier wall along the Hylebos Waterway and the upland, and the embankment where industrial materials were historically placed, will be backfilled and also be covered. This cover can consist of a membrane liner, reinforced concrete, asphalt, clay soil, or a combination of these materials. The specifications for the cover will be developed in the design phase and documented in the Engineering Design Report (EDR).

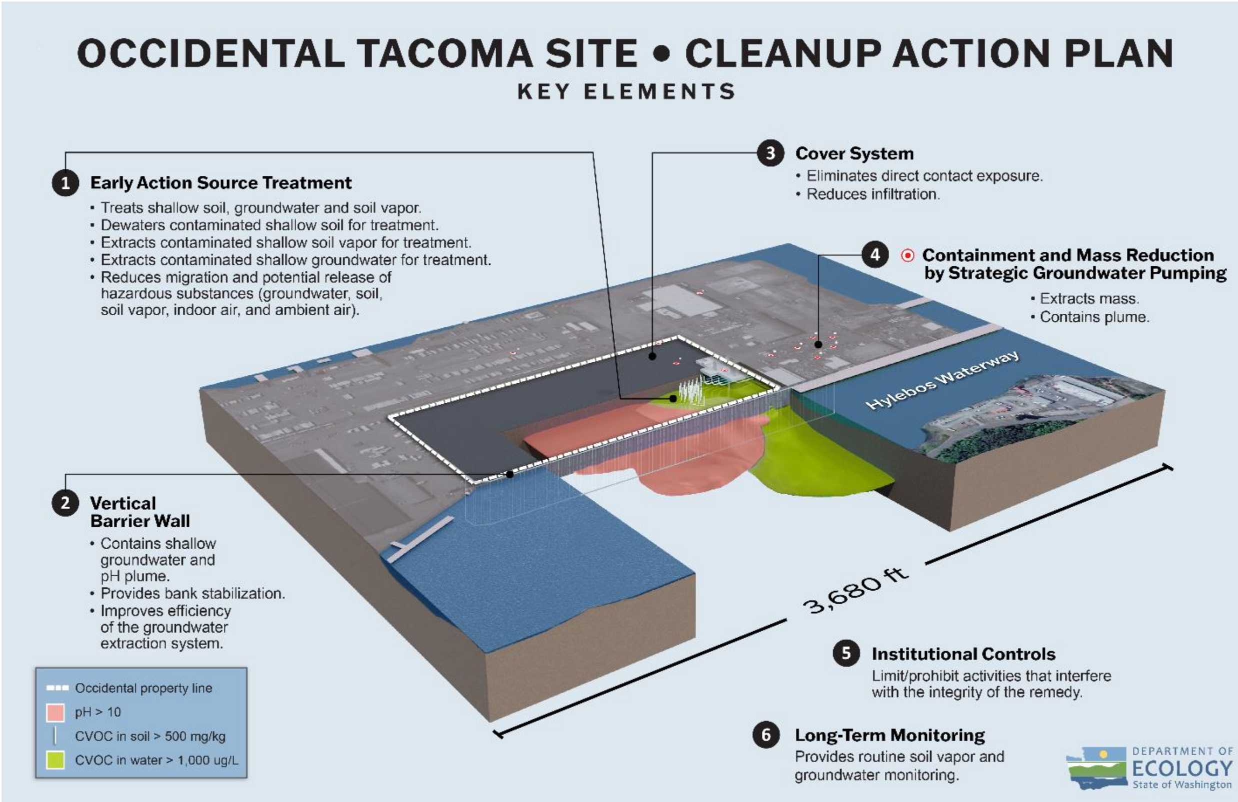
Ex situ- Groundwater Treatment

The existing groundwater treatment plant will be used for treating groundwater and soil vapor from dewatering and vapor extraction activities associated with the early action- source treatment element. A new groundwater treatment plant will be proposed in a new National Pollutant Discharge Elimination System (NPDES) permit application that includes an EDR. Also required is a study to evaluate the expected type and concentrations of constituents that will be sent to the plant for treatment.

Impact of this Action

Ecology is seeking comments on this CAP. Once the comment period is complete a Responsiveness Summary will be developed that responds to the input received. Ecology may choose to move forward with finalizing the CAP, make revisions and finalize as revised, or reevaluate the proposal based on public comment.

Figure A: Cleanup Action Plan Key Elements



1. Introduction and Background of Cleanup Actions

1.1 Purpose

This document is the Cleanup Action Plan (CAP) for the former Occidental Chemical Corporation (OCC or Occidental) Site, located in Tacoma, Washington (Site). OCC operated a former manufacturing facility at the Site (also referred to in this document as Occidental). The general location and layout of the Site is described in Section 2 **Site Description** and is shown on Figures 1.1 and 1.2, respectively. A CAP is required as part of the site cleanup process under Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation. The purpose of the CAP is to identify the proposed cleanup action for the Site and to provide an explanatory document for public review. More specifically, this plan:

- Describes the Site
- Summarizes current Site conditions
- Summarizes the cleanup action alternatives considered in the remedy selection process
- Identifies Site-specific cleanup levels (CULs) and points of compliance (POC) or conditional POC (CPOC) for each hazardous substance and medium of concern for the proposed cleanup action
- Identifies applicable state and federal laws for the proposed cleanup action
- Describes the selected cleanup action for the Site and the rationale for selecting this alternative
- Identifies residual contamination remaining on the Site after cleanup and restrictions on future uses and activities at the Site to ensure continued protection of human health and the environment
- Discusses compliance monitoring requirements, institutional, and engineering controls
- Presents the schedule for implementing the CAP.

The Washington State Department of Ecology (Ecology) made a preliminary determination that a cleanup conducted in conformance with this CAP will comply with the requirements for selection of a remedy under WAC 173-340-360.

Figure 1.1 Vicinity Map

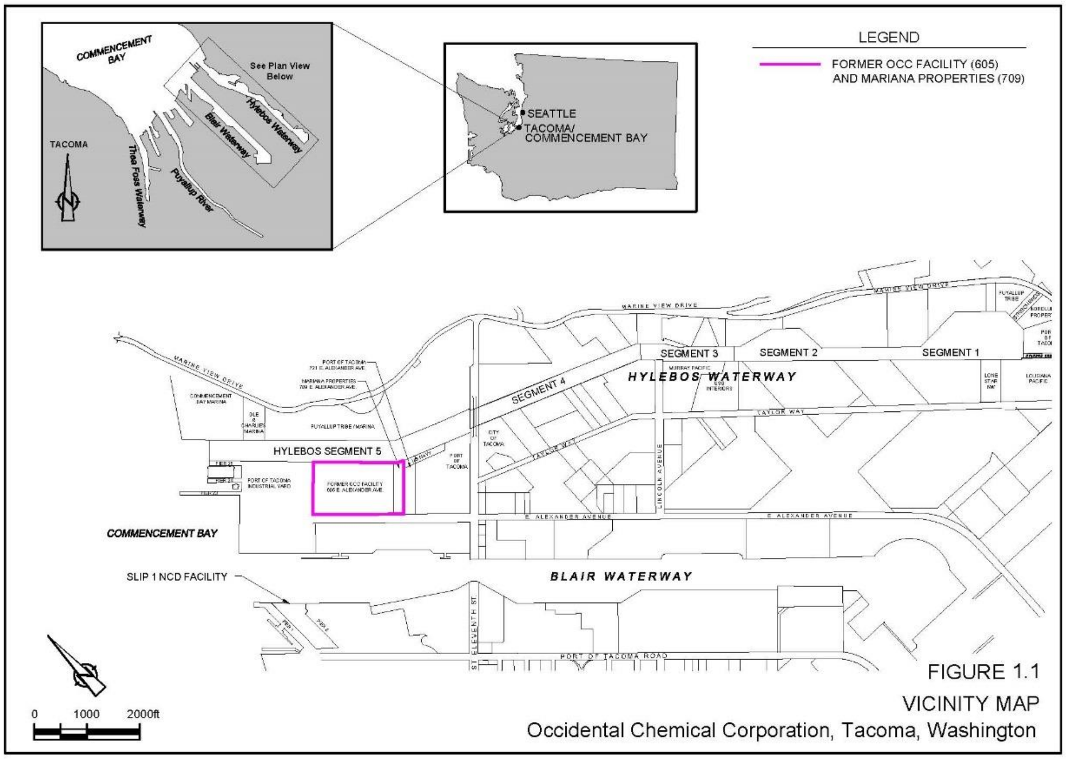
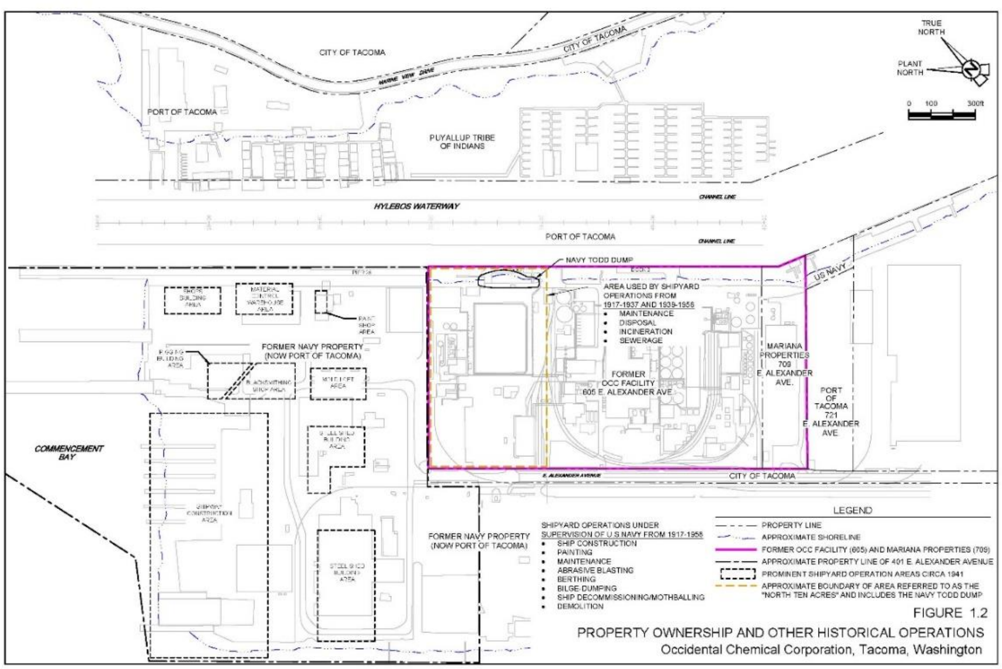


Figure 1.2 Facility Plan View



1.2 Previous Studies

All studies at the Site from 2005 to 2021 were performed by OCC under the oversight of both Ecology and United States Environmental Protection Agency (EPA or USEPA) under an Administrative Order on Consent (AOC), as amended in 2005, in USEPA Docket No. 10-97-0011 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (2005 AOC). The studies have been documented in various reports and deliverables that were reviewed and commented on by both Ecology and EPA. OCC was required to revise the documents before final approval.

The following lists and briefly describes the studies:

- Site Characterization - performed supplemental field investigations and completed the Remedial Investigation (RI) including a Conceptual Site Model. :
- Vapor Intrusion Investigation—performed studies related to possible subsurface vapor intrusion into buildings on and off the Site.
- pH Investigation - performed investigations and studies related to evaluating possible treatment of elevated pH at the Site including most recently research by the University of Washington.
- Sediment and Porewater Investigation—performed field investigations at the bottom of the Hylebos near the Site.
- Feasibility Study (Groundwater/Sediment Remediation) - performed studies related to groundwater and sediment remediation.
- Drain Tile/Embankment Cap Modeling - performed modeling to evaluate the potential for implementing a drain tile and cap along the embankment of the Site.
- Groundwater flow model - developed a comprehensive model for the Site to aid in evaluation of the potential remedial alternatives.
- Groundwater Extraction Demonstration—performed to evaluate hydraulic properties and groundwater chemistry.
- Seasonal Water Level Monitoring—performed to evaluate changes in groundwater levels during annual seasons.

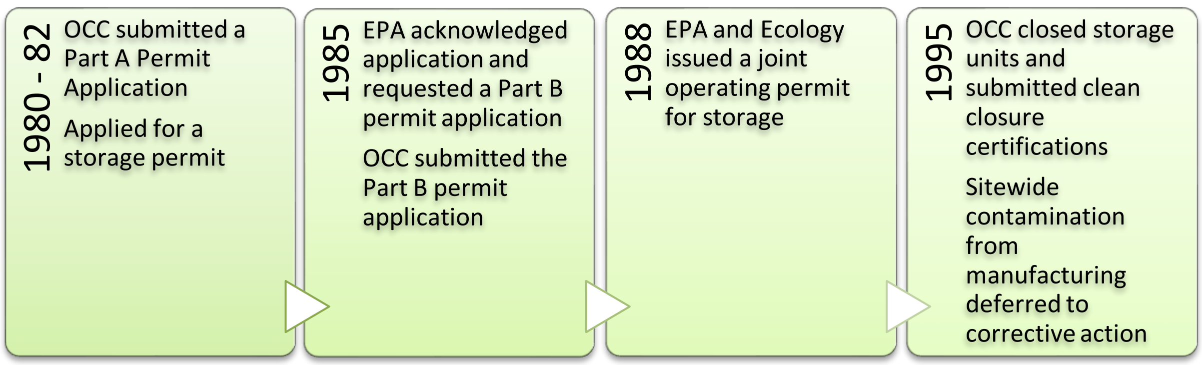
Some of the above activities were not anticipated in the 2005 AOC Statement of Work, but have been defined by OCC, EPA, and Ecology, scheduled consistent with the 2005 AOC activities, and accomplished by OCC under the oversight of EPA and Ecology.

After EPA adopted hazardous waste management regulations in response to the promulgation of the Resource Conservation and Recovery Act (RCRA), Ecology incorporated the new regulations into the Dangerous Waste Regulations, Chapter 173-303 WAC, and obtained authorization to implement the federal program.

1.3 Permit for Waste Storage

OCC submitted a timely application for a permit to store dangerous waste under the Resource Conservation and Recovery Act (RCRA) requirements. Figure 1.3 below illustrates the timeline for OCC's Dangerous Waste Permit during manufacturing operations.

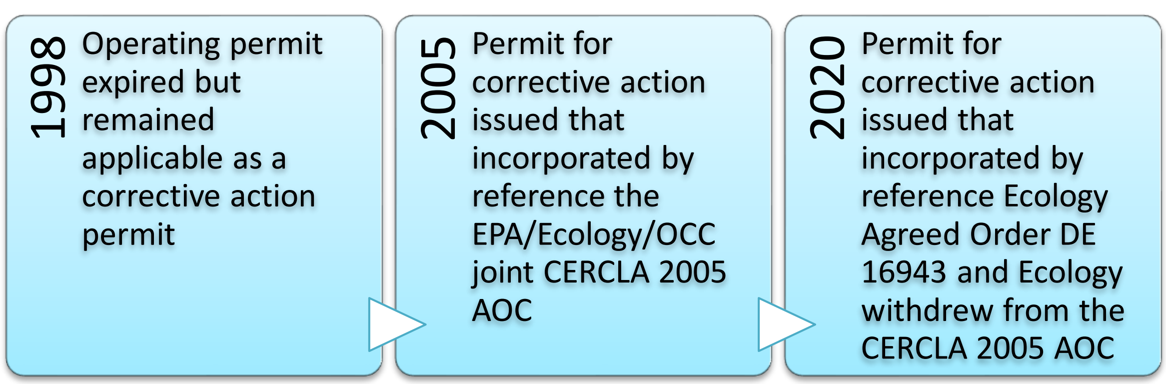
Figure 1.3 Timeline for Dangerous Waste Permit



On November 16, 1988, Ecology and EPA issued a joint operating permit (1988 Permit) for the storage of dangerous waste at the Facility. The permit authorized dangerous waste management in the following units without specific capacity limits:

- Two railcar container storage units in areas referred to as TC1, TC2, and TC3. Wastes authorized to be stored were chlorinated hydrocarbons/sulfuric acid mixture (waste codes K073, D002), decanted chlorinated hydrocarbons (K073), decanted sulfuric acid (D002, K073), and chlorinated hydrocarbons (K073).
- One container drum storage unit authorized to store solid residues from closure and/or spill cleanup of chlorinated hydrocarbons (K073). Spent graphite electrode "blades and butts", mastic, and dross (D008), and contaminated clothing (K073).
- Graphite waste pile building containing spent graphite electrode "blades and butts", mastic, and dross (D008).

Figure 1.4 RCRA Corrective Action Permit History



Closure of the permitted units was accomplished between 1990 and 1995. In May 1990, OCC closed permitted storage areas TC1 and TC3 as well as the graphite waste pile. These units were certified by

OCC to be clean closed, and Ecology approved the certifications in August 1990. Between March and August 1995 OCC completed, and Ecology approved, the certified closure of the remaining units. Ecology also made the determination that site-wide groundwater and soil contamination that remained after closure would be addressed under a corrective action permit.

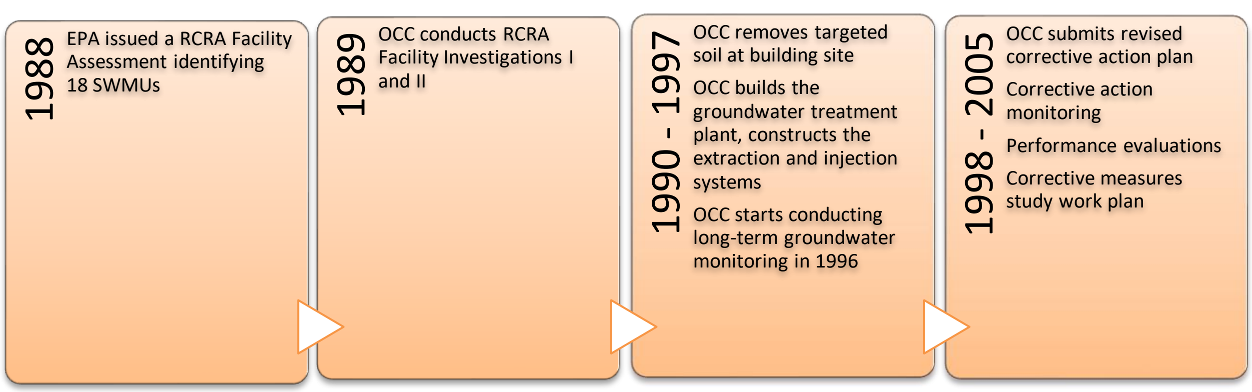
A Part B permit renewal application was received on May 20, 1998, to continue the corrective action requirements after closure of the permitted units. The 1988 Permit expired on November 16, 1998, but remained effective until April 29, 2005, when a permit for RCRA corrective action (2005 Permit) was issued. This permit incorporated by reference the 2005 AOC.

The 2005 Permit expired on April 29, 2015. Corrective action activities continued under the 2005 AOC. A new permit for corrective action was issued on January 1, 2020 (2020 Permit) that incorporated the Corrective Action Agreed Order DE 16943 effective as of December 31, 2019, by reference. Ecology will use its independent corrective action authority as referenced in the regulations within Chapter 173-303 WAC, the Dangerous Waste Regulations, as the legal framework for moving forward with cleanup at the Site.

1.4 EPA and Ecology Corrective Action Oversight

From 1979 to 2005 corrective action was conducted with both Ecology and EPA oversight. In February 1988, EPA issued a RCRA Facility Assessment report identifying 18 solid waste management units (SWMUs) at the Facility.

Figure 1.5 Corrective Action Timeline



After the 1988 Permit was issued, corrective action was addressed under Section V.A. "Corrective Action for Past Practices." The 1988 Permit required OCC to continue investigations already underway, and OCC submitted RCRA Facility Investigation I and II reports in July and October 1989, respectively.

Under the 1988 Permit, OCC addressed upland soil and groundwater contamination. This includes:

- the removal of 750 cubic yards of contaminated soils during construction of the groundwater treatment plant,
- submittal of a corrective action plan and a corrective action monitoring plan,

- analysis of preliminary pumping tests,
- construction and start-up of the groundwater treatment plant.
- the start-up of groundwater extraction and injection systems.

Beginning in 1996, OCC submitted quarterly monitoring event reports under a revised corrective action plan and an updated Corrective Action Monitoring Plan, approved by EPA in October 1998. After the start-up of the extraction system, OCC submitted annual data and performance evaluations. OCC also submitted a Compilation of Soils and Related Data Report in January 1999, and an Annual "Investigation Progress Reports" in December 2000.

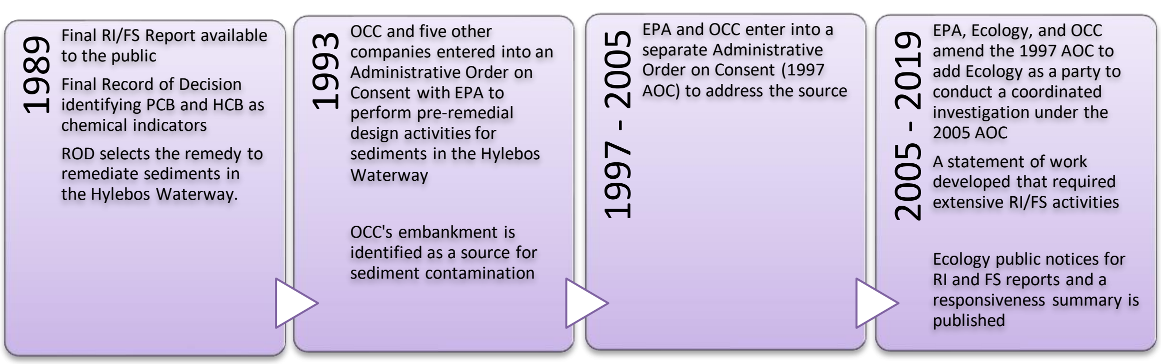
In 2005, Ecology required OCC to submit a work plan for corrective measures study. The work plan was submitted by OCC and approved by Ecology and EPA on February 1, 2005.

The last groundwater monitoring report under the Corrective Action Monitoring Plan was dated May 2009. Ecology formally suspended implementation of the Corrective Action Monitoring Plan in 2013 acknowledging that the plan would be revised when Ecology determined clear objectives for continued groundwater monitoring.

1.5 EPA and Ecology Oversight under CERCLA

CERCLA, commonly known as Superfund, was enacted by Congress on December 11, 1980. This law provides broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. As described below, Site activities have been overseen pursuant to CERCLA, 42 United States Code (U.S.C) Sections 9601 et seq. and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Regulations (CFR) Part 300.

Figure 1.6 EPA Superfund Timeline



Under a Cooperative Agreement with EPA, Ecology conducted a RI/FS of the Commencement Bay Nearshore/Tideflats Superfund site (CB/NT site). Within the Tideflats area of the CB/NT site, the RI/FS evaluated the nature and extent of contamination in the Sitcum, Blair, Milwaukee, Hylebos, St. Paul, Middle, Thea Foss (formerly known as City), and Wheeler-Osgood Waterways. The final RI/FS was made available for public comment in February 1989.

Several chemicals were detected in sediments at the Mouth of the Hylebos Waterway (Hylebos or Waterway), including, but not limited to, polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), trichloroethylene (TCE), tetrachloroethylene (PCE), 1, 2-dichlorobenzene, 1,3-dichlorobenzene, hexachlorobutadiene (HCBD), and lead. On September 29, 1989, EPA issued a Record of Decision (ROD) that selected the remedy for remediation of sediments for Operable Unit 1 (Mouth of the Hylebos and Head of the Hylebos) and sources of contamination (Operable Unit 05 or Segment 5) in the CB/NT site. PCBs and HCB were selected as chemical indicators of biological effects and human health risks at the Mouth of the Hylebos Waterway because these chemicals were found at the highest concentrations over the greatest area.

The ROD for the Hylebos also determined that natural recovery could not sufficiently reduce contaminant concentrations in some areas of the Mouth of the Hylebos Waterway within a 10-year period, so the ROD required active sediment cleanup with one of the four technology options as a component of the remedy.

OCC, along with five other companies or entities identified as potentially responsible parties for the mouth of the Hylebos, performed pre-remedial design activities pursuant to the ROD on the Hylebos Waterway under an AOC with EPA, dated November 25, 1993.

During pre-remedial design activities, organic compounds were detected in sediment adjacent to the OCC property and in the vicinity where barges were historically used for sludge dewatering. Identified as “Area 5106,” concentrations of TCE, PCE, vinyl chloride (VC), HCB, and HCBD were identified as above the sediment quality objectives.

An investigation into the embankment area of the Site, between +18 feet mean lower low water level (MLLW) and 0 feet MLLW, found concentrations of contaminants significantly above the sediment quality objectives, including dichlorodiphenyldichloroethylene (DDE) a pesticide, dichloro-diphenyl-trichloroethane (DDT), PCBs, and semi-volatile organic compounds (SVOCs). Intertidal sampling conducted as part of the pre-remedial design studies also identified chemicals in the intertidal area similar in composition and concentration and on the adjacent PRI Northwest embankment at 709 E. Alexander Avenue.

On November 6, 1997, EPA and Occidental entered into an AOC in USEPA Docket No. 10-97-0011 CERCLA (1997 AOC) to conduct removal actions to abate an imminent and substantial endangerment to the public health, welfare, or the environment presented by the actual or threatened release of hazardous substances at or from the Site.

On February 2, 2005, the 1997 AOC was amended to add Ecology as a Party in order to require compliance with CERCLA, MTCA, and RCRA (2005 AOC), and to conduct additional site characterization for both upland areas and beneath the Hylebos Waterway. The 2005 AOC Statement of Work included determining the nature and extent of soil, groundwater, surface water, and sediment contamination; develop feasible alternatives to address the remaining contamination of all media; and develop an integrated remedy or set of remedies to be selected and designed to satisfy both EPA and Ecology's statutory requirements.

The tasks required by the 2005 AOC Statement of Work were listed as an appendix. The list also included tasks performed by OCC under Ecology and EPA oversight in addition to those specified in the 2005 AOC Statement of Work. An update of this table was included as Appendix C to Agreed Order 16943.

A draft Site Characterization Report (SCR) was submitted to Ecology and EPA on August 29, 2015. This report was a comprehensive compilation and analysis of the investigations and data collected to date. According to the SCR, hazardous substances continue to exist at and beyond the property in the environment including under the Hylebos Waterway, shallow and deep in the groundwater beneath and beyond the Facility, and near and under buildings at the Port of Tacoma "Port Industrial Yard" (now known as the Port's Earley Business Center). The draft SCR (referred to in the public notice as the RI Report) was conditionally approved by Ecology and EPA via letter dated October 11, 2016.

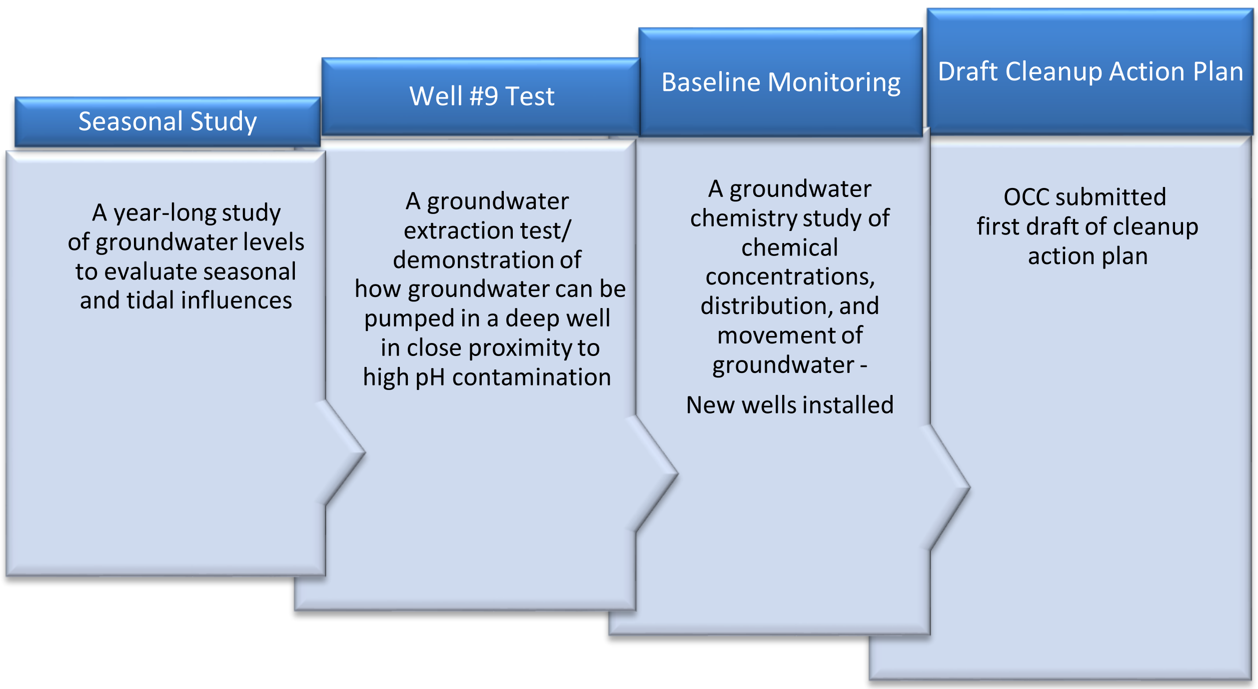
An FS report was submitted to Ecology and EPA for review in January 2017, revised, and released for public comment from January 27 to June 26, 2017.

In 2017, a draft corrective action agreed order and permit for corrective action were posted for public notice along with the FS Report. Comments were considered and responded to in a Responsiveness Summary (Ecology, 2018). EPA was provided the opportunity for review and provide comments to Ecology. The FS Report was amended by Ecology in response to the comments and approved, as amended, by letter dated November 6, 2018. Corrective Action Agreed Order DE 16943 was revised and updated before final signatures by OCC and Ecology. The 2020 Permit for corrective action incorporated Agreed Order DE 16943 (effective as of December 31, 2019) by reference and was issued on January 1, 2020.

1.6 Corrective Action Agreed Order

Agreed Order DE 16943 re-establishes the corrective action process under Washington State's Dangerous Waste Regulations and the MTCA Cleanup Regulation (chapters 173-303 and 173-340 WAC). The groundwater, surface water, soil, and air are subject to the Agreed Order DE 16943, and the sediments are subject to EPA's oversight under the amended 2005 AOC that was signed and effective as of January 2020 (2020 AOC). The corrective action compliance schedule or "Schedule of Work" is included as an attachment to Ecology's Agreed Order in accordance with WAC 173-303-64620(3). Figure 1.7 shows the progression of work by OCC under this compliance schedule.

Figure 1.7. OCC Activities under Ecology's Agreed Order DE 16943



EPA, Ecology, and OCC amended the 2005 AOC in 2020 (2020 AOC) to recognize the separate Agreed Order DE 16943 between Ecology and OCC, and returned EPA focus to potential future actions on sediments. With this amendment, Ecology withdrew from the 2005 AOC. The 2020 AOC provides that OCC will continue to report all Site activities to EPA. Ecology and OCC will continue to provide EPA with opportunities to review and comment upon Site activities as they are considered and accomplished, and Ecology and EPA will continue to coordinate Site activities pursuant to the “Occidental Site Memorandum of Understanding” between EPA and Ecology signed by the agencies in February 2005. The 2020 AOC provides for EPA’s evaluation of the outcome of OCC’s Site cleanup and a determination of whether more sediment cleanup is required.

A water level monitoring program was implemented in 2019 to collect data that describe seasonal changes in water levels at selected existing monitoring wells on the Site. Eighteen existing monitoring wells were equipped with calibrated pressure transducers and data loggers. Water levels were monitored at these locations continuously from September 2019 to October 2020. Data were also collected in the Hylebos Waterway to describe tidal fluctuations. These data describe water levels and water level fluctuations prior to remedy design and implementation.

A thirty-day pumping test was conducted during July and August of 2020 at inactive extraction well EXT-9. The overall objective of this test was to evaluate the feasibility of pumping groundwater in close proximity to areas with high pH and high dissolved silica concentrations. The tests provided data describing how groundwater levels are affected by pumping. These data will be used to estimate the radius of influence for extraction wells. Water quality field measurement data were collected from nearby monitoring wells and from the pumping wells during the thirty-day test. The tests demonstrated that that it is feasible pump groundwater at the Site in close proximity to high pH and high dissolved silica concentration areas in the short term where there is hydraulic separation from the extraction well and the zones of high pH and high dissolved silica concentrations.

Groundwater quality monitoring, and soil vapor and indoor air sampling, were completed in accordance with an approved monitoring plan attached to the Agreed Order DE 16943. The objective of that work is to describe baseline conditions prior to future remedial measures at the Site and to provide information for remedy design. During February and March 2020, eight replacement groundwater monitoring wells and ten soil vapor sampling probes were installed. During October to December 2020, OCC completed groundwater sampling at 66 of the planned 73 groundwater monitoring wells, and completed all of the vapor intrusion sampling. The results of that work were presented to Ecology on May 18, 2021. In September 2021, three new groundwater monitoring wells were installed at the Chinook Marina after gaining property owner access and a permit. Groundwater samples from these wells and a separate shallow groundwater grab sample were collected in September 2021. The results of the groundwater quality monitoring were presented to Ecology in the Baseline Groundwater Monitoring report dated December 29, 2021. For groundwater, one monitoring well nest (three wells at the Army Pier) has recently been installed and the groundwater from these wells will be sampled. Once completed the additional groundwater data will be submitted to Ecology. For vapor initial vapor intrusion sampling was completed in December 2020. On May 21, 2021, OCC submitted a proposal for additional VI sampling. In July 2021, three additional soil vapor sampling probes were installed, and additional vapor intrusion sampling was completed. The results were presented to Ecology in the Baseline Soil Vapor and Indoor Air Monitoring report dated December 29, 2021.

Drafting of this CAP was required by the Agreed Order DE 16943 and was developed in accordance with WAC 173-340-360, selection of cleanup actions, as incorporated by reference into WAC 173-303-64620)(4)(b), corrective action requirements.

This CAP includes Ecology's selected remedy, analysis of alternatives, disproportionate cost analysis (DCA), cleanup levels, and points of compliance. The existing corrective action permit issued to OCC on January 1, 2020 (incorporating by reference Agreed Order DE 16943) will be modified to require OCC to implement the Site remedy selected by Ecology (and will incorporate the final CAP by reference). The current permit expires December 31, 2030. Prior to the expiration date, Ecology will assess whether an updated or new Agreed Order is needed to continue the remediation process, or whether the agency will propose to enter into a Consent Decree. If necessary, Ecology may elect to continue the expired permit until an updated or new Agreed Order or Consent Decree is ready to sign, or whether the existing Agreed Order should stay in place. A new permit will be issued at that time.

2. Site Description

The Site is located on the eastern-most peninsula that extends into Commencement Bay at the mouth of the Puyallup River Valley. The Site is defined in the 2005 AOC and includes areas of ownership and operations of the Port of Tacoma. A vicinity map showing the Site, including the formerly OCC-owned properties and that portion of Segment 5 of the Hylebos Waterway contained within the Site, is presented on Figure 1.1.

A plan showing property ownership is presented on Figure 1.2. The properties formerly owned and/or operated on by OCC or its predecessors include:

605 E. Alexander Avenue property (former OCC Facility currently owned by Mariana Properties, Inc. (Mariana))

709 E. Alexander Avenue property (formerly known as the PRI Northwest and Fletcher Oil facilities, and currently owned by Mariana)

The properties are referred to as the '605 Alexander Ave.' and '709 Alexander Ave.' properties on Figure 1.2. The properties are bounded on the west, north, and south by former Todd Shipyards and/or United States Navy (US Navy) properties (now owned by the Port of Tacoma), and on the east by the Hylebos Waterway.

The Site is located to the north of, and overlaps with, portions of the Alexander Avenue Petroleum Tank Facilities (AAPTF) Site. Ecology Site ID 1377 and Cleanup Site ID 743. The preparation of a dCAP for the AAPTF Site is being conducted under Agreed Order No. DE 9835 among Ecology, Port of Tacoma, and Mariana Properties, Inc.

The Site is within the roughly 12-square-mile area CB/NT site which includes several waterway problem areas and adjoining uplands as described by the CB/NT site ROD (EPA, 1989). The Site includes part of Segment 5 of the Mouth of Hylebos Problem Area where impacted sediments were dredged and disposed from 2003 to 2005 (CRA, 2015), or excavated and capped in 2007 and 2008 (Hart Crowser, 2013). This work was performed under the Mouth of Hylebos Consent Decree (EPA, 2005b).

2.1 Environmental Setting

Regionally, the Site, Puyallup River Valley, and surrounding area are part of the Puget Sound Lowlands, which are surrounded by the Puget Sound Bluffs. The bluffs extend along the sides of the Puyallup River Valley and correspond to the highland areas at the east and west sides of the Port of Tacoma. The bluffs extend upwards from the eastern shoreline of the Waterway to approximately 350 feet (ft) above the Site peninsula.

The peninsula on which the Site is located is man-made and was created in the early 1900s. The Hylebos and Blair Waterways located on the east and west sides of the Site peninsula, respectively, were dredged and the materials were used to build up the land mass (Figure 1.1).

2.2 Land Use

Historical operations at the Site over the past 100 years have included chemical manufacturing; shipbuilding, maintenance, and dismantling; and petroleum and fuel storage and distribution (709 E. Alexander Avenue). The 605 E. Alexander Avenue property was used for chemical manufacturing from 1929 to 2002. The chemical operations primarily involved the production of chlorine and caustic soda, but during various time frames also involved the production of sodium hypochlorite, TCE/PCE, ammonia, muriatic acid, calcium chloride, saturated (hydrogenated) oil, aluminum chloride, and sodium aluminate.

An aerial photograph of the Site is presented on Figure 2.1. Buildings, structures, and pavement including parking lots and access roads cover much of the land surface at the Site.

The Site meets the definition of an industrial property under WAC 173-340-200. There are no residential properties currently existing or planned to be located on or near the Site, and access control fencing ensures access to the property is limited.

The City of Tacoma conducts land use planning under the Growth Management Act. The City has zoned the Site as industrial under the zoning designations of Port Maritime & Industrial District (PMI District) and Port Industrial Area-High Intensity (S-10) (Tacoma, 2018). The S-10 zoning designation applies to the shoreline areas of the Site and the PMI zoning designation applies to the interior of the peninsula. The zoning at the Site is presented on Figure 2.2.

2.3 Groundwater Use

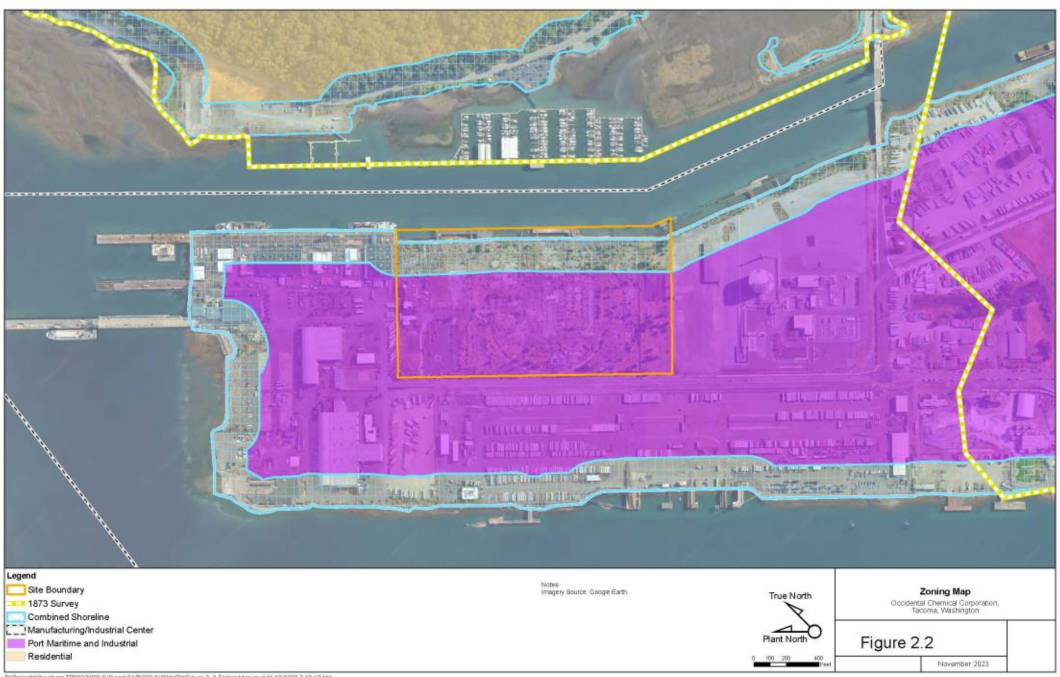
Groundwater at the Site groundwater is naturally non-potable (unfit for human consumption). This non-potability designation is based on two criteria within WAC 173-340-720(2). Ecology has determined that Site groundwater contains naturally occurring saltwater levels, which renders it unfit for human consumption. Because of this Ecology determined that Site groundwater is not a current source or future source of drinking water.

This groundwater non-potability designation means the human ingestion of groundwater exposure pathway does not apply to this Site. The final cleanup remedy for this Site will be based on three potentially complete exposure pathways: 1) groundwater discharge to surface water, which includes marine sediments/aquatic life that may be consumed by humans, 2) vapor intrusion (human inhalation of indoor air), and 3) direct contact with the soil by human activity on the Site.

The following subsections present the regulatory criteria for making this decision in bold followed by Ecology's site-specific analysis under each one.

Figure 2.1 Aerial Site Map and Figure 2.2 Zoning

Figure 2.2 Zoning Map



2.3.1

WAC 173-340-720(2) Groundwater Cleanup Standards - potable groundwater defined. "Groundwater shall be classified as potable to protect drinking water beneficial uses unless the following can be demonstrated:[3]

(a) The groundwater does not serve as a current source of drinking water;"

Groundwater at the Site is not currently used as a source of drinking water.

2.3.2

WAC 173-340-720(2)(b) "The groundwater is not a potential future source of drinking water for <u>any</u> of the following reasons:

(i) The groundwater is present in insufficient quantity to yield greater than 0.5 gallon per minute on a sustainable basis to a well constructed in compliance with chapter 173-160 WAC and in accordance with normal domestic water well construction practices for the area in which the site is located;"

The Site does not qualify for the less than 0.5 gallons per minute (gpm) yield criteria as a site groundwater extraction/treatment system has been in place for some time. The overall yield (~ 100-120 gpm) of this groundwater extraction/treatment system has been hampered by the pH/caustic plume but pumping rates from some individual wells exceed 0.5 gpm.

2.3.3

WAC 173-340-720(2)(b)(ii) "The groundwater contains natural background concentrations of organic or inorganic constituents that make use of the water as a drinking water source not practicable. Groundwater containing total dissolved solids at concentrations greater than 10,000 mg/l shall normally be considered to have fulfilled this requirement; (NOTE: The total dissolved solids concentration provided here is an example. There may be other situations where high natural background levels also meet this requirement.)"

Groundwater at the Site is impacted by naturally occurring salinity intrusion from the surrounding waterways. The Site is located on a man-made peninsula of land between the Blair and Hylebos waterways. Because the Site is on land reclaimed from the sea, the natural state (or occurrence) of underlying groundwater has probably always been more of a fresh/saltwater mix (brackish). Groundwater is not a source of drinking water because it contains natural background concentrations of saltwater which renders it unfit for human consumption. The occurrence and distribution of naturally occurring saltwater were determined using a set of site-specific water quality data that allowed natural saltwater to be distinguished from groundwater that had been impacted by site activities.

Groundwater at the Site contains naturally high total dissolved solid levels (> 10,000 mg/L), which makes it unfit for human consumption. Ideal drinking water has 0 – 50 mg/L total dissolved solid and hard to marginally acceptable water has 200 – 400 mg/L total dissolved solid. Historical OCC operations (pH/Anthropogenic Density Plume) may have biased some of these total dissolved solid levels, but the

[3] See Department of Ecology, memo from Charles San Juan to Kerry Graber, March 6, 2015, "Groundwater Non-Potability Designation, former Occidental Chemical (OCC) Site, Tacoma"

weight of evidence points to groundwater with naturally occurring salinity levels that are unfit for human consumption.

A salt/freshwater equilibrium study conducted in 2013 determined that, in its natural state, the peninsula groundwater is a mix of both freshwater and seawater. There are higher freshwater levels near land surface, however, seawater levels increase over depth. Consequently, in its natural state (high salinity), this groundwater is unfit for human consumption.

2.3.4

WAC 173-340-720(2)(b)(iii) "The groundwater is situated at a great depth or location that makes recovery of water for drinking water purposes technically impossible; and"

The groundwater table at the Site is less than 25 feet deep and a groundwater treatment/extraction system has also been operating for over 20 years so this criterion does not apply.

2.3.5

WAC 173-340-720(2)(c) "The department determines it is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water, as defined in (a) and (b) of this subsection, at concentrations which exceed groundwater quality criteria published in chapter 173-200 WAC.

In making a determination under this provision, the department shall consider site-specific factors including:

(i) The extent of affected groundwater;

(ii) The distance to existing water supply wells;

(iii) The likelihood of interconnection between the contaminated groundwater and groundwater that is a current or potential future source of drinking water due to well construction practices in the area of the state where the site is located;

(iv) The physical and chemical characteristics of the hazardous substance;

(v) The hydrogeologic characteristics of the site;

(vi) The presence of discontinuities in the affected geologic stratum; and

(vii) The degree of confidence in any predictive modeling performed."

Ecology has determined that it is unlikely that hazardous substances will be transported from the contaminated groundwater to current or potential future source of drinking water. The peninsula is bounded by marine water. The closest public supply well (City of Tacoma Tideflats well ACN703; 775 feet deep) is roughly 0.6 miles southeast and upgradient of the former OCC property.

2.3.6

WAC 173-340-720(2)(d) "Even if groundwater is classified as a potential future source of drinking water under (b) of this subsection, the department recognizes that there may be sites where there is an extremely low probability that the groundwater will be used for that purpose because of the site's proximity to surface water that is not suitable as a domestic water supply. An example of

this situation would be shallow groundwaters in close proximity to marine waters such as on Harbor Island in Seattle. At such sites, the department may allow groundwater to be classified as nonpotable for the purposes of this section if each of the following conditions can be demonstrated. These determinations must be for reasons other than that the groundwater or surface water has been contaminated by a release of a hazardous substance at the site.

(i) The conditions specified in (a) and (c) of this subsection are met;

(ii) There are known or projected points of entry of the groundwater into the surface water;

(iii) The surface water is not classified as a suitable domestic water supply source under chapter 173-201A WAC; and

(iv) The groundwater is sufficiently hydraulically connected to the surface water that the groundwater is not practicable to use as a drinking water source."

The Site is located near or within close proximity to surface water, meeting the "Harbor Island" example above. If a site is near or abuts a marine waterway, then you may conclude that there is an "extremely low probability" of future human consumption of groundwater.

Although there is a freshwater lens near land surface, the underlying groundwater is tidally influenced, with much higher salinity levels. While these natural salinity levels vary over depth for the most part levels exceed drinking water standards (e.g. total dissolved solid > 500 mg/L). If a drinking water well was installed on this peninsula the water would have to be treated (desalinization). This would be costly and technically impracticable.

2.4 Site Historical Uses

Site historical uses in the past 100 years have included chemical manufacturing; ship building, maintenance, and dismantling; and petroleum and fuel storage and distribution. Those operations primarily occupied the real properties designated as:

- 401 E. Alexander Avenue (now the Port of Tacoma's Earley Business Center, formerly described as the Port Industrial Yard, the United States Naval Station Tacoma, and Todd Shipyards)
- 605 E. Alexander Avenue (the former OCC Facility now owned by Mariana Properties)
- 709 E. Alexander Avenue (now owned by Mariana Properties and formerly described as the PRI Northwest and Fletcher Oil facilities)
- 901 E. Alexander Avenue (now Port of Tacoma's property, a portion formerly designated as 721 E. Alexander Avenue and formerly described as the Maxwell Petroleum, General Petroleum, and United States Air Force facilities)

Those historical operations have been described in previous Site reports, and are generally summarized below from the text in the FS.

2.4.1 Chemical Manufacturing

OCC's predecessor's chemical manufacturing operations began at the Site in 1929 at 605 E. Alexander Avenue and were continued by OCC and others until 2002. The operations primarily involved the production of chlorine and caustic soda, but during various time frames also involved the production of sodium hypochlorite, TCE/PCE, ammonia, muriatic acid, calcium chloride, saturated (hydrogenated) oil, aluminum chloride, and sodium aluminate. Chlorine and caustic soda production using electrolysis occurred throughout the history of the former OCC Facility. TCE/PCE production occurred from 1947 to 1973, primarily on the North 10 Acres of 605 E. Alexander Avenue. Other production processes occurred for various time periods.

Wastes generated during the various manufacturing processes were managed at 605 E. Alexander Avenue, and included wastewater treatment (settling) ponds, settling barges, landfills, disposal pits, and waste piles. Seventeen SWMUs were historically located on the property.

Chemical manufacturing ceased in 2002, and nearly all buildings and structures at 605 E. Alexander Avenue were demolished between 2006 and 2008. The property continues to be the operations center for the groundwater treatment and containment systems installed by OCC and operated since 1996.

2.4.2 Building, Maintenance, and Dismantling of Ships

Shipbuilding began at the Site at least as early as World War One, with the establishment of the Todd Shipyards facility at 401 E. Alexander Avenue and on a portion of 605 E. Alexander Avenue (the portion described as the North 10 Acres). Shipbuilding by Todd Shipyards and by the United States occurred in those locations during both World War One and World War Two. The North 10 Acres of 605 E. Alexander Avenue was used during World War Two for the gathering and incineration of shipyard wastes, among other activities, and in 1945 became the location of the "Navy Todd Dump" on the shoreline of the Hylebos Waterway.

The Todd Shipyards facility subsequently became the United States Naval Station Tacoma where ships were stored, maintained, and dismantled until the 401 E. Alexander Avenue property was acquired by the Port of Tacoma from the United States.

Since 1960, numerous tenants' operations have included additional shipbuilding and dismantling. In connection with the historical ship-related activities, other industrial activities such as waste landfilling, incineration, and disposal occurred along the shoreline and in the uplands.

2.4.3 Petroleum and Fuel Storage Distribution

The petroleum and fuel tank farm facilities located at 709 E. Alexander Avenue and 901 E. Alexander Avenue operated from approximately the 1930s to the 1980s. Those historical operations resulted in an area of contaminated soil and groundwater at those and adjacent properties currently being addressed under Ecology oversight as the AAPTF Site and Agreed Order DE 9835 by the Port of Tacoma and Mariana Properties, Inc. The 709 E. Alexander Avenue property also includes an embankment fill area along the Hylebos Waterway shoreline that was associated in part with the former chemical manufacturing operations at 605 E. Alexander Avenue. The 709 E. Alexander Avenue embankment, as well as the 605 E. Alexander Avenue embankment, are being addressed as part of the Site.

2.5 Potential Sources of Contamination

Contaminants of concern (COCs) were established in the development of the RI for the Site based upon historical processes, investigations and characterizations as part of the requirements under the CERCLA 2005 AOC. The COCs were presented in the RI and FS reports for groundwater, porewater, soil (unsaturated and saturated), sediment, and indoor air. CULs are proposed for the COCs for soil, groundwater, porewater, and air (indoor air and soil gas). Performance of the selected remedy components will be monitored and evaluated based on the CULs.

Investigations were conducted throughout the Site to define the nature and extent of impacts. The chemical characterization of soil, groundwater, porewater, and sediment is based upon the analytical data obtained during the various investigations summarized in the approved RI Report (CRA, 2015) and Anchor Report (Anchor QEA, 2016).

Past operations at the property generated wastes that were managed on the property. Waste management practices included wastewater treatment (settling) ponds, settling barges, landfills, disposal pits, and waste piles. In total, 17 SWMUs were historically located at the property, in addition to the Navy Todd Dump. Detailed discussions of the SWMUs and the chemicals associated with them were presented in the RI Report approved on October 11, 2016 (Ecology, 2016).

Environmental investigations at the Site began in the 1980s and show that the following parameters are the principal COC:

- CVOCs
- Fuel-related VOCs
- Caustic (sodium hydroxide)
- Salt (sodium chloride or NaCl)
- Metals (arsenic, chromium, copper, lead, mercury, nickel, thallium, zinc)
- SVOCs (HCBD, which is a by-product of solvent production)
- PCBs
- Dioxins/furans

The principal COC were either used, produced, generated, and/or stored in various locations on the property. In addition, some wastes generated in the production processes were managed on Site. Key "potential source areas," where the majority of releases are thought to have occurred, are listed below and described more fully in the RI Report approved on October 11, 2016.

The metals listed above as principal COCs were not likely used in the former OCC operations on the property, but some of those metals were used in former ship building, maintenance, and dismantling operations. Geochemical conditions created by the release of caustic and brine (dissolved NaCl), and reducing conditions in groundwater, have resulted in the mobilization of some of these metals in the subsurface.

The PCBs listed above as a principal COC were used in and generated by the shipbuilding, maintenance, and dismantling operations on the property. PCBs were not likely used in the former OCC operations other than in electrical equipment (such as transformers and capacitors).

The dioxins/furans listed above as a principal COC were used in and generated by the ship building, maintenance, and dismantling operations. Dioxins/furans were not likely used in the former OCC operations other than potentially in spent graphite anodes used in chemical production, and in overheated electrical equipment (such as transformers and capacitors) containing PCBs.

Table 2.1 Contaminants of concern	Ground-water	Pore-water	Un-Saturated soil	Saturated soil	Sediment	Indoor air
VOCs						
1,1,2,2-Tetrachloroethane	√	-	-	√	NA	-
1,1,2-Trichloroethane	√	-	-	√	NA	-
1,1-Dichloroethene	√	-	-	√	NA	-
Carbon tetrachloride	√	-	√	√	NA	√
Chloroform(Trichloromethane	√	-	√	√	NA	√
Ethylbenzene	√	-	NA	NA	-	√
Methylene chloride	√	-	-	√	NA	-
Tetrachloroethene	√	-	√	√	-	√
cis-1,2-Dichloroethene	√	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	-	-	-	√	NA	-
Trichloroethene	√	-	√	√	NA	√
Vinyl chloride	√	√	√	√	NA	√
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	-
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	√
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	√
Benzene	-	-	-	-	NA	√
m&p-Xylenes	-	-	-	-	NA	√
Naphthalene	-	-	-	√	NA	√
o-Xylene	-	-	-	-	NA	-
Styrene	NA	NA	NA	NA	NA	-
Toluene	-	-	-	-	NA	-
SVOCs	Ground-water	Pore-water	Unsaturated Soil	Saturated Soil	Sediments	Indoor Air
1,2,4-Trichlorobenzene	NA	-	NA	NA	-	√
bis(2-Ethylhexly)phthalate	NA	-	NA	NA	-	√
Hexachlorobutadiene	√	-	√	√	-	√
Hexachlorobenzene	√	-	√	√	-	NA
Pentachlorophenol	√	-	√	√	-	NA
Acenaphthene	-	-	-	-	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA
Anthracene	-	-	-	-	NA	NA
Benz(a)anthracene	-	-	√	√	NA	NA
Benzo(a)pyrene	-	-	√	√	NA	NA
Benzo(b)fluoranthene	-	-	√	√	NA	NA
Benzo(k)fluoranthene	-	-	√	√	NA	NA
Chrysene	-	-	√	√	NA	NA
Dibenz(a,h)anthracene	-	-	√	√	NA	NA

Table 2.1 Contaminants of concern	Ground-water	Pore-water	Un-Saturated soil	Saturated soil	Sediment	Indoor air
Fluoranthene	-	-	-	-	NA	NA
Fluorene	-	-	-	-	NA	NA
Indeno(1,2,3-cd)pyrene	-	-	√	√	NA	NA
2-Methylnaphthalene	-	-	-	-	NA	NA
Naphthalene	-	-	-	√	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Pyrene	-	-	-	-	NA	NA
Pesticides/PCBs	Ground-water	Pore-water	Unsaturated Soil	Saturated Soil	Sediments	Indoor Air
4,4'-DDD	-	-	-	√	-	NA
4,4'-DDE	-	-	√	√	-	NA
4,4'-DDT	√	-	-	√	-	NA
Total PCBs	√	-	√	√	-	NA
Dioxin-Furan(2,3,7,8TCDD)	NA	-	NA	NA	NA	NA
Metals	Ground-water	Pore-water	Unsaturated Soil	Saturated Soil	Sediments	Indoor Air
Antimony	NA	-	NA	NA	-	NA
Arsenic	√	-	√	√	-	NA
Cadmium	NA	-	NA	NA	-	NA
Chromium, total	√	-	√	√	NA	NA
Copper	√	-	√	√	-	NA
Lead	√	-	√	√	-	NA
Mercury	√	-	√	√	-	-
Nickel	√	-	√	√	-	NA
Silver	NA	-	NA	NA	-	NA
Thallium	√	-	-	-	NA	NA
Zinc	√	-	√	√	-	NA
Other	Ground-water	Pore-water	Unsaturated Soil	Saturated Soil	Sediments	Indoor Air
pH	√	-	NA	NA	NA	NA

√ COC exceeds criterion in media indicated.
- COC does not exceed criterion in media.
NA COC does not apply to the media or there is no established criterion.
DDD dichlorodiphenyldichloroethane

2.5.1 VOC Potential Sources

Chlorinated solvents (TCE and PCE) were produced from approximately 1947 to 1973. The TCE and PCE impacts in soil and groundwater are primarily associated with the former solvent production plant (S1), former settling ponds (SWMU A [S3], SWMU G [S4], and SWMU H [S5]), former settling barge (SWMU F [S2]), and Area 5106. Lime sludge and solvent residue from the chlorinated solvents process were sent to settling ponds and a settling barge over time and in the first year of production in 1947 were discharged to the Waterway through a direct discharge line.

CVOC and fuel-related VOC groundwater impacts are present on the 709 and 721 E. Alexander Avenue properties, including a solvents tank formerly on the 721 Alexander property. These properties are being addressed as the AAPTF Site under a separate Agreed Order No. DE 9835, effective October 3, 2013.

2.5.2 Caustic Potential Sources

The elevated pH present in groundwater at the Site is likely primarily due to the release of sodium hydroxide (caustic soda) produced from operations. The principal potential source area appears to be the Caustic House (S8).

2.5.3 Salt Potential Source

Salt was used as a feedstock in the production of chlorine, chlorinated solvents, and caustic soda. Salt was delivered to the Site by ship and stored in open piles on the Salt Pad. Uncovered salt piles were maintained on this pad from the early 1960s until operations ceased. Water was sprayed on the salt piles to make brine. The asphalt pad was diked and sloped to a sump. However, leaks in the asphalt pad or in the sump likely led to salt impacts beneath the Salt Pad.

2.5.4 Metals Potential Sources

The N Landfill and the Navy Todd Dump were located adjacent to the embankment of the Waterway. The N Landfill was used between 1929 and 1971 and investigations have shown that the landfill received wastes containing metals, corrosives, chlorinated organics, and non-burnable debris. The Navy Todd Dump was created in approximately 1945, as a result of World War Two ship construction and waste disposal/incineration activities accomplished by Todd Shipyards and instrumentalities of the United States. Navy Todd Dump investigations show that the waste material contains metals (primarily cadmium, chromium, copper, mercury, nickel, and zinc). The N Landfill and Navy Todd Dump are considered potential metals sources.

In addition to the N Landfill and Navy Todd Dump, metals-impacted waste material derived from shipbuilding and dismantling activities during and after World War Two as well as chemical production were disposed along the embankment of the Waterway.

The vast majority of metals in the groundwater are present as a result of geochemical conditions (high pH and ionic strength) created by the release of other COC. The geochemical conditions mobilize (dissolve) metals at concentrations above those that would exist naturally in groundwater. This process was explained in detail in Subsection 5.5.2 of the approved RI Report.

2.5.5 SVOC Potential Sources

The two SVOCs detected most often at concentrations above their respective criteria are HCB and HCBD. These compounds are by-products of the production of chlorinated solvents, and are found in areas where chlorinated solvents were produced or stored, or where the waste products were handled and disposed.

2.5.6 PCBs and Dioxins/Furans Potential Sources

Significant potential sources of PCBs at the Site are likely from the shipbuilding operations performed on the property including PCB-containing materials disposed at the Navy Todd Dump, and from ship dismantling and maintenance operations performed on the property involving PCB-containing materials disposed and handled. Other potential sources of PCBs in the soil and sediment could have spills from equipment such as transformers and capacitors containing PCBs.

Dioxins (the common name for polychlorinated dibenzo-para-dioxins) and furans (polychlorinated dibenzofurans) are two closely related groups of chemical byproducts. A potential source of dioxins/furans was the incinerator installed and used on the 605 Alexander Avenue property for waste disposal by the US Navy and Todd Shipyards during World War Two. The burning of wastes such as PCB-containing materials in the incinerator and along the embankment at the Navy Todd Dump would also be a potential source for dioxins/furans detected at the Site.

Various other forms of combustion and smelting processes (e.g., welding) that occurred at the World War Two shipyard also potentially produced dioxins/furans. Other potential sources of dioxins/furans are spent graphite anodes used in chemical production, and disposed on the property and overheated electrical equipment (such as transformers and capacitors) containing PCBs.

2.5.7 Anthropogenic Density Plume (ADP) Potential Sources

A plume of elevated groundwater density, termed the Anthropogenic Density Plume (ADP), exists beneath the property and within the plume due to releases of high-density materials from historical operations. Specific gravity is used to comparatively measure density. Specific gravity is the ratio of the density of a substance to the density of a standard, usually water for a liquid or solid, and air for a gas. Water has a specific gravity equal to 1. Materials with a specific gravity less than 1 are less dense than water, and will float on the pure water; substances with a specific gravity more than 1 are more dense than water, and will sink.

The potential sources for the ADP consist of:

- Lime placed in SWMU A, SWMU F, SWMU G, and SWMU H, while lime sludge/calcium chloride was placed in WMU C. Lime sludge (calcium chloride) is miscible in water, and a calcium chloride solution with water can have a specific gravity of approximately 1.3 (at 15 degrees Celsius).
- Caustic soda, with a specific gravity of approximately 1.3 to 1.5, is another component of the Site ADP. The "Potential Caustic Source Area" represents a potential source location for the ADP.
- Brine (sodium chloride) was created at the Salt Pad and had a specific gravity of approximately 1.2 and is a further component of the ADP. The Salt Pad represents a potential source location for the ADP.

The noted potential contaminant sources have resulted in contamination of environmental media at the Site.

2.6 Human Health and Environmental Concerns

During the investigations of the nature and extent of contamination OCC used screening levels for the contaminated media to determine where further investigation was needed and to identify potential risks and exposure pathways. The screening approach provided a preliminary method of figuring out what scenarios to use for risk assessments. Existing risk assessment evaluations that were conducted in the early years of the CB/NT Superfund project were consulted. OCC also conducted its own risk assessments for human health and ecological resources.

As the project moved forward to developing a final RI Report and a final FS report Ecology re-evaluated risk as part of the Conceptual Site Model. The Conceptual Site Model combines the data about the nature and extent of contamination with potential exposure scenarios and proposes the primary pathways that must be addressed by the final remedy.

2.6.1 Human Health Concerns

Human health impacts were a focus of comments during the public involvement period for the OCC FS. Commenters were concerned about the consumption of fish and shellfish from the Hylebos and Commencement Bay. Some comments concerned the disproportionate impacts of site contamination to communities of low-income people, immigrant populations, and people of color. Other comments were concerned about risks to drinking water, to people living nearby with domestic wells, workers nearby or on the Site, or recreational activities such as paddle boarding or wading on the shore.

Ecology took steps to independently evaluate human health risks. The currently available data were evaluated to assess the risk from potential exposure to humans from contamination and the result was documented in a technical memorandum provided during both the RI and the FS public comment period (Ridolfi, 2015).

Based on this technical memorandum Ecology concluded that the existing risk assessments conducted by EPA for the CB/NT for the Hylebos were out of date, did not address the constituents of concern from the Site, and were not adequately protective. Ecology also concluded that the previous risk assessments produced for the Site were either out of date or did not adequately address all of the potentially complete exposure pathways for the Conceptual Site Model.

The MTCA Cleanup Regulation defines a conceptual site model as a conceptual understanding of a site that identifies potential or suspected sources of hazardous substances, types and concentrations of hazardous substances, potentially contaminated media, and actual and potential exposure pathways and receptors. WAC 173-340-200. OCC submitted a Conceptual Site Model Report to Ecology in 2014. (CRA, 2014)

In addition to the Conceptual Site Model an exposure pathway assessment was presented in the RI Report (CRA, 2015), (see Section 2.7 below). The purpose of the assessment was to identify media and locations that might need corrective action, risk-management measures, or further evaluation. Ecology identified the following two additional areas for further investigation to help with assessing exposure risk for the FS:

- An updated evaluation of contamination in sediments and porewater (groundwater directly under the waterway intermixed with layers of sediment), and
- An expanded investigation of vapor intrusion in buildings on the Port of Tacoma's Earley Business Center property at 401 E. Alexander Avenue north of the 605 E. Alexander Avenue property boundary.

OCC conducted this work, and based on these additional studies Ecology updated the Conceptual Site Model to more specifically represent the exposure pathways that must be addressed by the remedy.

In Section 4.0 **Cleanup Standards and Points of Compliance** this CAP proposes cleanup levels for each contaminated media that address all of the potentially complete exposure pathways. The cleanup levels are protective of human health as well as comply with the requirements of MTCA to apply the most conservative cleanup standards based on risk. The remedy will address these exposure pathways by achieving the proposed cleanup levels.

2.6.2 Ecological Concerns

Ecology received comments that expressed concern about the potential effects of the Site on marine life in the surrounding waterways. Commenters are concerned about the health of animals that may be impacted by contamination from sediments or ingestion of biota.

Impacts to ecological resources in the Hylebos Waterway from the Site may potentially occur through exposure to contaminated run-off, sediment, porewater, or through the food chain. The proposed remedy must address these potential ecological risks.

The contaminants most frequently found in groundwater at the Site, including volatile and semi-volatile organic chemicals, do not have state or federal water quality criteria or standards based on the protection of aquatic life. Although the cleanup levels are not based on the protection of aquatic life, Ecology conducted a review of available scientific literature (Ridolfi 2015), and determined that the human health criteria are also protective of aquatic organisms.

Ecology proposes cleanup levels in Section 4.0 that are protective of both human health and the environment. The proposed cleanup levels for groundwater are based on protection of surface water. Protection of surface water also protects other receptors in the environment, preventing recontamination of sediments and reducing the potential for marine life to be impacted by contamination once the remedy is implemented.

2.7 Exposure Pathway Assessment

An Exposure Pathway Assessment was conducted for the Site that included a human health exposure pathway assessment and an ecological health exposure pathway assessment. The purpose of the assessment was to identify media and locations that might need corrective action, risk-management measures, or further evaluation. The Exposure Pathway Assessment was presented in the RI Report (CRA, 2015) and is summarized below.

The transport of COCs may lead to the exposure and uptake of COCs by human and ecological receptors. Potentially complete human and ecological exposure pathways and potential receptors are shown schematically on Figure 2.3.

Table 2.2 Primary Human Receptors and Potentially Complete Exposure Pathways

Receptor	Exposure Pathway
Industrial/Commercial Worker	• Inhalation of indoor air impacted by VOC volatilizing from soil and shallow groundwater • Incidental ingestion and dermal contact with impacted surface soil • Incidental ingestion and dermal contact of sediments in the intertidal zone
Construction/Utility Worker	• Incidental ingestion and dermal contact with surface and subsurface soil • Incidental ingestion and dermal contact with impacted groundwater while conducting subsurface excavations that extend to the groundwater table • Inhalation of soil particulates and/or ambient air
Trespasser	• Incidental ingestion and dermal contact with impacted surface soil • Inhalation of soil particulates and/or ambient air • Incidental ingestion and dermal contact of sediments in the intertidal zone
Recreational User	• Incidental ingestion and dermal contact with surface water in the Waterway
Fisher	• Ingestion of fish tissue

The HHEPA identified the following media and potentially complete exposure pathways that might require corrective action, risk-management measures, or further evaluation.

Table 2.3 Media and Potentially Complete Exposure Pathways

Medium	Exposure Pathway
Soil	• Inhalation of indoor air impacted by VOC volatilizing from soil • Inhalation of ambient air impacted by VOC volatilizing from soil • Direct contact with impacted surface soil
Groundwater	• Inhalation of indoor air impacted by VOC volatilizing from shallow groundwater • Inhalation of ambient air impacted by VOC volatilizing from shallow groundwater • Direct contact with shallow groundwater
Sediment	• Direct contact with impacted sediment

The 2016 Anchor QEA investigation of surface sediment results stated that most CVOC concentrations were below detection and no reported concentrations exceeded the CB/NT site Sediment Quality Objectives. Future monitoring of sediments will be expanded to include SVOCS, constituents of concern that must be included in future sediment studies required by Ecology to monitor potential impacts from the release of contamination from the Site.

MTCA requires that Ecology consider protection of sediments by proposing cleanup levels based on the Chapter 173-204 WAC Sediment Management Standards (SMS). The proposed cleanup levels for this CAP are based on SMS levels and will be used for compliance and performance monitoring (screening) to determine whether the groundwater cleanup portion of the remedy is adequately protecting sediments.

Under the current configuration of the Site limited exposure of terrestrial ecological receptors is expected. This is primarily along the embankment of the Hylebos Waterway. The primary ecological exposure pathway at the Site is associated with the potential for discharge of impacted groundwater to the biologically active zone of the Hylebos and Commencement Bay. The terrestrial and aquatic ecological receptors and potentially complete exposure pathways at the Site are summarized below.

Table 2.4 Primary Ecological Receptors and Potentially Complete Exposure Pathways

Receptor	Exposure Pathway
Soil invertebrates and burrowing animals	• Direct contact and ingestion of soil • Impacted soil gas vapors
Benthic organisms in sediment of Waterway and Commencement Bay	• Impacted sediment within the biologically active zone • Impacted groundwater discharge into the biologically active zone
Avian carnivore, piscivore, insectivore	• Dietary uptake of prey/food
Aquatic vegetation and invertebrates	• Exposure to impacted groundwater through root uptake and direct contact • Direct contact and ingestion of sediment
Forage and predator fish	• Dietary uptake of plants and small aquatic species

The 2016 Anchor QEA investigation surface sediment results determined that most CVOC were below detection and no reported concentrations exceeded the CB/NT site Sediment Quality Objectives. The 2016 Anchor QEA investigation near-bottom surface water and near-surface porewater results showed that only one parameter (VC), reported in one sample (adjacent to the northern end of the 605 E. Alexander Avenue property), had the potential to exceed the associated screening levels. Future monitoring of the COC concentrations in sediment and porewater is appropriate to ensure that existing conditions of sediment and porewater quality do not change over time. The SMS cleanup levels will be used in the future to determine whether sediments are protected by the remedy.

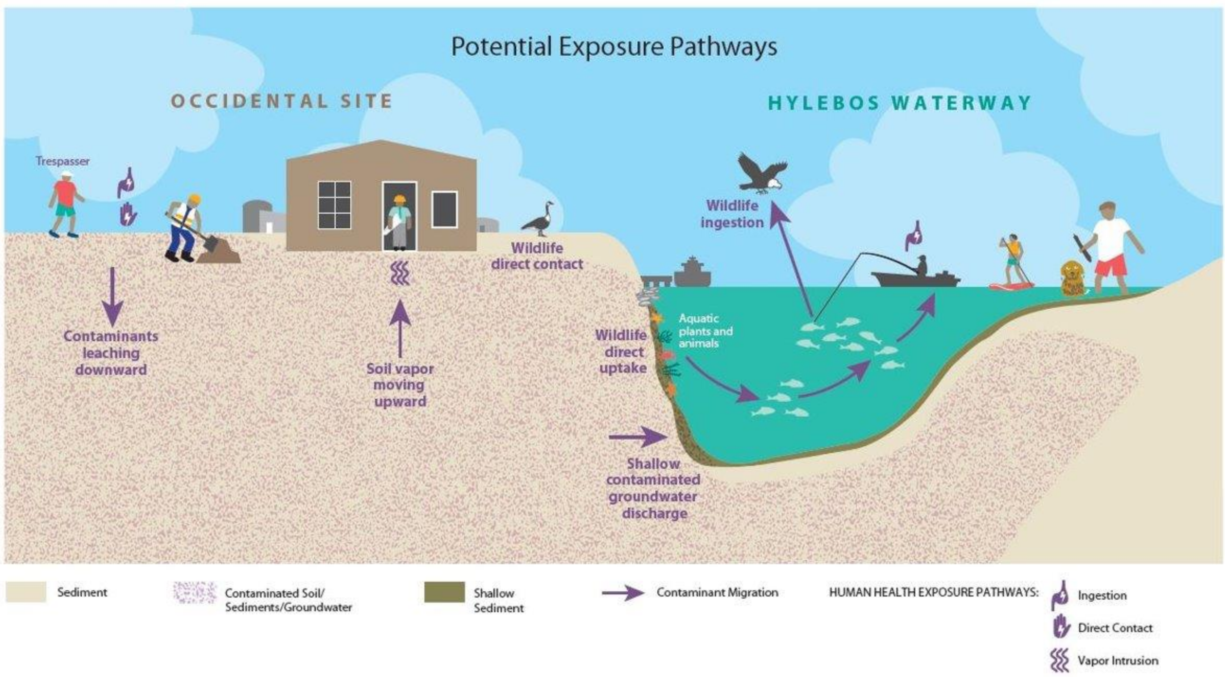
As stated earlier, Ecology took steps to independently evaluate human health and ecological risks as a result of public comment. The currently available data were evaluated to assess the risk of potential exposure to humans and biota from Site contamination. The result was documented in a technical memorandum provided during both the RI and the FS public comment period. (Ridolfi, 2015). Ecology updated the Conceptual Site Model based on this evaluation and used the information for selecting cleanup standards for the Site.

2.8 Conceptual Site Model

A Conceptual Site Model is typically developed during the RI phase as information becomes available, and further refined as additional information is collected. It is a tool used to assist in making decisions.

The draft conceptual site model for the Site was developed just prior to finalizing the Site Characterization Reports into a draft RI report, and was issued for public comment. The Conceptual Site Model brought together information and data about the plumes, groundwater flow, and nature and extent of contamination. It also identified the potentially complete exposure pathways discussed in the previous section.

Figure 2.3 Potential exposure pathways



2.8.1 Modeling of the Plumes

There are three primary groundwater plumes on the Site: the anthropogenic density plume , the pH plume, and the plume of chlorinated volatile organic compounds (abbreviated as the CVOC plume). Physical and chemical interactions among these plumes contribute to the complexities associated with Site restoration. Additional information regarding transport processes at the Site is provided in the Conceptual Site Model Report . A summary of the nature and extent of contamination is described in Section 2.9.

As described previously, historical operations at the Site resulted in surface releases of high-density liquids, including caustic soda and brine, resulting in a plume called the anthropogenic density plume or ADP. These releases occurred primarily in the vicinity of the settling ponds, barge, salt pad, and caustic source areas. The ADP tends to sink due to its higher density relative to the density of fresh groundwater and saltwater. While migrating downwards, the ADP displaced groundwater initially present beneath the release locations. The groundwater displacement from the sinking ADP caused lateral groundwater flow away from the source areas.

The high-density liquids released in the caustic source areas also had high pH. These caustic fluids co-mingled with the brine released from the Salt Pad to form the ADP. As a result, the pH plume is largely coincident with the ADP plume. Reaction of the pH plume with aquifer materials results in high concentrations of silica and aluminum dissolved in the groundwater at some locations.

Changes in geochemical conditions, such as lowering pH, can cause silica gel to form within the aquifer or within groundwater wells and piping associated with groundwater extraction systems. Silica gel effectively plugs up the aquifer and can cause groundwater extraction wells and systems to become inoperable.

The CVOC sources were in close proximity to the Salt Pad, and as a result dissolved CVOCs have comingled and migrated with the ADP. As the ADP displaced groundwater, comingled CVOCs within the ADP were carried by the ADP as it migrated laterally and downward. In addition, CVOCs already dissolved in groundwater at the periphery of the ADP were displaced laterally and vertically in advance of the ADP migration. This lateral spreading resulted in a portion of the CVOC plume migrating eastward, beneath the Waterway.

The lateral ADP migration is a primary reason for the presence of CVOCs beneath the Hylebos Waterway east of the CVOC source areas, even though the average groundwater flow direction observed under current conditions is more north to northwest. Dissolved-phase CVOCs in groundwater outside the ADP migrates with groundwater. This leads to northward migration as the regional groundwater flow direction in the deltaic deposits is generally toward Commencement Bay.

The downward migration of the ADP, pH, and CVOC plumes is ultimately limited by low-permeability materials and upwelling groundwater (upward vertical hydraulic gradients) that occur at depth. The deepest contamination from the Site extends to a depth of approximately 175 feet.

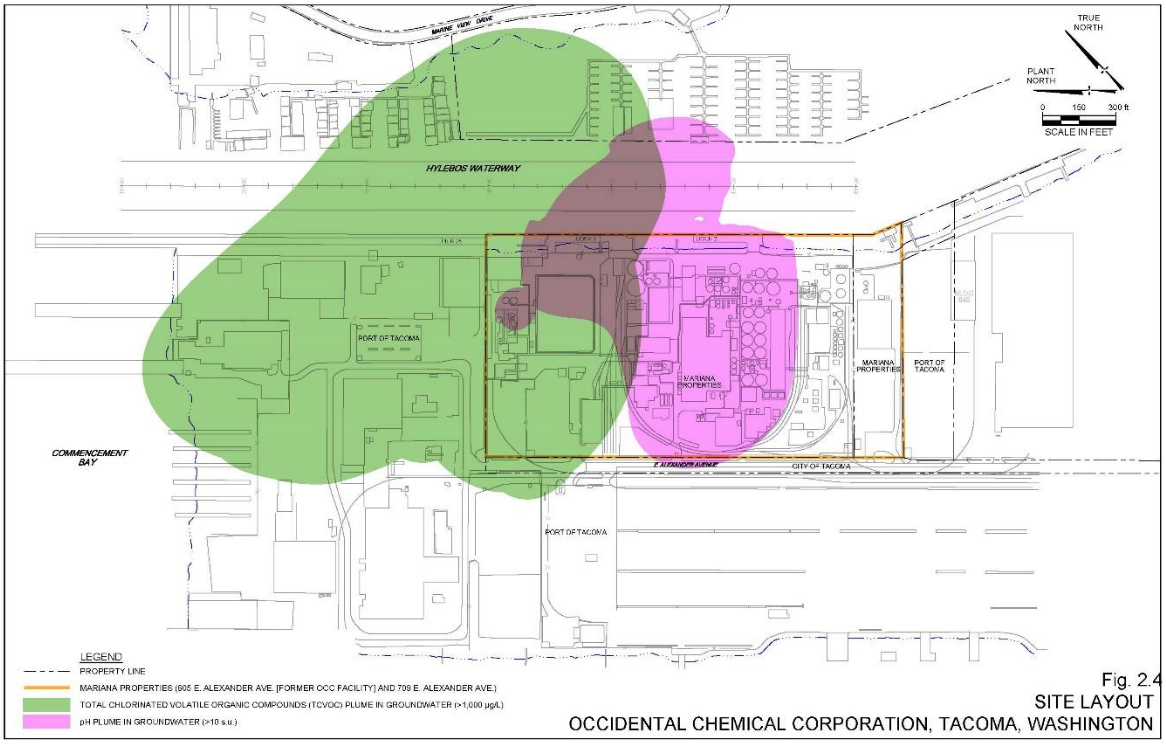
Much of the contamination occurs between depths of 100 and 150 feet. As the plumes moved downward, regional groundwater flow directions caused them to move to the north toward Commencement Bay so that the deepest parts of the plume are to the north nearer to Commencement Bay.

Breakdown of contaminants contributes to the conditions in the plumes. Biological degradation of PCE and TCE (parent compounds) have produced cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride and ethene ("daughter" products) at the Site. In general, the concentrations of PCE/TCE are highest near the surface sources.

The concentrations of "daughter" or breakdown products are highest in the source zones and beyond the PCE/TCE plume. The presence of cis-1,2-DCE, vinyl chloride, and ethene, which are "daughter" products of the biological degradation of PCE and TCE, confirms that PCE/TCE biodegradation is occurring. Ethene detected in groundwater samples, indicate that complete degradation of vinyl chloride is occurring at least in some areas of the Site.

The Conceptual Site Model also summarized information about potentially complete exposure pathways, detailed here in Tables 2.1, 2.2, and 2.3. Ecology supplemented the information with additional evaluations of human health and ecological risk and concluded the selection of surface water criteria would be protective of both risks and should be used to develop cleanup standards. (Ridolfi, 2015).

Figure 2.4 Site Layout



2.9 Nature and Extent of Contamination

An in-depth evaluation of the nature and extent of contamination was presented to the public in the RI Report. During the multiple investigations for the final RI OCC used screening levels as a preliminary approach to identifying sources of contamination and risk by media. The following subsections discusses these conditions by media.

2.9.1 Soil

The nature and extent of impacts to unsaturated soil are summarized as follows:

- CVOCs, primarily as PCE, are present in unsaturated soil at concentrations exceeding the unsaturated soil screening levels, primarily in the vicinity of SWMU A, the Salt Pad/SWMU G, SWMU H, and the N Landfill.
- SVOCs, primarily HCB and HCBD, are present in unsaturated soil at concentrations exceeding the soil screening levels within the same general areas as CVOC, as well as at several embankment locations.

- PCBs are present in unsaturated soil at concentrations exceeding the soil screening levels primarily near the Navy Todd Dump and the N Landfill.
- Metals, primarily copper, but also arsenic, zinc, and nickel, are present at concentrations exceeding the soil screening levels in the vicinity of the Salt Pad/SWMU G, the former Caustic House, the N Landfill, and Navy Todd Dump.

The nature and extent of impacts in saturated soil are summarized as follows:

- CVOCs, primarily as PCE, TCE, and associated degradation products, are present in saturated soil at concentrations exceeding the saturated soil screening levels. This presence is greatest near SWMU A, the Salt Pad/SWMU G, and SWMU R, as well as below the Hylebos. CVOCs are also present along the embankment and in the vicinity of the N Landfill.
- SVOCs, primarily as HCB, are present in saturated soil at concentrations exceeding the soil screening levels within the same general areas as CVOCs.
- Pesticides and PCBs are present in saturated soil at concentrations exceeding the soil screening levels within the embankment, primarily near the Navy Todd Dump and the N Landfill.
- Metals, primarily copper, total chromium, nickel, arsenic, and zinc, are present at concentrations exceeding the soil screening levels in nearly all samples analyzed across the property. The highest concentrations occur within the embankment in the vicinity of the N Landfill and Navy Todd Dump.

2.9.2 Groundwater

The nature and extent of impacts to groundwater are summarized as follows:

CVOC are present in groundwater at concentrations above the groundwater screening criteria as described below. Figures 2.5 through 2.10 show the plume distributions.

- 25-ft zone - The areas of highest concentrations are located near the Salt Pad and (S)WMU A (Figure 2.5)
- 50-ft zone - The extent of PCE and TCE is similar to the 25-ft zone, but the extent of VC increases significantly within the 50-ft zone area beyond the limits of PCE and TCE toward the eastern side of the Hylebos (Figure 2.6)
- 75-ft zone - The highest CVOC concentrations extend eastward under the Hylebos, with lower concentrations extending further north (Figure 2.7)
- 100-ft zone - The area of highest concentration is somewhat reduced, but has migrated further north (Figure 2.8)
- 130-ft zone - The area of highest concentration is somewhat reduced, but has migrated north and east when compared to the 100-ft zone (Figure 2.9)
- 160-ft zone - CVOC concentrations in the 160-ft zone are reduced compared to the 130-ft zone, but the plume continues further northward (Figure 2.10)

SVOCs, primarily HCB and HCBD, are present within the embankment and beneath the Hylebos at depths down to at least 111 ft below ground surface (bgs) upland and 164 ft below mud line (BML) under the Waterway. PCBs are present in groundwater, primarily within the embankment in the vicinity of the Navy Todd Dump and N Landfill and below the Hylebos.

Figures 2.5 through 2.10

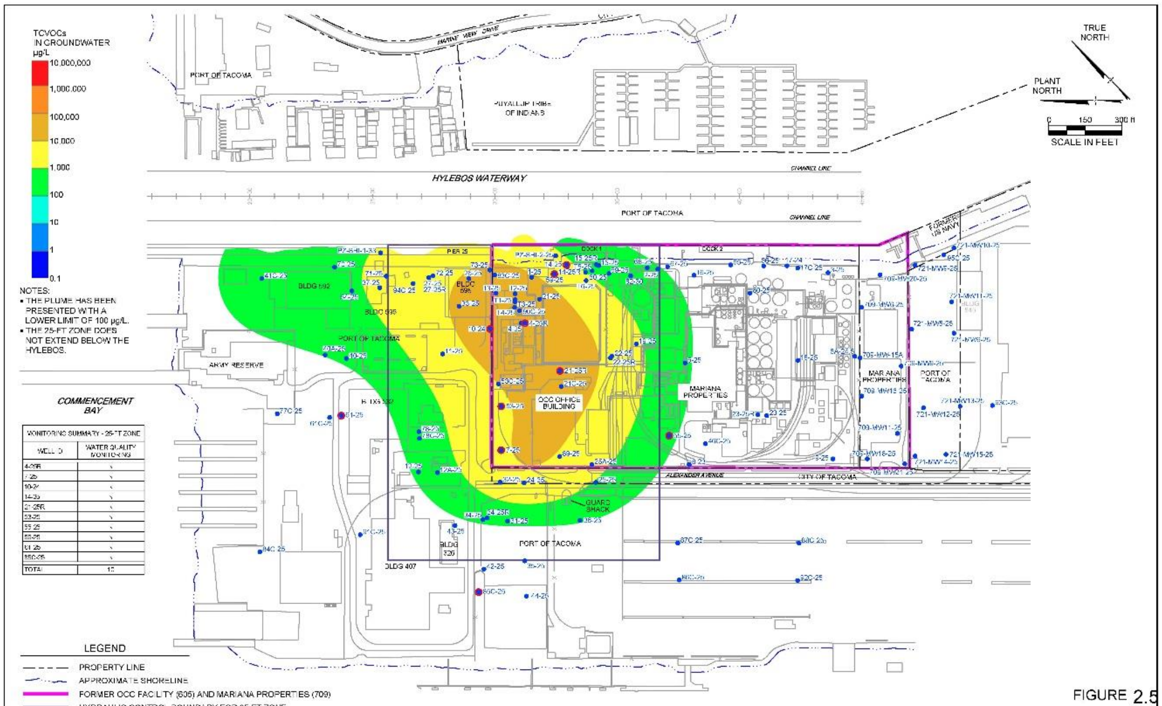


FIGURE 2.5
TCVOC - MONITORING NETWORK 25-FT ZONE
Occidental Chemical Corporation, Tacoma, Washington

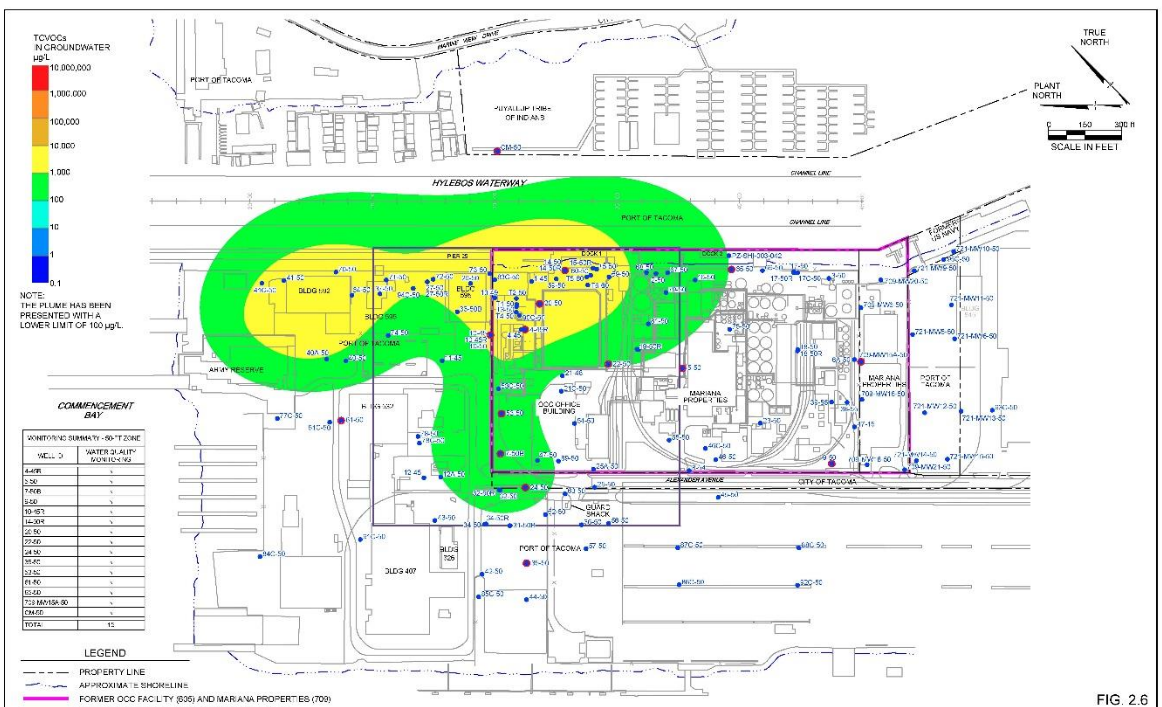


FIG. 2.6
TCVOC - MONITORING NETWORK 50-FT ZONE
Occidental Chemical Corporation, Tacoma, Washington


TCVOCs
IN GROUNDWATER
µg/L
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
0.1
NOTE:
THE PLUME HAS BEEN
PRESENTED WITH A
LOWER LIMIT OF 100 µg/L.
TRUE NORTH
PLANT NORTH
SCALE IN FEET
HYLEBOS WATERWAY
PORT OF TACOMA
PUYALLUP TRIBE OF INDIANS
COMMENCEMENT BAY
ARMY RESERVE
OCC OFFICE BUILDING
MARIANA PROPERTIES
ALEXANDER AVENUE
CITY OF TACOMA
GUARD SHACK
BLDG 407
LEGEND
PROPERTY LINE
APPROXIMATE SHORELINE
FORMER OCC FACILITY (605) AND MARIANA PROPERTIES (709)
HYDRAULIC CONTROL BOUNDARY FOR 75-FT ZONE
MONITORING WELL LOCATION
SAMPLED IN 2020/2021
FIG. 2.7
TCVOC - MONITORING NETWORK 75-FT ZONE
Occidental Chemical Corporation, Tacoma, Washington


TCVOCs
IN GROUNDWATER
µg/L
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
0.1
NOTE:
THE PLUME HAS BEEN
PRESENTED WITH A
LOWER LIMIT OF 100 µg/L.
TRUE NORTH
PLANT NORTH
SCALE IN FEET
HYLEBOS WATERWAY
PORT OF TACOMA
PUYALLUP TRIBE OF INDIANS
COMMENCEMENT BAY
NEW STANDARD WELL (ARMY PIER)
OCC OFFICE BUILDING
MARIANA PROPERTIES
ALEXANDER AVENUE
CITY OF TACOMA
GUARD SHACK
BLDG 407
LEGEND
PROPERTY LINE
APPROXIMATE SHORELINE
FORMER OCC FACILITY (605) AND MARIANA PROPERTIES (709)
HYDRAULIC CONTROL BOUNDARY FOR 100-FT ZONE
MONITORING WELL LOCATION
SAMPLED IN 2020/2021
FIGURE 2.8
TCVOC - MONITORING NETWORK 100-FT ZONE
Occidental Chemical Corporation, Tacoma, Washington

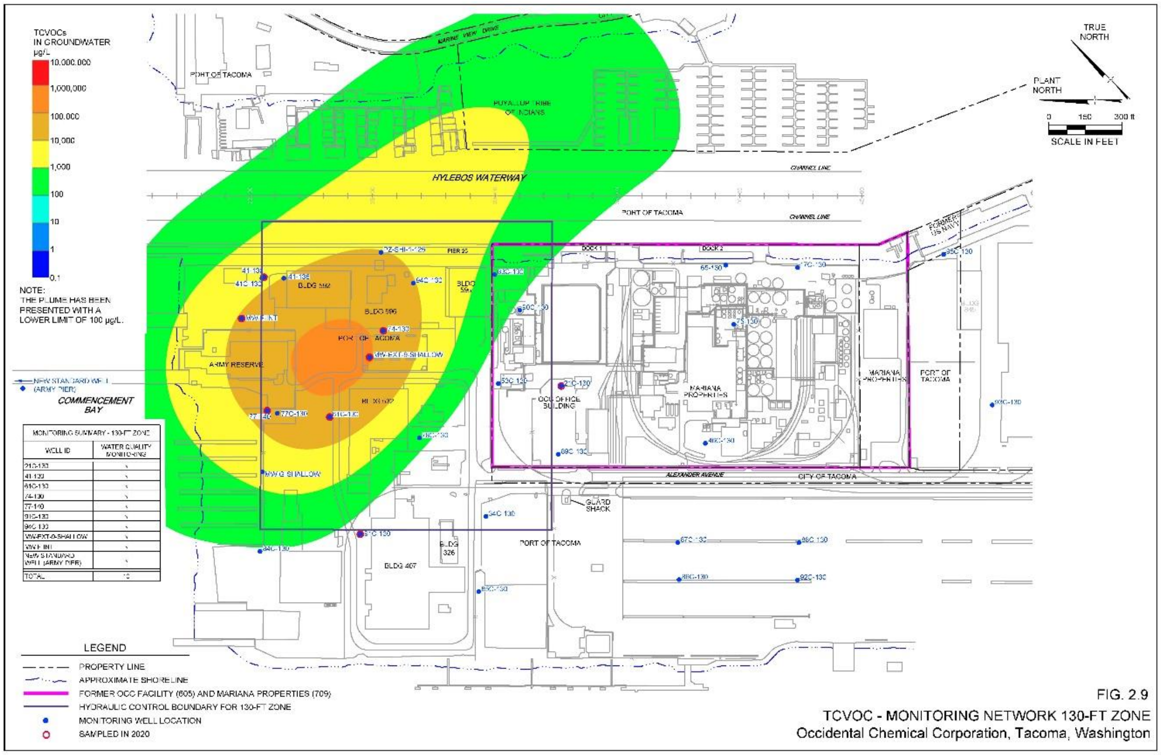


FIG. 2.9
TCVOC - MONITORING NETWORK 130-FT ZONE
Occidental Chemical Corporation, Tacoma, Washington

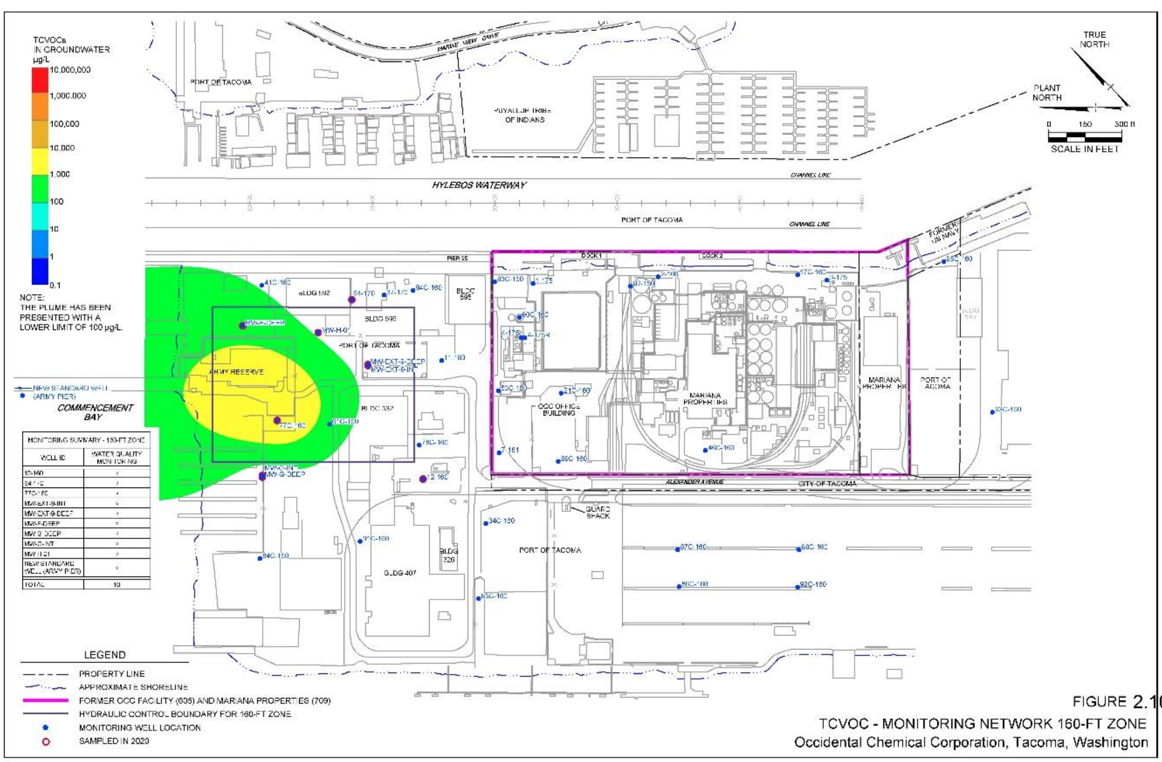


FIGURE 2.10
TCVOC - MONITORING NETWORK 160-FT ZONE
Occidental Chemical Corporation, Tacoma, Washington

Metals, primarily arsenic, copper, and nickel, are present at concentrations exceeding the groundwater screening criteria. The highest concentrations occur in the vicinity of the Salt Pad and Navy Todd Dump, within the embankment, and beneath the Hylebos.

Elevated pH groundwater is present above the groundwater screening criteria as follows:

- 25-ft zone - elevated pH was measured across the Site, with the highest values (>13 s.u. (standard units of pH)) detected within the eastern portion of the Site beneath the former plant production areas
- 50-ft zone - the extent of the highest pH values increases in size relative to the 25-ft zone and is located more to the north toward the Salt Pad
- 75-ft zone - the extent of the pH plume within the 75-ft zone is reduced relative to the 50-ft zone, but has migrated east with the highest groundwater pH (>12 s.u.) located in the vicinity of the former caustic tanks and the south end of Dock 1
- 100-ft zone - the pH plume has migrated north and east, with the highest pH near the north end of Dock 1, but is limited to beneath the facility and Hylebos
- 130-ft zone - the pH plume continues further northeast
- 160-ft zone - the area of high pH values is reduced in the 160-ft zone, with the highest readings diminishing
- The seep study performed in the Hylebos confirmed the presence of seeps from impacted groundwater.

2.9.3 Sediment

The August 2016 Anchor QEA investigation of potential CVOC in sediments in the Hylebos Waterway included collection of surface sediment samples from the 0- to 10-cm interval at 33 locations in the Hylebos adjacent to the Site and comparison of reported concentrations to the CB/NT site Sediment Quality Objectives. The investigation determined that most CVOC were below detection levels and no reported concentrations exceeded the CB/NT site Sediment Quality Objectives.

Based on the results presented in the 2016 Anchor QEA Data Summary Report for sediment and porewater, remedial alternatives for sediments will be evaluated by EPA pursuant to the 2020 AOC. The 2020 AOC expressly states EPA's reserved authority to require additional assessment of sediment impacts after the uplands remedy is implemented at the Site. It should be noted that it has been over 10 years since dredging was completed and it does not appear that re-contamination of the sediments has occurred, based on the 2016 data. Future monitoring of COC concentrations in sediments are appropriate to ensure that existing conditions of sediment quality do not change over time.

Ecology proposes to protect sediments from recontamination by implementing the selected remedy. Section 4.0 proposes cleanup levels based on Ecology's Sediment Management Standards that will be used to monitor the effectiveness of the remedy.

2.9.4 Porewater

The July/August 2016 Anchor QEA investigation of potential CVOC in porewater beneath the Hylebos Waterway included attempted collection of near-bottom surface water samples from 2 to 4 cm above the mudline at 6 locations, and porewater samples from depths of 2 to 4 cm (near-surface), 10 cm, 30 cm, and 90 cm below the mudline at 33 locations in the Hylebos adjacent to the Site.

The reported concentrations for near-bottom surface water and near-surface porewater samples collected at 2 to 4 cm above and below the mudline, respectively, were compared to applicable water quality criteria. Only one parameter (VC), reported in one sample (adjacent to the northern end of the 605 E. Alexander Avenue property), had the potential to exceed the associated screening criterion at the applicable POC. The vinyl chloride result was 0.45J ug/L. The lowest screening benchmark for vinyl chloride listed in the sediment report is 0.26 ug/L (based on human health consumption of organisms (WAC 173-201A-240).

Future monitoring of COC concentrations in porewater is appropriate to ensure that existing conditions of porewater quality do not change.

2.9.5 Indoor Air

The VI investigation included nine buildings in the Site area, including the Army Reserve Facility , Buildings 326, 407, 532, 592, 595, and 596, and the Guard Shack located on properties owned and/or controlled by the Port of Tacoma at 401 E. Alexander Avenue (the Earley Business Center), and the OCC Office Building at 605 E. Alexander Avenue.

Exceedances of screening levels in indoor air and their potential sources were primarily as follows:

- Indoor sources: 1,2,4-trimethylbenzene, 1,4-dichlorobenzene, naphthalene, m&p-xylenes, styrene, PCE, and TCE
- Outdoor sources: No exceedances
- Sub-slab sources: PCE and TCE

The majority of exceedances are likely attributable to non-Site related indoor sources (e.g., ongoing vehicle operations, paint operations, miscellaneous power and hand tools, parts washing tubs, chemical storage tanks, flammable material storage lockers, paint cans, cleaning products, miscellaneous building materials, aerosol cans containing chemical cleaners, lubricants, cutting oils, and diesel fuel). Only a few of the exceedances were concluded to be potentially partially attributable to sub-slab sources, and two of which were sources likely unrelated to the Site. The recommendations for mitigation or actions at the nine buildings are:

- Manage occupancy of the OCC Office Building-with removal or mitigation should concentrations be above Site-specific indoor air CULs after early-action source treatment is discontinued
- Continued monitoring of Building 595
- No Further Action in ARF, Buildings 326, 407, 532, 592, 596, and Guard Shack

3. Regulatory Requirements

3.1 Applicable local, state, and federal laws

WAC 173-340-710 discusses requirements for identifying applicable local, state, and federal laws. Applicable state and federal laws are outlined in -710(1) through (8). Permits and exemptions for local, state, and federal laws are outlined in -710(9).

Table 3.1 presents applicable state and federal laws and potential permits and exemptions for state and local.

Table 3.1 Potential Applicable State and Federal Laws and Relevant and Appropriate Requirements

Topic	Standard or Requirement	Regulatory Citation		Project-Specific Comments
		Federal	State	
Hazardous Substance Cleanup	Washington State Cleanup Standards; Cleanup Screening Levels (CSL)		Model Toxics Control Act (MTCA) (RCW 70A.305; WAC 173-340), especially WAC 173-340-710 through 173-340-760	Applicable to determining cleanup of hazardous waste sites to protect human health and the environment.
Surface Water Quality	Surface water quality standards. National Recommended Water Quality Criteria (WQC); National Toxics Rule (NTR); State Water Quality Standards (WQS); Clean Water Act and NPDES Requirements Model Toxics Control Act (MTCA)	WQC per Clean Water Act Section 304(a) (33 USC § 1314) NTR at 40 CFR 131.36(b)(1) as applied to Washington, 40 CFR 131.36(d)(14) 40 CFR 122-125	Water Pollution Control Act (RCW 90.46); WQS (WAC 173-201A); Aquatic Life Criteria (ALC) numerical criteria (WAC 173-201A-240)	Relevant to remedial actions impacting contaminant migration to surface water and groundwater. Applicable to remedial actions involving discharge to a Port of Tacoma. Substantive requirements will be applicable to any alternative that discharges effluent to surface water.
	State Waste Discharge Program; Clean Water Act Pretreatment Requirements	40 CFR Part 403 and 405-471	WAC-173-216	Applicable if the option of discharge to the sanitary sewer (Port of Tacoma) is part of a remedy. Substantive requirements must be met.
Solid Waste Disposal	Requirements for solid waste handling management and disposal	Solid Waste Disposal Act (42 U.S.C 6901-6992K; 40 CFR 257-258)	Solid Waste Management (RCW 70.95; WAC 173-350)	Substantive requirements for non-dangerous or non-hazardous waste generated during remedial activities unless wastes meet recycling or other exemptions will be complied with.
Waste Treatment, Storage, and Disposal	Dangerous or Hazardous Waste Management Ecology Dangerous Waste Regulations	Resource Conservation and Recovery Act, Hazardous Waste (42 U.S.C §§ 6901-6992K, 40 CFR 260-279)	Dangerous Waste Management (RCW 70A.300; WAC 173-303)	Applicable if remedial activities include land disposal of RCRA hazardous waste, such as that generated from excavation of waste that is characterized as hazardous.
	Transportation of Hazardous Waste	49 CFR 170-189		Applicable to remedial activities that involve the off-Site transportation of hazardous waste
Land Disposal of Waste	Management and disposal of materials containing polychlorinated biphenyls (PCBs)	Toxic Substances Control Act (15 U.S.C § 2605; 40 CFR 761.61(c))	Dangerous Waste Management (RCW 70A.300; WAC 173-303-140, 141)	Any dangerous or hazardous waste land disposal shall meet substantive land disposal requirements.
	Hazardous Waste Land Disposal Restrictions	Resource Conservation and Recovery Act Land Disposal Restrictions (42		

Topic	Standard or Requirement	Regulatory Citation		Project-Specific Comments
		Federal	State	
		U.S.C §§ 6901-6992K; 40 CFR 268)		
Dredge/Fill and Other In-Water Construction Work	Discharge of dredged/fill material into navigable waters or wetlands	Clean Water Act Sections 401, 404 (33 U.S.C §§ 1341, 1344; 40 CFR 121.2 (content of 401 certifications), 230 (disposal sites/mitigation), 232 (definitions/exemptions); 33 CFR 320, 322-3, 328-30 (Army Corps of Engineers 404 Permitting))	Hydraulic Code Rules (RCW 77.65; WAC 220-110) Dredged Materials Management Program (DMMP) (RCW 79.105.500; WAC 332-30-166 (3))	Applicable to construction of barrier wall east.
	Navigation and Commerce	Rivers and Harbor Act Section 10 (33 U.S.C. § 403)		Unauthorized obstruction or alteration of navigable waterways is prohibited. In-water dredging and disposal are not anticipated.
Endangered Species and Critical Habitat	Taking or jeopardy to endangered or threatened species; adverse modification of critical habitat	Endangered Species Act (16 U.S.C.§§ 1531-1544; 50 CFR 17 (listings, prohibitions), 402 (interagency consultations), 222-224 (endangered and threatened marine species), 226.212 (critical habitat for Northwest salmon and steelhead))		It is unlawful to take (or possess, deliver, carry, transport or ship) any endangered species, or violate any regulation re-endangered or threatened species. EPA in consultation with the Services shall insure any authorized action is not likely to jeopardize endangered or threatened species or adversely modify critical habitat, absent an exemption.
Migratory Birds	Taking or adversely affecting migratory birds	Migratory Bird Treaty Act, (16 U.S.C §§ 703-712; 50 CFR 10 and 21)		Applicable to avoid adversely affecting migratory bird species as defined in federal regulations, including individual birds and their nests
Eagles	Taking or harming eagles	Bald and Golden Eagle Protection Act (16 U.S.C. § 668, 50 CFR 22)	Bald Eagle Protection Rules (RCW 77.12.655; WAC 232-12-292)	Taking or harming of eagles, their eggs, nests or young is prohibited; substantive requirements for the protection of bald eagle habitat including nesting, perching and roosting at the site will be met.
Floodplain Protection	Adverse impacts; potential harm	Floodplain Management Procedures (40 CFR 6, Appendix A, Section 6, see also Executive Order 11988)		Applicable to avoid potential adverse impacts and to minimize impacts for which no practical alternative exists.
Shoreline Management	Construction and development		Shoreline Management Act RCW 90.58; WAC 173-26; City of Tacoma Shoreline Master Program; Pierce County Shoreline Master Program (18S.10.010 Title.21)	Master plans within their jurisdiction apply within 200 feet of the shoreline to the extent they impose or establish more stringent requirements.
Air Emissions	Ambient air quality standards; fugitive emission/fugitive dust	Clean Air Act (42 U.S.C. §§ 7401-7671q; 40 CFR 50)	Washington Clean Air Act (RCW 70.94; WAC 173-400)	Some treatment alternatives may impact ambient air quality. Substantive requirements will be applicable if alternative results in emission from treatment processes.
	National Ambient Air Quality Standards (NAAQS)	40 CFR Part 50		Applicable to treatment alternatives that may emit pollutants to the air, establishes standards to protect health and welfare.
	National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 261		Applicable to treatment alternatives that may emit toxic pollutants to the air.
	State Environmental Policy Act (SEPA)		WAC 192-11	SEPA checklist may be required prior to construction of the remediation system.

Topic	Standard or Requirement	Regulatory Citation		Project-Specific Comments
		Federal	State	
Native American Graves and Sacred Sites	Protections	Native American Graves Protection and Repatriation Act (25 U.S.C. §§ 3001 et seq.); American Indian Religious Freedom Act (42 U.S.C. §§ 1196 et seq.)		Requirements for the protection of Native American remains, funerary objects and associated cultural artifacts when burial sites are encountered; and protection of tribal exercise of traditional tribal religions, including traditional cultural properties, sites and archeological resources. See also Executive Order 13007 which requires federal agencies to avoid physical damage to tribal sacred sites, and interfering with access of tribes thereto.
Noise	Permissible noise levels		Noise Control Act (RCW 70.107;WAC 173-60-040-050)	Maximum levels at specified times for specified durations are WAC 173-60-040, subject to exemptions in WAC 173-60-050, including 050(3) (a) (sounds originating from temporary construction sites as a result of construction activity) and (3)(f) (sounds created by emergency equipment and work necessary in the interests of law enforcement or for health, safety or welfare of the community).
Historic Preservation		National Historic Preservation Act Section 106 (16 U.S.C. § 470; 36 CFR 800)		Potentially applicable if potential remedial activity on the site, building, structure, or object included or eligible for inclusion in the National Register of Historic Places.
Groundwater Quality	EPA Underground Injection Control (UIC) Program Regulations	40 CFR 144 and 146		To be considered for any in situ remediation technologies that involve injection into an aquifer.

3.2 Applicable or Relevant and Appropriate Requirements.

“Legally applicable requirements include those cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations adopted under state or federal law that specifically address a hazardous substance, cleanup action, location, or other circumstances at the site.” [WAC 173-340-710(3)]

“Relevant and appropriate requirements include those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstances at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.” WAC 173-340-710(4) lists the criteria that Ecology evaluates when determining whether certain requirements are relevant and appropriate for a cleanup action.

If other requirements are identified later, then those requirements will be applied to the cleanup actions at that time. Ecology shall consider new applicable state and federal laws as part of periodic review under WAC 173-340-420 (see Section 10 **Periodic Review**). Cleanup actions will be evaluated in light of these new requirements to determine whether the cleanup action is still protective of human health and the environment.

A listing of applicable or relevant and appropriate requirements for the Site is found in Table 3.1.

3.3 Permits and Exemptions

Remedial actions conducted under a consent decree, order, or agreed order, are exempt from the procedural requirements of certain laws, but the actions must still comply with the substantive requirements of these laws.

MTCA provides an exemption from the procedural requirements of several state laws and from any laws authorizing local government permits or approvals for remedial actions conducted under a consent decree, order, or agreed order (RCW 70A.305.090). However, the substantive requirements of a permit must be met. In addition, this exemption does not apply if Ecology determines the exemption would result in loss of approval from a federal agency.

This exemption applies to the following laws:

- Chapter 70A.15 RCW, Washington Clean Air Act
- Chapter 70A.205 RCW, Solid Waste Management, Reduction, and Recycling
- Chapter 70A.300 RCW, Hazardous Waste Management Act
- Chapter 75.20 RCW, Construction Projects in State Waters
- Chapter 90.48 RCW, Water Pollution Control
- Chapter 90.58 RCW, Shoreline Management Act of 1971
- Any laws requiring or authorizing local government permits or approvals for this cleanup action

Ecology will identify the permit exemptions and the substantive requirements, to the extent known according to the requirements in WAC 173-340-610(9), in an agreed order implementing this cleanup action.

3.4 Selection of Cleanup Actions

The selection of a final remedy involves consideration of a number of minimum requirements identified in the MTCA Cleanup Regulation. WAC 173-340-360 and -370 provide both the requirements and expectations for selected remedies.

3.4.1 Minimum Requirements for Remedy Selection

The minimum requirements and procedures for selecting cleanup actions include:

Threshold requirements:

- Protect human health and the environment

- Comply with cleanup standards
- Comply with applicable state and federal laws
- Provide for compliance monitoring

Other requirements:

- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
- Consider public concerns

Groundwater cleanup actions:

- Permanent at the standard POC where a permanent cleanup action is practicable or determined by the department to be in the public interest. (A permanent solution is defined as one where CULs can be met without further action being required at the site other than the disposal of residue from the treatment of hazardous substances.)
- For non-permanent groundwater cleanup actions (WAC 173-340-360(2)(c)(ii)) source removal and/or treatment is required
- If not practicable, containment using barriers or hydraulic control through groundwater pumping is required

3.4.2 Determining Permanence to the Maximum Extent Practicable

WAC 173-340-360(3) describes the specific requirements and procedures for determining whether a cleanup action uses permanent solutions to the maximum extent practicable. The MTCA Cleanup Regulation defines practicable as: "…capable of being designed, constructed and implemented in a reliable and effective manner including consideration of cost. (WAC 173-340-200, Definitions).

To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis (DCA) is conducted. This analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors, including:

- Protectiveness
- Permanence (reduction of toxicity, mobility, or volume of hazardous substances)
- Cost
- Effectiveness over the long term
- Management of short-term risks
- Technical and administrative implementability
- Consideration of public concerns

The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment.

Ecology developed a Remedial Action Objectives (RAO) (additional RAOs are identified in Section 3.3 **Cleanup Action Expectations**) to addresses mass removal at the Site by removing as much of the contaminant mass from groundwater and soil using permanent solutions to the maximum extent practicable using acceptable engineering means. Ecology defines “acceptable engineering means” as proven environmental cleanup measures with proven outcomes that have been used in the past to accomplish cleanup goals.

3.5 Cleanup Action Expectations

Remedial Action Objectives were presented in the FS as part of Ecology’s partnership with EPA to coordinate with CERCLA requirements. . Ecology, EPA, and OCC developed RAOs collaboratively, and they are summarized below.

Table 3.2 Remedial Action Objectives (RAOs)

Environmental Medium	Remedial Action Objectives (RAOs)
Groundwater	Prevent discharge of contaminated groundwater to Hylebos Waterway and Commencement Bay resulting in surface water contaminant concentrations exceeding Ambient Water Quality Criteria (AWQC) and applicable health-based standards for aquatic life and human consumption of resident fish and shellfish. Prevent discharge of contaminated groundwater to sediments in the Hylebos Waterway and Commencement Bay at concentrations that will re-contaminate the sediments above sediment quality standards for Site contaminants and applicable health-based standards for aquatic life and human consumption of resident fish. Prevent use of aquifer groundwater for drinking water, irrigation, or industrial purposes which would result in unacceptable risks to human health. Prevent further migration of the contaminant plume and high pH plume to prevent the spread of contaminated groundwater to the Hylebos Waterway, Commencement Bay, and non-impacted portions of the aquifer.
Surface Water	Prevent marine ecological receptors from contacting surface waters that have contaminant concentrations that exceed surface water CULs. Prevent migration of hazardous substances, pollutants, or contaminants to the surface waters at concentrations that exceed surface water CULs. Control bioaccumulation exposures to human receptors associated with releases to surface water from the Site.
Sediment	Reduce to protective levels risks to benthic invertebrates and other biota from exposure to contaminated sediments and debris. Reduce risks from direct contact (skin contact and incidental ingestion) to contaminated sediments and debris to protect human health.

Soil	Prevent human health risks associated with direct contact, ingestion, or inhalation of shallow soil contaminated above levels for industrial use. Prevent terrestrial ecological receptors from contacting soils that have contaminant concentrations that exceed industrial soil CUL. Prevent migration of hazardous substances, pollutants, or contaminants from soil to the surface waters at concentrations that exceed surface water CULs.
Indoor air	Prevent human exposure to hazardous substances, pollutants, or contaminants from subsurface soil vapor at concentrations in excess of applicable standards and risk-based CULs.

In addition to the RAOs, WAC 173-340-370 provides expectations for developing cleanup action alternatives and selecting cleanup actions. These expectations represent the types of cleanup actions that Ecology considers in the remedy selection process; however, we recognize cleanup actions conforming to these expectations may be inappropriate at some sites. These expectations are:

- Treatment technologies will be emphasized at sites with liquid wastes, areas with high concentrations of hazardous substances, or with highly mobile and/or highly treatable contaminants
- To minimize the need for long-term management of contaminated materials, hazardous substances will be destroyed, detoxified, and/or removed to concentrations below CULs throughout sites with small volumes of hazardous substances
- Engineering controls, such as containment, may need to be used at sites with large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable
- To minimize the potential for migration of hazardous substances, active measures will be taken to prevent precipitation and runoff from coming into contact with contaminated soil or waste materials
- When hazardous substances remain on site at concentrations which exceed CULs, they will be consolidated to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substances
- For sites adjacent to surface water, active measures will be taken to prevent/minimize releases to that water; dilution will not be the sole method for demonstrating compliance.

4. Cleanup Standards and Points of Compliance

This section explains the regulatory requirements for selecting cleanup levels (CULs) and combining CULs with both the physical Site setting and known Site conditions into cleanup standards. Cleanup standards are used for design of the selected remedy and performance monitoring throughout the life of the cleanup.

WAC 173-340-700(3) states cleanup standards consist of the following components: (1) CULs for hazardous substances; (2) the point of compliance; and (3) other applicable, or relevant and appropriate requirements (ARARs) under state and federal laws. A CUL is the concentration of a hazardous substance in a media such as soil or water that is protective of human health and the environment under specified exposure conditions. A point of compliance designates the location on the Site where the CULs must be met. ARARs are other state or federal regulatory requirements that apply because of the location and type of action that will occur at a site.

For each type of contaminated media and potentially complete exposure pathway there is a point of compliance that must be protective of human health. For the Site there are three primary pathways of exposure to address with the proposed remedy, direct contact, ingestion of fish or shellfish that could be contaminated via the groundwater to surface water pathway, and inhalation from contaminated soil to vapor pathway.

The Model Toxics Control Act (MTCA) law, in RCW 70A.305.030(2)(e), requires cleanup standards to be at least as stringent as all applicable state and federal laws. "Cleanup levels must be established at concentrations that prevent violations of cleanup levels for other media" (WAC 173-340-700(6)(b)). For example, the release of hazardous substances in soil may cause groundwater contamination that could eventually contaminate surface water.

The following sections evaluate, by media, applicable CULs for the Site.

4.1 Soil Cleanup Standards

4.1.1 Soil Cleanup Levels

Under MTCA, soil CULs are based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under both current and potential future site use conditions. Ecology has determined, based on the criteria in WAC 173-340-745(1)(a), that industrial land use represents the reasonable maximum exposure for the Site (see Section 2.2 **Land Use**). For industrial properties, cleanup levels for the protection of human health (direct-contact) are based on an adult worker exposure scenario. The need for institutional controls such as environmental covenants to provide long-term worker protection related to direct contact with contaminated soil and groundwater is discussed in Section 5 **Cleanup Action Alternatives and Analysis**.

In addition to the direct-contact CULs that are based on ingestion of soil, soil cleanup levels must be established at concentrations that do not directly or indirectly cause exceedances of groundwater, surface water, sediment, or air cleanup standards established under MTCA or applicable state and federal laws. To address the potential for soil contaminants leaching to groundwater, soil CULs must be established at concentrations that will not cause contamination of groundwater that exceeds groundwater CULs under WAC 173-340-720, including surface water beneficial uses under WAC 173-340-730. The soil cleanup levels shown in Table 4.1 are based on protection of the groundwater to surface water pathway for marine waters.

Soil contamination can also impact indoor air quality directly though volatilization from the soil vadose zone. MTCA does not contain a process for setting soil cleanup levels protective of indoor air and the soil vapor pathway. Screening levels have been developed for groundwater and for soil gas to be protective of indoor air, but not for soil (Ecology, 2022). The cleanup levels for soil gas included in Section 4.5 are used to help ensure that the subsurface soil is protective of indoor air from vapor intrusion.

MTCA also provides procedures for determining whether a release of hazardous substances to soil may pose a threat to the terrestrial environment (WAC 173-340-7490). Because the proposed remedy for this

Site will result in all soil contaminated with hazardous substances being covered by pavement or other physical barriers that will prevent plants or wildlife from being exposed to the soil contamination, no further ecological evaluation is required (WAC 173-340-7491). However, soil CULs based on the protection of groundwater and surface water are more stringent than the ecological screening levels included in MTCA (Table 749-3).

The soil CULs address the following potentially complete exposure pathways and potential receptors:

- Direct contact and ingestion (human health)
- Leaching to ground water that ultimately discharges to sediment/surface water (human health and aquatic life)
- Soil vapor (human health)

The approved RI Report used a fixed parameter three-phase partitioning model (WAC 173-340-747(4)) to calculate soil cleanup levels for the protection of groundwater and surface water quality. This method may be used to establish soil concentrations for any hazardous substance to calculate both unsaturated zone and saturated zone soil concentrations. Default or fixed input parameters are used in the three-phase partitioning model with the intention to be protective under most circumstances and conditions. Site-specific measurements are not required but may be appropriate to use in some cases.

Since the RI Report was completed, both state and federal water quality criteria have been revised. Table 4.1 **Soil Cleanup Levels** presents unsaturated and saturated soil CULs for protection of surface water using the current federal and state water quality criteria. The CULs for the unsaturated soils based on the protection of surface waters are also considered to be protective of direct contact for industrial and construction workers.

4.1.2 Soil Point of Compliance

The point of compliance for soil is based on the exposure pathway addressed by the soil cleanup level.

For soil cleanup levels based on human exposure through direct contact or other potentially complete exposure pathways where contact with the soil is required to complete the pathway, the standard point of compliance is in soils throughout the site from the ground surface to fifteen feet below the ground surface. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities.

For soil cleanup levels based on the protection of ground water, the standard point of compliance is in the soils throughout the Site.

As noted above, MTCA does not contain a process for setting soil cleanup levels based on protection for indoor air. Soil vapor concentrations are used as a surrogate for soil cleanup levels to be protective of indoor air. The point of compliance for these vapor concentrations is described in Section 4.5.

The unsaturated soil CULs in Table 4.1 apply to unsaturated soils and the saturated soil CULs in Table 4.1 apply to saturated soils (below the water table). Until CULs are met, human direct contact risks will be addressed through institutional controls and protectiveness will be demonstrated through on-Site safety plans, monitoring and the periodic review process. This monitoring will include soil gas monitoring to ensure that soil cleanup levels are protective of indoor air.

Table 4.1 Soil Cleanup Levels

Contaminants of Concern	Method C soil cleanup levels (Direct Contact) (mg/kg)	Unsaturated soil cleanup levels based on surface water protection (173-340-747(4)(e)) (mg/kg)	Saturated soil cleanup levels based on surface water protection (173-340-747(4)(a)) (mg/kg)
VOCs			
1,1,1-Trichloroethane	7,000,000	370	21
1,1,2,2-Tetrachloroethane	660	0.0017	0.00001
1,1,2-Trichloroethane	2,300	0.01	0.00033
1,1-Dichloroethene	180,000	26	1.40
1,2,4-Trichlorobenzene	4,500	0.0014	0.0001
1,2,4-Trimethylbenzene	35,000		
1,4-Dichlorobenzene	24,000	3.30	0.18
Benzene	2,400	0.01	0.0006
Carbon tetrachloride	1,900	0.0029	0.00015
Chloroform	4,200	2.90	0.19
cis-1,2-Dichlorethene	7,000		
Ethylbenzene	350,000	0.26	0.02
Methylene chloride	21,000	0.43	0.03
m-Xylene	700,000		
o-Xylene	700,000		
p-Xylene	700,000		
Styrene	700,000		
Tetrachloroethene	21,000	0.03	0.0016
Toluene	280,000	0.92	0.06
trans-1,2-Dichloroethene	70,000	5.20	0.32
Trichloroethene	1,800	0.0044	0.00027
Vinyl chloride	88	0.001	0.00006
SVOCs			
2-Methylnaphthalene	14,000		
Acenaphthene	210,000	3.10	0.16
Anthracene	1,100,000	47	2.40
Benz(a)anthracene			
Benzo(a)pyrene	130	0.0003	0.00002
Benzo(b)fluoranthene			
Benzo(k)fluoranthene			
Bis(2-Ethylhexyl)phthalate	9,400	0.10	0.01
Chrysene			
Dibenz(a,h)anthracene			
Fluoranthene	140,000	5.90	0.30
Hexachlorobenzene	82	0.000008	0.0000004
Hexachlorobutadiene	1,700	0.01	0.001
Indeno(1,2,3-cd)pyrene		0.01	0.001
Naphthalene	70,000	140	7.30
Pentachlorophenol	330		0.0000018
Pyrene	110,000	11	0.55

Pesticides/PCBs/Dioxin			
4.4'-DDD	110		0.00000036
4.4'-DDE	390	0.0000015	0.000000076
4.4'-DDT	390	0.000016	0.000000810
Total PCBs	0.0017		0.0000000013
Dioxin (2,3,7,8-TCDD)	66		0.0000022
Metals			
Antimony	1,400	81	4.10
Arsenic	88	2.90	0.15
Cadmium	3,500	1.10	0.06
Chromium, hexavalent	11,000	19	0.96
Copper	140,000	1.40	0.07
Lead		1,100.00	56
Mercury		0.026	0.001
Nickel	70,000	11	0.54
Silver	18,000	0.32	0.02
Thallium	35	0.32	0.02
Zinc	1,100,000	100	5

4.2 Groundwater Cleanup Standards

4.2.1 Groundwater Cleanup Levels

Ecology has determined that groundwater at the Site is non-potable (naturally unfit for human consumption) based on criteria in WAC 173-340-720(2) (see Section 2.3 **Groundwater Use**) This designation is based on the determination that Site groundwater is not a current or future source of drinking water because it contains naturally occurring saltwater levels which renders it naturally unfit for human consumption.

For non-potable groundwater, MTCA requires that groundwater cleanup levels shall not exceed the surface water cleanup levels derived under WAC 173-340-730 at the ground water point of compliance or exceed the surface water or sediment quality standards at any point downstream, unless it can be demonstrated that the hazardous substances are not likely to reach surface water. This demonstration must be based on factors other than implementation of a cleanup action at a site.

Groundwater from the Site eventually discharges into the Hylebos Waterway and Commencement Bay. Groundwater CULs at the Site are based on protection of surface water beneficial uses in marine water (Table 4.2). The groundwater CULs address the following potentially complete exposure pathways and potential receptors:

- Discharge to marine sediment (human health and aquatic life)
- Discharge to marine surface water (human health and aquatic life)

The CULs for the Site COCs are based on the current state and federal water quality criteria for marine surface water (WAC 173-201A and Clean Water Act Section 304(a)).

Table 4.2. Surface Water and Groundwater Cleanup Levels

Contaminants of Concern	Aquatic Life Criteria				Human Health Criteria	
	Marine Acute 173-201A WAC (µg/L)	Marine Acute CWA §304 (µg/L)	Marine Chronic 173-201A WAC (µg/L)	Marine Chronic CWA §304 (µg/L)	Marine Water 40 CFR 131.45 (µg/L)	Marine Water CWA §304 (µg/L)
VOCs						
1,1,2,2-Tetrachloroethane						
1,1,2-Trichloroethane					0.9	8.9
1,1-Dichloroethene					4,000	20,000
Carbon tetrachloride					0.35	5
Chloroform					600	2,000
Ethylbenzene					31	130
Methylene chloride					100	1,000
Tetrachloroethene					2.9	29
cis-1,2-Dichlorethene						
trans-1,2-Dichloroethene					1,000	4,000
Trichloroethene					0.7	7
Vinyl chloride					0.18	1.6
1,1,1-Trichloroethane					50,000	200,000
1,2,4-Trimethylbenzene						
1,4-Dichlorobenzene					200	900
Benzene					1.6	16
m-Xylene						
o-Xylene						
p-Xylene						
Styrene						
Toluene					130	520
SVOCs						
1,2,4-Trichlorobenzene					.037	.076
Bis(2-Ethylhexyl)phthalate					.046	.37
Hexachlorobutadiene					0.01	0.01
Hexachlorobenzene					0.000005	0.000079
Pentachlorophenol	13	13	7.9	7.9	0.002	0.04
Acenaphthylene						
Acenaphthene					30	90
Anthracene					100	400
Benz(a)anthracene					0.00016	0.0013
Benzo(a)pyrene					0.000016	0.00013
Benzo(b)fluoranthene					0.00016	0.0013
Benzo(k)fluoranthene					0.0016	0.013
Chrysene					0.016	0.13
Dibenz(a,h)anthracene					0.000016	0.00013
Fluoranthene					6	20

Indeno(1,2,3-cd)pyrene					0.00016	0.0013
2-Methylnaphthalene						
Naphthalene						
Phenanthrene						
Pyrene					8	30
Pesticides/PCBs/Dioxin						
4.4'-DDD					0.0000079	0.00012
4.4'-DDE					0.00000088	0.000018
4.4'-DDT					0.0000012	0.00003
Total PCBs	10		0.03	0.03		
Dioxin (2,3,7,8 TCDD)					0.000000064	0.0000000051
Metals						
Antimony					90	640
Arsenic	69	69	36	36	0.14	0.14
Cadmium	42	33	9.3	7.9		
Chromium, hexavalent	1,100	1,100	50	50		
Copper	4.8	4.8	3.1	3.1		
Lead	210	210	8.1	8.1		
Mercury	1.8	1.8	0.025	0.94		
Nickel	74	74	82	82	100	4,600
Silver	1.9	1.9				
Thallium					0.27	0.47
Zinc	90	90	81	81	1,000	26,000
Water Quality Criteria for "Good" Marine Water						
pH			7.0 – 8.5			
Temperature (highest 1-day Max)			19°C			
Dissolved Oxygen (lowest1-day Min)			5.0 mg/L			
Turbidity			10 NTU over background			

Notes: NTU – nephelometric turbidity unit
µg/L – Micrograms per liter

4.2.2 Groundwater Point of Compliance

The standard POC for groundwater is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site.

4.3 Sediment Cleanup Standards

4.3.1 Sediment Cleanup Levels

EPA established cleanup objectives for the Hylebos Waterway and Site sediments. Pursuant to the 2020 AOC, EPA intends to re-evaluate the Site sediments "[f]ive years [after] the date that a consent decree or order implementing a final MTCA CAP for the [Site] is issued…."

Under this arrangement Ecology's role is to ensure that sediments are protected from contaminated groundwater. The proposed remedy is focused on source removal, control, and containment of contamination from the Site.

Section 3.3 Cleanup Action Expectations established RAOs that include prevention of further contamination of sediments. These RAOs were developed in consultation with EPA so that the two agencies are aligned in expectations for the effectiveness of the cleanup remedy.

EPA's cleanup levels for sediment are based on Sediment Quality Objectives that were established during the development of the 1989 ROD for the mouth of the Hylebos. A sediment dredging, capping, and natural recovery remedy was implemented for the Head and the Mouth of Hylebos Waterway under EPA's oversight. Active dredging and capping were completed between 2002 and 2008. These levels, while considered protective at the time, are not as stringent as Ecology's current, updated cleanup standards for sediments. MTCA addresses sediment cleanup levels by reference to the Washington State Sediment Management Standards (SMS) (Chapter 173-204 WAC). Under the SMS, the primary endpoints for sediment quality evaluations is protection of the environment and human health from adverse effects associated with the Site COCs. Under MTCA's requirements Ecology must establish cleanup levels based on the SMS. Table 4.3 provides a comparison of Sediment Quality Objectives to SMS cleanup levels by constituent.

The proposed remedy in this CAP protects sediments by establishing groundwater cleanup levels that are below the SMS cleanup standards.

Table 4.3 Sediment Cleanup Levels.

Contaminants of Concern	Sediment Cleanup Levels	
	Sediment Quality Objectives (From EPA ROD)	Sediment Management Standards (WAC 173-204)
VOCs	**µg/kg Dry Weight**	**µg/kg Dry Weight**
1,1,2,2-Tetrachloroethane		
1,1,2-Trichloroethane		
1,1-Dichloroethene		
Carbon tetrachloride		
Chloroform		
Ethylbenzene	10	
Methylene chloride		
Tetrachloroethene	57	
cis-1,2-Dichlorethene		
trans-1,2-Dichloroethene		
Trichloroethene		
Vinyl chloride		
1,1,1-Trichloroethane		
1,2,4-Trimethylbenzene		
1,4-Dichlorobenzene		
Benzene		
m-Xylene		

o-Xylene		
p-Xylene		
Styrene		
Toluene		
Pentachlorophenol	360	360
SVOCs	**µg/kg Dry Weight**	**mg/kg Organic Carbon[1]**
1,2,4-Trichlorobenzene	51	0.81
Bis(2-Ethylhexyl)phthalate	1,300	47
Hexachlorobutadiene	11	3.9
Hexachlorobenzene	22	0.38
Acenaphthene	500	16
Acenphthylene	1,300	66
Anthracene	960	220
Benz(a)anthracene	1,600	110
Benzo(a)pyrene	1,600	99
Benzo(b)fluoranthene		
Benzo(k)fluoranthene		
Total benzofluoranthenes	3,600	230
Chrysene	2,800	110
Dibenz(a,h)anthracene	230	12
Fluoranthene	2,500	160
Indeno(1,2,3-cd)pyrene	690	34
2-Methylnaphthalene	670	38
Naphthalene	2,100	99
Phenanthrene	1,500	100
Pyrene	3,300	1,000
Pesticides/PCBs/Dioxin	**µg/kg Dry Weight**	**mg/kg Organic Carbon[1]**
4.4'-DDD	16	
4.4'-DDE	9	
4.4'-DDT	34	
Total PCBs	0.30	12
Dioxin (2,3,7,8 TCDD)		
Metals	**mg/kg Dry Weight**	**mg/kg Dry Weight**
Antimony	150	
Arsenic	570	57
Cadmium	5.1	5.1
Chromium, hexavalent		260
Copper	390	390
Lead	450	450
Mercury	0.59	0.41
Nickel	140	
Silver	6.1	6.1
Thallium		
Zinc	410	410

[1] For chemical criteria listed in "mg/kg Organic Carbon", the criteria are in parts per million "normalized" or expressed on a total organic carbon basis. To normalize to total organic carbon, the dry weight concentration for each parameter is divided by the decimal fraction representing the percent total organic carbon content of the sediment.

4.3.2 Sediment Point of Compliance

The point of compliance for achieving the sediment cleanup levels to protect aquatic life is within the biologically active zone. Ecology and EPA have generally applied the 0 to 10 cm biologically active zone interval within the Hylebos Waterway based on available information on the distribution of abundance and biomass of biota in Commencement Bay sediments.

4.4 Surface Water Cleanup Standards

Under MTCA (WAC 173-340-730), surface water CULs are based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under both current and potential future Site use conditions. The surface water of the Hylebos Waterway is marine water. People may consume fish (or other aquatic organisms) that are present in the Hylebos Waterway during certain fish life stages.

Surface water cleanup standards for the Site, consisting of surface water cleanup levels and the location (point of compliance) where these cleanup levels must be met, have been established based on the surface water cleanup standards in the MTCA regulations, WAC 173-340-730, and with the state water quality standards in WAC 173-201A, and Clean Water Act Section 304(a) water quality criteria.

4.4.1 Surface Water Cleanup Levels

Surface water cleanup levels for the Site are based on water quality criteria protective of aquatic organisms or risk to human health from the consumption of fish and other aquatic organisms. The surface water quality criteria listed in Table 4.2 are also the surface water CULs.

4.4.2 Point of Compliance

The standard point of compliance for surface water cleanup levels is the point or points at which hazardous substances are released to surface waters of the state. However, because site groundwater cleanup levels must be as stringent as surface water cleanup levels, the point of compliance for surface water cleanup levels is in groundwater throughout the Site.

4.5 Air (Soil Vapor and Indoor Air)

4.5.1 CUL

Cleanup levels for indoor air and sub-slab soil vapor are set equal to the screening levels described in Ecology's Guidance for Evaluating Vapor Intrusion in Washington State Ecology (Ecology, 2022). These screening levels, which are included in the Cleanup Levels and Risk Calculation (CLARC) VI data tables (Ecology, 2021b), are based on the standard MTCA Method C carcinogenic and non-carcinogenic indoor air cleanup levels calculated using procedures in WAC 173-340-750.[4] The screening levels apply to any building where subsurface contamination poses a potential threat to indoor air quality from vapor intrusion, including buildings where the primary receptors of concern are workers.[5]

Although the MTCA Cleanup Rule (Chapter 173-340 WAC) does not contain a specific process for establishing soil gas cleanup levels protective of indoor air, the screening levels included in the CLARC VI

[4] Workplace safety is regulated by both the Washington State Department of Labor & Industries (L&I) Division of Occupational Safety and Health (DOSH) and the federal Occupational Safety and Health Administration (OSHA). OSHA and DOSH establish permissible exposure limits for workplace chemicals. For most VOCs, the human health-based indoor air cleanup levels required under MTCA are much lower than the permissible exposure limits (Ecology, 2021a).

[5] The screening levels in the Ecology vapor intrusion guidance (2022) and in the CLARC VI data tables include values for indoor air and values for sub-slab soils. The screening levels apply to "air within any building, utility vault, manhole or other structure large enough for a person to fit into" (WAC 173-340-750(1)(a)).

data tables are based on cleanup levels calculated using procedures in WAC 173-340-750. These screening levels can be used to help ensure that the subsurface media cleanup levels are protective of indoor air from vapor intrusion (Ecology, 2021a).

Addressing vapor intrusion as part of the site cleanup action not only focuses on existing buildings, but also on future actions, including new building construction, significant modifications to existing structures, or changes to the types of occupants present. Two options are available to ensure that cleanup actions are protective of both current and future uses: 1) achieve subsurface levels low enough that vapor intrusion is unlikely to result in indoor air concentrations higher than the air cleanup levels, or, 2) use institutional controls, and if needed engineered controls, to assure that vapor intrusion will not result in indoor air cleanup level exceedances.

Table 4.4 Indoor Air and Sub-slab Vapor Cleanup Levels

Contaminants of Concern	Method C cleanup levels (CLARC)				
	Risk Driver for Individual Chemicals	Indoor Air Cleanup Level Method C Noncancer (µg/m³)	Indoor Air Cleanup Level Method C Cancer (µg/m³)	Sub-Slab Soil Gas Screening Level Method C Noncancer (µg/m³)	Sub-Slab Soil Gas Screening Level Method C Cancer (µg/m³)
Benzene	Cancer	30	3.2	1,000	110
Carbon tetrachloride	Cancer	100	4.2	3,300	140
Chloroform	Cancer	98	1.1	3,300	36
1,4-Dichlorobenzene	Cancer	800	2.3	27,000	76
1,1-Dichloroethene	Noncancer	200		6,700	
trans-1,2-Dichloroethene	Noncancer	40		1,300	
Ethylbenzene	Noncancer	1000		33,000	
Hexachlorobenzene	Cancer		0.054		1.80
Hexachlorobutadiene	Cancer		1.1		38
Methylene chloride	Noncancer	600	2500	20,000	83,000
Naphthalene	Cancer	3	0.74	100	25
Styrene	Noncancer	1000		33,000	
1,1,2,2-Tetrachloroethane	Cancer		0.43		14.0
Tetrachloroethene	Noncancer	40	96	1,300	3,200
Toluene	Noncancer	5000		170,000	
1,2,4-Trichlorobenzene	Noncancer	2		67	
1,1,1-Trichloroethane	Noncancer	5000		170,000	
1,1,2-Trichloroethane	Noncancer	0.20	1.6	6.70	52
Trichloroethene	Noncancer	2	6.1	67	200
1,2,4-Trimethylbenzene	Noncancer	60		2,000	
Vinyl chloride	Cancer	100	2.8	3,300	95
Xylenes (total)	Noncancer	100		3,300	

Note: $\mu g/m^3$ – micrograms per cubic meter.

Table 4.5 Soil Vapor Screening Levels

Substance	Indoor Air CUL ($\mu g/m^3$)	Target Soil Vapor Level ($\mu g/m^3$)
1,2,4-Trimethylbenzene	60	1,980
Chloroform	1.1	3.7
Naphthalene	0.7	23
PCE	40	1,300
TCE	2	67
VC	2.8	93

5. Cleanup Action Alternatives and Analysis

5.1 Overview of Cleanup Action Alternatives

The alternatives in the approved FS represent a complete evaluation of technologies that use permanent solutions to the maximum extent practicable. Ecology combined the technologies into additional alternatives that are more aggressive in removing contamination and consider the Conceptual Site Model, MTCA's requirements, and public concerns. Seven cleanup action alternatives, identified as A through G, were evaluated, pursuant to WAC 174-340-360 and -370. These alternatives were developed by combining or repackaging elements of various alternatives that were included in the FS.

Ecology selected Alternative E as the remedy for the Site. The following sections explain Ecology's analysis that arrived at this decision. Alternatives A through G are first presented and described, then analyzed and evaluated to explain Ecology's selection of Alternative E.

5.1.1 Combining Technologies

To assemble the seven alternatives that best represent the options, Ecology identified a number of common elements necessary for all of the alternatives to be effective. Each alternative includes technologies that address the common elements and then adds additional technologies.

The following elements are common to all the proposed alternatives:

- Institutional controls (ICs)
- Physical direct contact exposure (PDCE) barrier
- Vertical barrier wall adjacent to the Hylebos Waterway
- Extraction and treatment of groundwater
- Groundwater monitoring
- Soil vapor and indoor air monitoring
- Porewater and sediment monitoring

5.1.2 Descriptions of Alternatives

Alternative A: Hydraulic containment

The hydraulic containment alternative is designed to eliminate, reduce, or otherwise control risks posed through potentially complete exposure pathways and migration routes, and includes the following elements:

- Physical direct contact exposure (PDCE) barrier for 605 and 709 E. Alexander Avenue properties, Navy Todd Dump, N Landfill, and the 709 E. Alexander Avenue Embankment Fill Area

- Vertical barrier wall adjacent to the Hylebos Waterway
- Hydraulic containment through a newly-constructed groundwater extraction and treatment system

Alternative B: Alternative A plus volatile organic compound (VOC) source area mass reduction by strategic groundwater pumping

Source area mass reduction by strategic groundwater pumping involves extracting shallow and deep groundwater within areas of high concentrations of CVOC outside the areas of high pH and high dissolved silica. The goal is to achieve a higher initial rate of mass removal than Alternative A. Mass reduction extraction wells would be strategically placed in areas of high CVOC concentrations in both saturated soil and groundwater (i.e., near dense non-aqueous phase liquids (DNAPL) source zones). The location of mass reduction extraction wells near CVOC source zones can accelerate mass dissolution from DNAPL. This will expedite source area depletion. Strategic pumping can increase mass removal efficiency and decrease mass loading to groundwater (i.e., reduces dissolved phase contamination).

Direct pumping from areas of high pH and high dissolved silica will be avoided to prevent or minimize:

1. potential fouling of the extraction and treatment system,
2. the need for treatment of high pH water, and
3. generation, handling, and disposal of significant additional solids associated with treatment of this groundwater.

Alternative C: Alternative B plus excavation of soil above 0 ft NAVD 88 containing total chlorinated volatile organic compound (TCVOC) concentrations greater than 100 mg/kg[6]

[6] The elevation of the ground surface at the Occidental site is approximately 16 ft NAVD 88. Elevation 0 ft NAVD 88 corresponds to a depth of approximately 16 feet below ground surface (bgs) and elevation -17 ft NAVD 88 corresponds to a depth of approximately 33 feet bgs.

The mass removal element of Alternative C was designed to remove near-surface soil potentially containing DNAPL that could be a future source of contamination in soil and groundwater. This alternative includes the following elements:

- Excavation of shallow soil above 0 ft NAVD 88 containing TCVOC concentrations greater than 100 mg/kg.
- Removal of VOC from the excavated soil by on-Site treatment.
- Backfill on Site of treated excavated soil. The TCVOC concentration of 100 mg/kg is representative of areas with confirmed or potential DNAPL.

The estimated mass of TCVOC in the area that is targeted for excavation is approximately 23,200 pounds, which represents 3.0 percent of the estimated total DNAPL mass of 780,000 pounds.

Soil above 0 ft NAVD 88 that has TCVOC concentrations greater than 100 mg/kg would be excavated and consolidated into piles set up for treatment to reduce VOC concentrations. Excavated soil that is saturated would require dewatering/drying before treatment. The excess water from the piles would drain back into the excavations. Soil that has TCVOC concentrations less than 100 mg/kg overlying the soil targeted for on-Site treatment would be temporarily stockpiled separately for reuse.

The on-Site treatment would involve ex situ soil vapor extraction (SVE) to remove VOC from the soil followed by treatment of the extracted vapors by a portable thermal oxidizer system and/or activated carbon. SVE is typically an in situ remedial technology that may be applied to stockpiles of excavated soil.

There are various types of vapor extraction methods including vertical and horizontal pipes, gravel beds, and trenches. Synthetic membranes are often placed over the soil surface to prevent short-circuiting and to increase the radius of influence of the extraction pipes.

Thermal oxidation would involve transferring extracted soil vapors through a vessel that uses thermal processes (e.g., exposure to flame) to oxidize VOC into innocuous compounds before being released to the atmosphere. Activated carbon treatment would involve transferring extracted soil vapors through filtrate vessels, which promote adsorption of VOC via contact with filter material.

Following completion of the SVE, the treated soil and soil suitable for reuse would be backfilled on the 605 E. Alexander Avenue property within and around the excavations and ultimately would be under a PDCE barrier. Excavations beyond the 605 E. Alexander Avenue property would be backfilled with soil suitable for reuse and/or imported clean material. The surfaces would be returned to the same or better conditions that were present prior to the excavation.

Alternative D: Alternative B plus excavation of soil above 0 ft NAVD 88 containing total chlorinated volatile organic compound (TCVOC) concentrations greater than 100 mg/kg and in-situ treatment

of soil below 0 ft NAVD 88 and above -17 ft NAVD 88 containing TCVOC concentrations greater than 500 mg/kg

Alternative D was designed to further reduce TCVOC concentrations in shallow soil potentially containing DNAPL that could be a future source of contamination in soil and groundwater. Alternative D includes the following elements:

- Excavation of shallow soil above 0 ft NAVD 88 containing TCVOC concentrations greater than 100 mg/kg.
- Removal of VOC from the excavated soil by on-Site treatment.
- Backfill on Site of treated excavated soil.
- Treatment of shallow soil below 0 ft NAVD 88 and above -17 ft NAVD 88 containing TCVOC concentrations greater than 500 mg/kg using in situ electrical resistance heating (ERH) with SVE.

The estimated mass of TCVOC within the volume of soil defined by the parameters above is approximately 66,200 pounds, which represents 8.5 percent of the estimated total mass of DNAPL of 780,000 pounds.

ERH is a thermal treatment technology that increases the temperature of the saturated zone and allows contaminants to be more easily volatilized, mobilized, and extracted from the subsurface. ERH involves the installation of electrodes in the ground and passing an alternating current through the electrodes, thereby heating the soil. Steam is generated when the subsurface temperature is raised to the boiling point of the saturated media. The steam strips the contaminants from the subsurface and enables extraction through liquid or vapor recovery wells.

Alternative E: Alternative B plus removal of 60,000 pounds of TCVOC through early-action soil treatment above -6 ft NAVD 88 containing total chlorinated volatile organic compound (TCVOC) concentrations greater than 500 mg/kg

Alternative E is the selected remedy for the Site. The shallow soil and shallow groundwater early removal action source treatments involves dewatering soils above -6 ft. NAVD 88 containing TCVOC concentrations greater than 500 mg/kg, via extracting and treating impacted shallow groundwater, and then treating the dewatered soils and soils above using soil vapor extraction (SVE).

Dewatering will be accomplished using groundwater extraction wells. The SVE system may include vertical and horizontal pipes, gravel beds, and trenches. Horizontal drilling may be used to access some locations. Groundwater from the dewatering system and vapors from the SVE system will be treated using the existing on-Site groundwater treatment plant.

SVE is an in situ remedial technology where a vacuum is applied through extraction wells located near elevated chemical concentrations in the unsaturated soil zone. Volatile constituents of the chemical mass volatilize and the vapors are drawn toward the extraction wells thus reducing the concentrations of VOC sorbed to the soil in the vadose zone. The extracted vapors are then typically treated as necessary using thermal oxidation or activated carbon before being released to the atmosphere. Synthetic membranes are often placed over the soil surface to prevent short-circuiting and to increase the radius of influence of the extraction wells.

Mass removal will be calculated by measuring SVE air concentrations, extracted groundwater concentrations, air flow rates, and groundwater flow rates. After 60,000 pounds of TCVOC mass are removed during these early removal action source treatments, the active VOC removal in the dewatered zone may stop. Continued periodic monitoring must occur to verify that sub-slab and soil vapor monitoring points outside of the property boundary are meeting or approaching the cleanup levels.

The OCC office building at 605 E. Alexander Avenue will be removed or mitigated for vapor intrusion within three years of the startup date for the early-actions source treatments should concentrations be above Site specific indoor air CULs, unless early-action source treatment continues and soil vapor concentrations in the vicinity of the office building are meeting or approaching the cleanup levels.

In order to address current and potential risk from vapor intrusion soil vapor contamination outside the OCC property boundary on the Earley Business Center will be monitored and compared to established screening levels. At the end of the early removal action source treatment, if soil vapor monitoring data are above screening levels OCC will initiate a focused feasibility study to evaluate practicable contingency actions. These may include additional treatment, engineered controls, or institutional controls, or a combination of actions. A Supplemental EDR may be required based on the supplemental FS.

The early removal action source treatments are designed to avoid significant delay in implementing the hydraulic containment and strategic groundwater pumping elements of the cleanup action. The early removal action will be implemented in the first 5 years of the remedy. Mass removal will be tracked over this period to ensure the performance standard of 60,000 lbs removed is progressing as designed. If the performance standard will not be met as projected an adaptive management process will be applied to evaluate further options.

The early removal action source treatment systems and the hydraulic containment and strategic groundwater pumping elements of the cleanup actions described under Alternatives A and B will be coordinated and scheduled so that none of the systems interfere with the implementation of the others. The groundwater containment and mass removal system described under Alternatives A and B must be designed so that it can operate simultaneously with the SVE system should both elements be required.

Alternative F: Alternative E plus in-situ treatment of groundwater above -56 ft NAVD 88 containing TCVOC concentrations greater than 10 mg/L

Alternative F was designed to further reduce TCVOC concentrations in shallow groundwater and in shallow soil potentially containing DNAPL (considered “principal threat waste” by EPA) that could be a future source of contamination in soil and groundwater. Alternative F includes elements from Alternative E (excavation, thermal treatment, and SVE) plus the following elements for in situ treatment of shallow groundwater:

- Treatment using in situ chemical oxidation (ISCO) of shallow groundwater above -56 ft NAVD 88 containing TCVOC concentrations greater than 10 mg/L within the zone where pH is between 10 s.u. and 12.5 s.u.

- Treatment using enhanced in situ bioremediation (ISB) of shallow groundwater above -56 ft NAVD 88 containing TCVOC concentrations greater than 10 mg/L within the zone where pH is less than 10 s.u.

The estimated mass of TCVOCs within the volume of soil and groundwater defined by the parameters above is approximately 81,600 pounds, which represents 10.5 percent of the estimated total mass of DNAPL of 780,000 pounds.

ISCO by injection would be used to introduce chemical oxidant into groundwater to react with and destroy organic contaminants. Multiple injections of the oxidant are usually required and for the Site would be completed using installed wells because of the depth of the target zone. Alkaline persulfate would be used as the oxidant because it would take advantage of the synergistic effects of the elevated pH in groundwater between 10 s.u. and 12.5 s.u. to activate the alkaline persulfate. This technology is non-selective meaning that other organic material present in the target zone would be oxidized along with the targeted organic material. Therefore, overdosing would be required to effectively treat the groundwater.

ISB by injection in wells would be used to establish vertical "curtains" of biological activity where impacted groundwater would flow through treating (degrading) VOCs. Multiple injections of the substrate (emulsified vegetable oil), Dehalococcoides spp. (DHC) and enhancements are usually required to maintain suitable conditions for biological activity. Additionally, an electron donor would be released into groundwater and would be transported downgradient of each "curtain." The electron donor would promote further contaminant biodegradation in the aquifer. The target zone for this technology would be within areas of pH that are less than 10 s.u., since it is not effective in higher pH.

Alternative G: Alternative F plus in-situ treatment of groundwater containing TCVOC concentrations greater than 10 mg/L

Alternative G was designed to further reduce TCVOC concentrations in shallow and deep groundwater and soil potentially containing DNAPL that could be a future source of contamination in soil and groundwater. Alternative G includes elements of Alternative F plus the following elements for in situ treatment of deeper soil and groundwater:

- Treatment using ISCO of deep soil below -56 ft NAVD 88 containing TCVOC concentrations greater than 500 mg/kg within the zone where pH is between 10 s.u. and 12.5 s.u.

- Treatment using ISB of deep soil below -56 ft NAVD 88 containing TCVOC concentrations greater than 500 mg/kg within the zone where pH is less than 10 s.u.

- Treatment using ISCO of deep groundwater below -56 ft NAVD 88 containing TCVOC concentrations greater than 10 mg/L within the zone where pH is between 10 s.u. and 12.5 s.u.

- Treatment using ISB of deep groundwater below -56 ft NAVD 88 containing TCVOC concentrations greater than 10 mg/L within the zone where pH is less than 10 s.u.

The estimated mass of TCVOC within the volume of soil and groundwater defined by the parameters above is approximately 613,300 pounds, which represents 78.6 percent of the estimated total mass of DNAPL of 780,000 pounds.

5.1.3 High pH

The January 2017 FS included alternatives for addressing high pH areas on the Site. These alternatives include in-situ treatment or containment of soil and groundwater in the high pH areas. The high pH conditions in the subsurface do not pose a risk to people, the environment, or to the stability of the ground surface. The potential discharge of shallow high pH groundwater via seeps adjacent to the Hylebos Waterway will be addressed through the vertical barrier wall that is a common element in all the alternatives.

For both Ecology and OCC, the primary concern about the high pH is that it presents technical problems for physically pumping and treating groundwater from areas that contain high pH and solvent contamination that is to be removed or contained. Although the effects of high pH are considered in evaluating the seven alternatives listed above, alternatives for addressing pH contamination are not explicitly required in this CAP. It is not intended that pumping for mass reduction will be conducted in areas where both high pH and high dissolved silica are present.

5.1.4 Initial Screening of Alternatives

Cleanup actions selected under the MTCA Cleanup Regulation must meet the four threshold (minimum) requirements. Alternatives that do not comply with these criteria are not acceptable cleanup actions under MTCA. The initial screening by Ecology considered these four threshold requirements and Ecology concluded that the requirements were met by all seven cleanup alternatives.

Requirements for minimum cleanup thresholds are specified in WAC 173-340-360(2)(a) as follows:

- Protect human health and the environment
- Comply with cleanup standards (see WAC 173-340-700 through 173-340-760)
- Comply with applicable state and federal laws (see WAC 173-340-710)
- Provide for compliance monitoring (see WAC 173-340-410 and 173-340-720 through 173-340-760)

In developing the FS, OCC separately considered remediation elements associated with containment and remediation elements associated with VOC mass removal. OCC determined that the containment elements are administratively and technically possible and would meet the minimum threshold requirements specified in WAC 173-340-360(2)(a).

OCC also determined that the VOC mass removal/reduction elements are administratively and technically possible but that they would not meet all the minimum threshold requirements specified in WAC 173-340-360(2)(a) unless they were combined with containment elements. Ecology agreed with this assessment and assembled the seven alternatives with a containment element. Ecology asserts that the seven Alternatives A through G meet the WAC 173-340-360(2)(a) threshold requirements, including protection of human health and the environment [-360(2)(a)(i)] and compliance with cleanup standards [-360(2)(a)(ii)], provided proper institutional controls are incorporated with each alternative. These include, but not be limited to:

- Site access control
- Restrictions on groundwater use
- Protection of indoor workers from vapor intrusion
- Building construction requirements to prevent vapor intrusion
- Protection of outdoor construction workers (“trenchers”) working below grade in areas of shallow soil, soil vapor, and/or shallow groundwater contamination

Ecology’s approach for evaluating the seven alternatives is that each will meet threshold requirements associated with protectiveness and cleanup standards. We factored in the different degrees of protectiveness the alternatives are likely to provide. While the seven alternatives all meet the threshold criteria, not all seven alternatives meet all other criteria and requirements included in MTCA, as discussed in the sections that follow.

5.2 DCA Methodology

The DCA methodology provides a systematic cost-benefit analysis as the way to select a cleanup action that ensures the selected remedy’s cost is in line with the benefits it will provide. This section provides a comparative analysis that supports the selection of Alternative E as the remedy.

5.2.1 Overview

Ecology prepared an agency DCA to compare a total of seven alternatives by evaluating their incremental costs and incremental degree of benefits. The MTCA Cleanup Regulations require a cost-benefit approach in the form of a DCA to assist Ecology in selecting a remedy. MTCA requires that only the alternatives that meet the threshold requirements are compared in the DCA. The process identifies the alternative whose incremental costs are not disproportionate to the incremental degree of benefits.[7]

Once screened through the threshold requirements the alternatives are evaluated with additional criteria:

- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
- Consider public concerns

Factors considered in this evaluation also include:

- Protectiveness
- Permanence
- Cost
- Effectiveness over the long term
- Management of short-term risks
- Technical and administrative implementability
- Consideration of public concerns

The DCA evaluation involves ranking the alternatives from most to least permanent and then comparing the incremental costs and incremental degree of benefits of ranked alternatives. To do the comparison a baseline alternative is selected that is the most practicable permanent solution or the alternative that provides the greatest degree of permanence (if no practicable permanent solution is feasible) irrespective of cost.

As previously stated, the selected cleanup action must use permanent solutions to the maximum extent practicable. Permanent solutions are actions in which cleanup standards are meet without requiring further action such as monitoring or institutional controls. MTCA requires selection of the most practicable permanent solution from among those cleanup action alternatives that are protective of human health and the environment and meet the threshold requirements.

Ecology's approach to this DCA also includes a qualitative evaluation. As the regulations note, a DCA "will often be qualitative and require the use of best professional judgment. In particular, the department

[7] Incremental cost between alternatives is the difference in cost between the higher-ranked alternative and the lower-ranked alternative. Incremental degree of benefits is the difference in benefit score between the higher-ranked alternative and the lower-ranked alternative.

has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action." (WAC 173-340-360(3)(e)(ii)(C) The next sections provide Ecology's analysis, and identifies the qualitative factors applied towards selection of the remedy.

5.2.2 Analysis

As presented earlier the seven cleanup alternatives evaluated all include hydraulic containment (containment by pumping groundwater) and a set of common elements. The seven alternatives differ in terms of the remediation that focuses on treating or removing contaminant mass from groundwater and soils.

With Alternative A, there is no additional mass removal beyond the mass removed as part of the containment system, and in situ treatment is not a component of the alternative. Alternative B adds mass removal by pumping groundwater for shallow and deep high-concentration areas, Alternative C adds to Alternative B mass removal by both pumping groundwater and excavating contaminated soil for shallow high-concentration areas. Alternative D adds to Alternative B groundwater pumping, soil excavation, and in-place treatment for shallow high-concentration areas. Alternative E adds to Alternative B shallow groundwater dewatering and vapor extraction for shallow high-concentration areas with possible contingent treatment if performance measures or CUL are not met. Finally, Alternatives F and G add additional treatment for high-concentration areas that are deeper than those treated under Alternatives D and E. See Table 4.1 summarizing the features of each alternative.

In general, the first alternatives listed (e.g., A and B) remove contamination more slowly than the remaining alternatives. Alternative D treats soil contamination that is deeper than soils treated under Alternative C, and Alternative E focuses on early-action shallow groundwater and soil treatment. Alternatives F and G are more technically difficult and risky to implement, but are also slightly more permanent and effective over the long term. They are also significantly more costly.

The analysis of the seven alternatives is detailed in the next subsections in order of the listed criteria.

5.2.2.1 Protectiveness, WAC 173-340-360(3)(f)(i)

Overall protectiveness of human health and the environment considers the degree that existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement to overall environmental quality.

The degree of expected protectiveness for an alternative varies. It depends on how quickly the protection is achieved and the certainty that protectiveness will be adequately maintained over time. The alternatives with more mass removal during the earlier phases of remediation have a higher score in terms of protectiveness. Alternative A is the least protective cleanup action and Alternative G the most protective. Alternative E has a relatively high score for overall protectiveness because it allows early removal of TCVOC mass from shallow soil without delaying implementation of the long-term cleanup actions.

Removing TCVOC mass from the subsurface or treating mass in-situ will be more protective than leaving the mass in place, particularly considering the long restoration time frame that is associated with the Site. The long restoration time frame increases the likelihood that institutional controls may deteriorate, and the likelihood that natural disasters will occur during the life of the remedy. This includes those associated with earthquakes and the effects of climate change. Ecology factored in considerations of resiliency for the remedy and the location of the Site consistent with current climate change guidance.

Removing TCVOC mass from shallow soils will also reduce the risk of potential exposures of CVOCs to indoor workers inhaling contaminated indoor air due to vapor intrusion from soils or to individuals working outdoors below grade in areas of shallow soil, soil vapor, and/or shallow groundwater contamination. Transport of CVOC into the vadose zone due to seasonal water table fluctuations are reduced through shallow VOC removal or treatment. This will also increase protectiveness.

While institutional controls may afford adequate protection from soil vapor, a greater degree of protection results from relying less on them and either reducing the length of time that CVOC concentrations in shallow soil, soil vapor, and shallow groundwater exceed health-based levels or reducing the physical extent of the shallow areas of contamination.

Each of the seven alternatives reduces the risk of potential exposures to the Hylebos Waterway and Commencement Bay potential receptors (including humans who consume fish or shellfish) due to potential Site-related contamination of surface water and/or sediments. The alternatives address this pathway via groundwater containment and treatment systems. For those alternatives that also include VOC removal and/or treatment there is less reliance on future containment to reduce groundwater CVOC concentrations and to achieve or maintain surface water-based cleanup levels. The reduction of risk to Commencement Bay and or the Hylebos Waterway depends on the amount of TCVOCs removed or treated before reaching the surface water pathway.

5.2.2.2 Permanence, WAC 173-340-360(3)(f)(ii)

Permanence is the degree that the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances. This includes the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of the waste treatment process, and the characteristics and quantity of treatment residuals generated.

Ecology recognizes that none of the seven alternatives result in permanent cleanup action at the Site. Permanent cleanup action as defined by MTCA at the Site is not practicable.

For non-permanent alternatives, MTCA requires treatment or removal of areas contaminated with high concentrations of hazardous substances, highly mobile hazardous substances, or hazardous substances that cannot be reliably contained. These include areas with high concentrations of VOCs in soil or groundwater that contribute to the vapor exposure pathway. While Ecology sought to include technologies that would provide treatment or removal of areas with high concentrations at the Site, the technical impracticability of these measures along with cost/benefit analysis must be considered.

At the same time cleanup actions must not rely primarily on institutional controls and monitoring alone where it is technically practicable to implement a more permanent cleanup action for all or a portion of a site. For example, institutional controls alone are not a preferred approach under MTCA.

By contrast alternatives that address the vapor pathway through VOC removal and/or treatment are preferred. Not all the alternatives address the vapor intrusion pathway except through institutional controls.

When off-site properties are impacted by the migration of contamination from a source, MTCA requires active cleanup up actions that protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route and accomplish site restoration. Since vapor intrusion is occurring off-Site the alternatives that actively address this exposure pathway are preferred.

Ecology determined for the Site the degree of permanence is directly associated with the amount and timing of mass removal and in-situ treatment. Alternatives A and B are considered to be the least permanent options among the seven alternatives evaluated. Alternative G is the most permanent.

It should be noted that all seven alternatives require hydraulic containment for an indefinitely long period of time. Even Alternative G, with the most aggressive and extensive removal or treatment elements, will result in large areas with groundwater and soil contamination exceeding cleanup standards. While none of the alternatives achieve full permanence in the 100-year time frame because of technical limitations of available technologies, alternatives with more up-front mass removal are more permanent than those with less up-front mass removal. Alternatives D and E are expected to remove approximately the same amount of mass over the long-term and are similar for permanence, although Alternative D may remove shallow mass slightly more quickly. However Alternative E is more implementable, is less of a short-term risk, and has a higher benefit/cost ratio. Therefore, Alternative E ranked higher than Alternative D.

The MTCA Cleanup Regulation requires that the most practicable permanent solutions evaluated in a feasibility study be the baseline cleanup action alternative against which cleanup action alternatives are compared. If no permanent solution has been evaluated in the feasibility study, the cleanup action alternative evaluated in the feasibility study that provides the greatest degree of permanence is to be the baseline cleanup action alternative (WAC 173-340-360(3)(e)(ii)(B)).

Based on these requirements, Alternative G is considered the baseline cleanup action alternative.

5.2.2.3 Cost, WAC 173-303-360(3)f)(iii)

The cost to implement the alternative includes the cost of construction, the net present value of any long-term costs, and agency oversight costs that are cost recoverable.

The estimated costs for each alternative based on cost estimates included in the 2017 FS report are summarized in Table 4.2 below. These represent capital costs plus the net present values of operation and maintenance (O&M) and periodic costs assuming 30 years and a 1.5% discount rate.[8]

Table 5.1 Estimated costs in millions of dollars for each alternative based on the 2017 FS report

Alternative	Capital(C)[2]	C+O&M, 30 yrs	Basis for Cost Estimate[1]
A	$50.40	81.1	Alternative C150
B	$50.60	81.9	Alternative MSP
C	$53.20	84.2	Alternative MSP plus M3
D	$58.70	92.1	Alternative MSP plus M6
E	$64.40	94.9	Alternative MSP plus modified M3
F	$126.20	179.7	Alternative MSP plus M8
G	$366.80	455.2	Alternative MSP plus M9

[1]Alternatives from the 2017 FS report that were used to derive cost estimates.
[2]Capital costs for the barrier wall from the 2017 FS were increased by $11.7 million to reflect updated cost estimates.

5.2.2.4. Effectiveness over the long term, WAC 173-340-360(3)(f)(iv)

An evaluation of long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes.

Alternatives relying most heavily on institutional controls and monitoring are less effective over the long term when compared to the baseline alternative. Alternatives capable of achieving the most important

[8] The FS includes present value calculations using discount rates of 1.5% and 7%. Because the various alternatives have future O&M costs that are of similar magnitude, the relative ranking of alternatives in terms of O&M costs is relatively insensitive to the discount rate used in calculating present values.

cleanup objectives were considered by Ecology to be more effective. Following this logic, Alternative G ranked as the most effective and Alternative A ranked as the least effective.

Groundwater restoration time frames for all alternatives are lengthy. While the speed of restoration is not used directly in WAC 173-340-360(3)(f)(iv) to rate alternatives under effectiveness over the long term, longer time frames have implications for the reliability of those alternatives because they are dependent on controls.

However even if more aggressive cleanup actions will only result in smaller areas or fewer zones where groundwater VOCs exceed cleanup levels, and may not dramatically shorten the overall restoration time frame for the Site, these actions may still be more effective. Reducing VOC levels more quickly in groundwater that is approaching and potentially discharging to Commencement Bay or the Hylebos Waterway, for example, is one of the primary cleanup objectives. When Ecology determined that this objective will be met by an alternative, even if it may not quickly attain cleanup levels, the alternative is credited as not only more protective but more effective for at least this groundwater-to-surface water pathway.

5.2.2.5. Management of short-term risks, WAC 173-340-360(3)(f)(v)

Short-term risks are risks to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.

Ecology considers Alternatives A and B to have the lowest associated risks during construction and implementation. Alternatives C through G are also associated with relatively low risks. This evaluation factor is titled “management of short-term risks” because the emphasis is intended to be on the effectiveness of measures included in each alternative that will be taken to manage such risks. The potential risks associated with all seven alternatives are manageable. However, alternatives that involve technologies such as thermal treatment, excavation, off-site disposal of waste materials, and/or import of fill materials increase health and safety risks and increase the carbon footprint of a cleanup action.

5.2.2.6. Technical and administrative implementability, WAC 173-340-360(3)(f)(vi)

Technical and administrative implementability requires that the alternative is technically possible, that necessary off-site facilities, services and materials are available, that administrative and regulatory requirements are met, and that the practical steps of scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions are possible.

Alternatives A, B, and E are the most implementable remedial options, followed by Alternatives C and then D. Alternatives F and G are considered the most difficult to implement.

Alternatives D, F, and G would be difficult to implement compared to the other alternatives. The excavation and in-situ remedial elements would require access to properties not owned by OCC or its related entities. Cost-effectively obtaining owner access to these properties will be difficult; on-going business and industrial activity pose challenges for alternatives that require disruption of those activities. Access to areas beneath the Hylebos Waterway, including areas beneath Puyallup Tribe's Chinook Landing Marina, may also be required to meet the objectives of F and G.

Alternatives that propose excavation or in-situ treatment in more focused areas within the 605 E. Alexander Avenue property boundary are viewed as more easily implementable. Likewise, alternatives that propose excavation or in-situ treatment on properties owned or controlled by OCC are likely to be more easily implementable than alternatives depending on access to (non-Potentially Liable Party) privately-owned properties.

5.2.2.7. Consideration of public concerns, WAC 173-340-360(2)(b)(iii) and -360(3)(f)(vii)

Ecology must evaluate whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have interest in or knowledge of the Site.

Ecology ranks Alternative G the highest under this criterion. Alternatives A and B are ranked lowest. The majority of the comments received on the 2017 FS asked Ecology to ensure the Site is cleaned up to the "maximum extent practicable." Based on these and other comments we have received in the past, Ecology believes the public:

- Supports restoration of the ecological habitat of the Hylebos Waterway and Commencement Bay and their availability for fish and shellfish harvesting. For this reason, Ecology concludes that remedial alternatives more likely to ensure no or minimal VOC discharge to Commencement Bay and the Waterway is favored by the public.

- Supports the use of exposure controls, such as vapor intrusion mitigation and restrictions on land and/or resource use, but only to the extent that these controls are coupled with active measures to reduce contaminant levels and hasten the ultimate achievement of conditions that no longer require such controls.

- Expects shrinkage of the extent of groundwater contamination, as expeditiously as practicable, so that properties above the current plume not owned by OCC or its related entities can be freed from the stigma of contamination.

- Will be reluctant to grant free access to privately-owned property for the purposes of Site remediation, monitoring, and other actions that disrupt normal operations.

5.2.3 Quantitative Evaluation and Comparison

Based on the set of seven cleanup alternatives described above, Ecology performed a quantitative evaluation and comparison of the alternatives using the criteria included in MTCA for determining whether proposed cleanup alternatives use permanent solutions to the maximum extent practicable. The seven alternatives were compared by calculating the total cost of implementing each alternative and comparing that cost with the total benefit score for that alternative. The total benefit score was calculated by summing the weighted scores for the six MTCA criteria not associated with cost.[9] The weights used in developing the benefit score are listed in the right-most column of Table 5.1. The scores for each of the six MTCA criteria were developed subjectively using the rationale described in the previous section and a scoring scale of 1 through 10, with 10 being the highest rating and 1 the lowest.

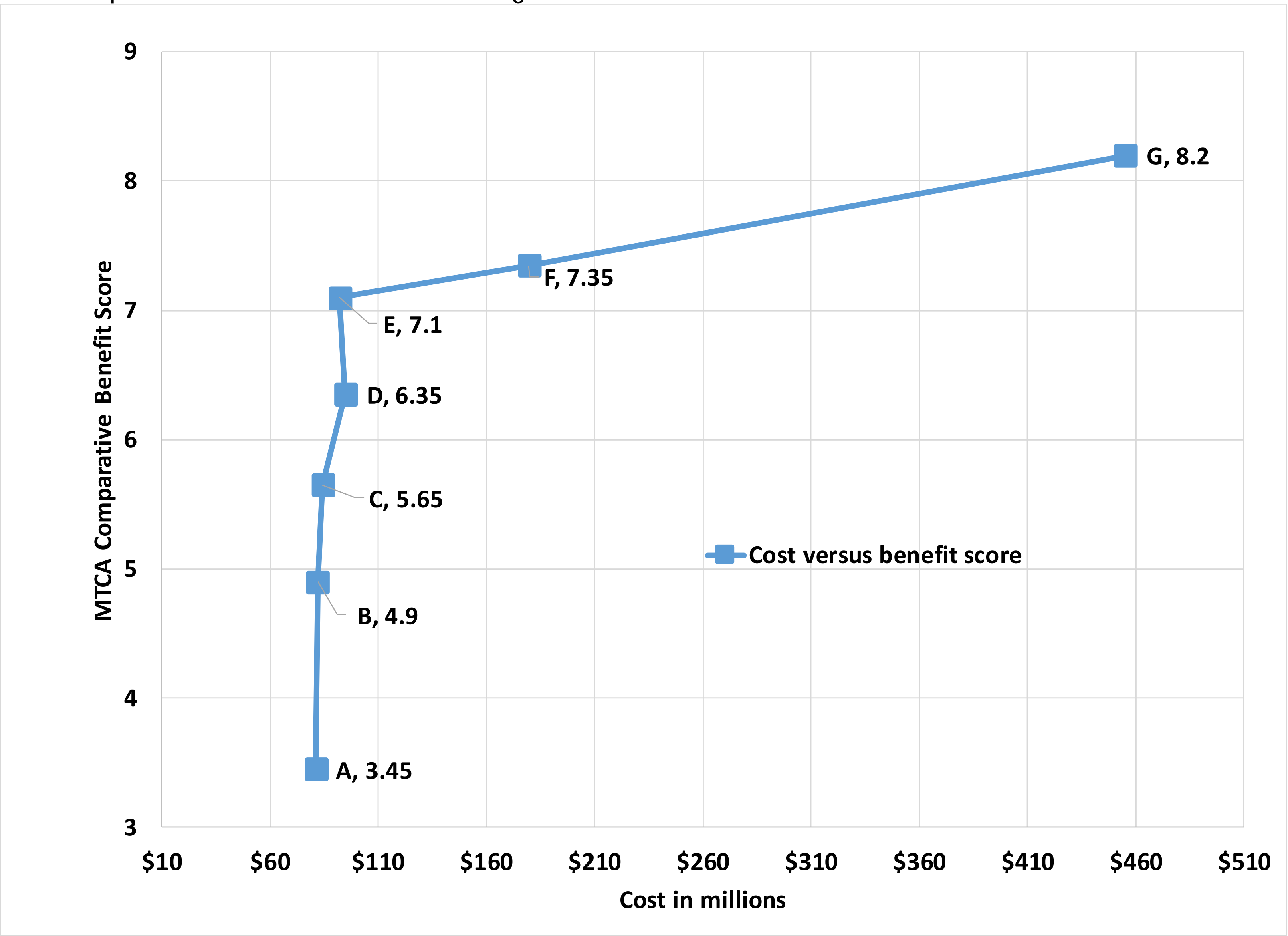
The results of this cost benefit comparison are presented in Table 5.1 and Figure 5.1. Figure 5.1 provides the 30-year present value cost on the horizontal axis and the overall weighted score on the vertical axis. The benefit scores increase sharply for Alternatives A through E and then flatten for Alternatives F and G.

[9] The six criteria are protectiveness, permanence, effectiveness over the long term, management of short-term risks, technical and administrative implementability, and consideration of public concerns.

Table 5.2 Results of the Cost and Benefit Comparison

	Alternative G	Alternative F	Alternative E	Alternative D	Alternative C	Alternative B	Alternative A	Weight
Overall Protectiveness	**9**	**7**	**7**	**6**	**5**	**4**	**2**	**25%**
Permanence	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**20%**
Effectiveness over the Long-Term	**9**	**8**	**7**	**7**	**6**	**4**	**3**	**15%**
Management of Short-Term Risk	**4**	**5**	**7**	**6**	**6**	**7**	**7**	**10%**
Technical and Administrative Implementability	**4**	**5**	**8**	**6**	**7**	**8**	**8**	**10%**
Consideration of Public Concerns	**10**	**9**	**7**	**7**	**6**	**5**	**2**	**20%**
Weighted Score	**8.20**	**7.35**	**7.10**	**6.35**	**5.65**	**4.90**	**3.45**	
Cost in millions (30 yrs, 1.5%)	$455.2	$179.7	$92.1	$94.9	$84.2	$81.9	$81.1	
Score/cost ratio	0.018	0.041	0.077	0.067	0.067	0.060	0.043	
Incremental costs	$275.5	$87.6	-$2.8	$10.7	$2.3	$0.8	$81.1	
Incremental score	**0.85**	**0.25**	**0.75**	**0.70**	**0.75**	**1.45**	**3.45**	
Incremental score/cost ratio	0.003	0.003	-0.268	0.065	0.326	1.813	0.043	

Figure 5.1. Comparison of Costs and Benefit Scoring



5.2.4 Summary

Ecology's selected remedy is Alternative E, summarized as follows in order that the actions will be implemented at the Site.

Early Action Source Treatments to Address Potential Sources of Vapor Intrusion

The selected remedy features a sequence of actions that remove shallow contamination from groundwater and soil by dewatering the groundwater in soils about 10 feet below ground surface using shallow extraction wells. Once dewatered the dewatered soils will be treated using soil vapor extraction (SVE) to remove 60,000 pounds of TCVOC mass. If performance standards are not met within a specific time frame, additional treatment will be implemented. This additional treatment may include additional dewatering activities, additional SVE wells, and air sparging components. If it is clear that by the end of the first three years of operation that the overall performance objective will not be met within a five-year timeframe, even with the enhancements identified in the EDR for this work, OCC will assess the system operation and data collected from the operation of the system to determine the reason for the lack of sufficient progress and will initiate a focused feasibility study to evaluate practicable contingency actions. A Supplemental EDR will then be developed for the selected contingency action(s) necessary to achieve the overall performance objective within the five-year timeframe.

The SVE system may include vertical and horizontal pipes, gravel beds, and/or trenches and will be developed and specified during the design phase. Horizontal drilling is an option to access some locations. Groundwater from the dewatering system and vapors from the SVE system is treated using the on-Site groundwater treatment facility. Continued periodic monitoring must occur to verify that the system is achieving the performance standards identified in this CAP.

Calculated soil-vapor screening levels are proposed in section 4.4 for continued monitoring. OCC will monitor soil vapor as part of compliance monitoring. OCC is required to continue monitoring soil vapor as long as screening levels are exceeded. If the soil vapor data are above screening levels at the first periodic review OCC will initiate a focused feasibility study to evaluate practicable contingency actions to reduce soil vapor at the Earley Business Center.

To address the vapor intrusion at the OCC office building it will either be removed or mitigated within three years of completion of the early action source treatment.

Figure 5.2 shows the target areas for the early action source treatment and Figure 5.3 shows soil vapor monitoring locations.

Figure 5.2 Locations of the Vapor Monitoring Points and CPOC

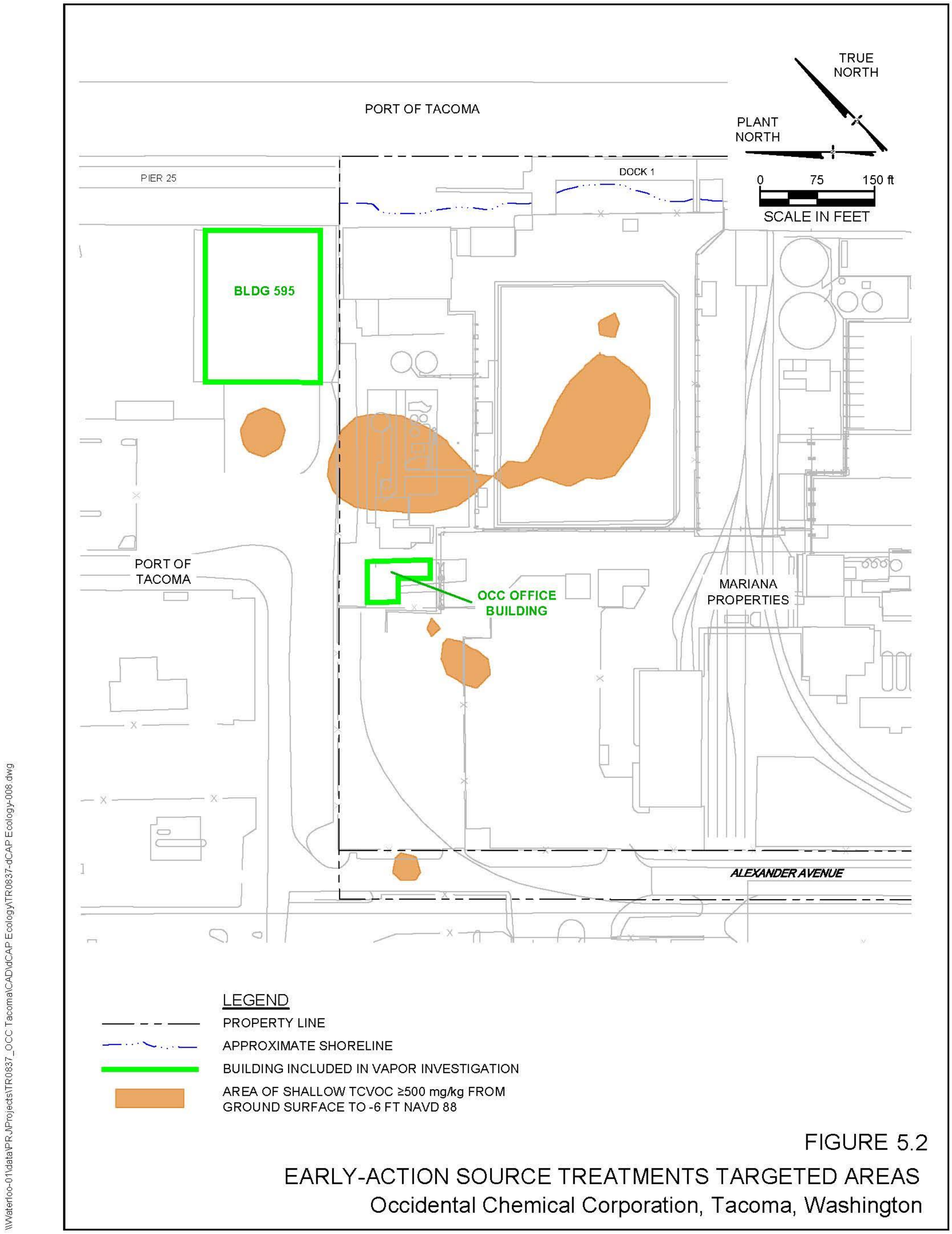
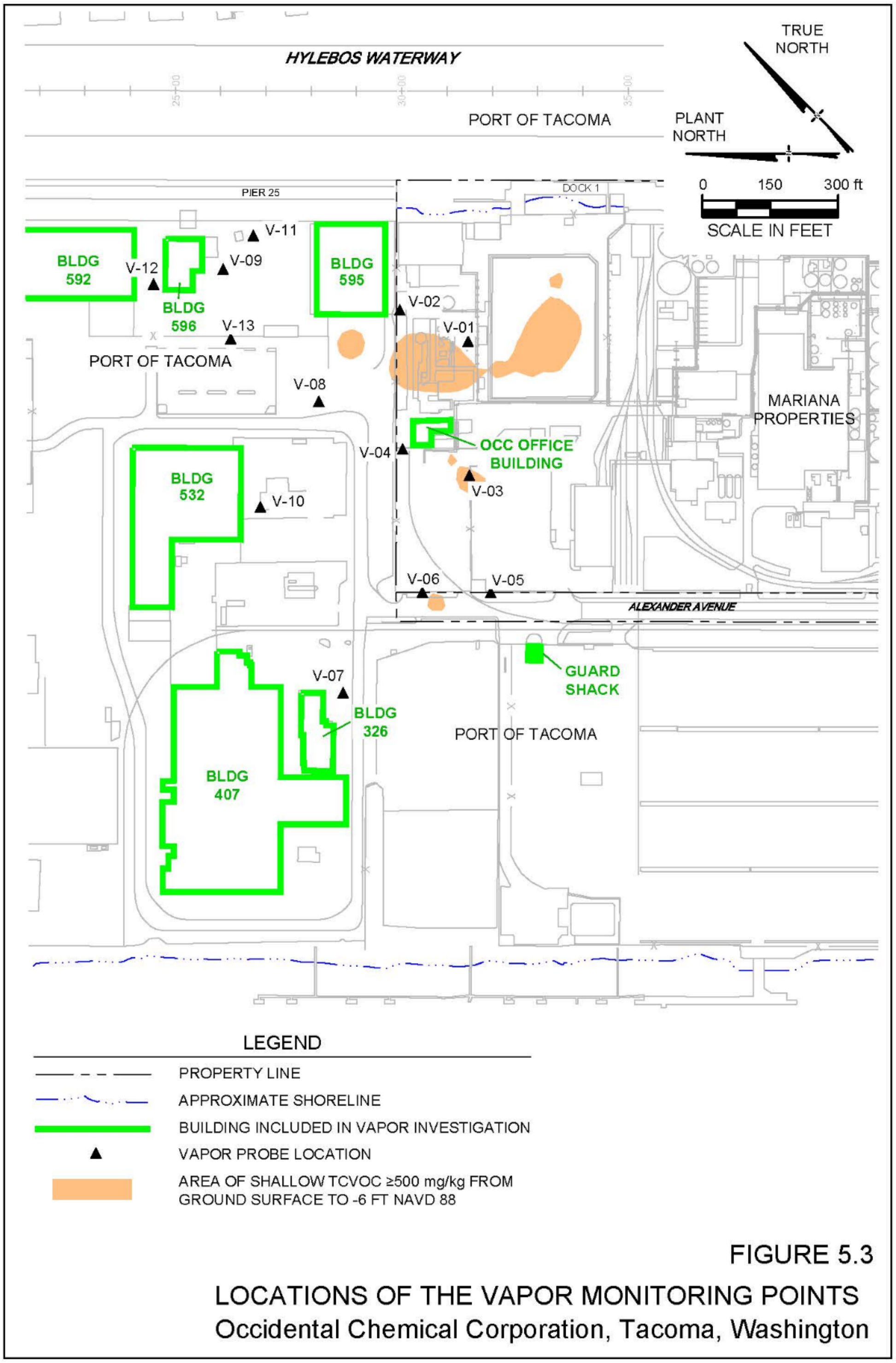


Figure 5.3 Early Action Source Treatments Targeted Areas



VOC Source Area Mass Reduction by Strategic Groundwater Pumping

To address the existing plume of contamination in the shallow and deep groundwater that has travelled beyond the Site property boundary the remedy includes extracting shallow and deep groundwater at specific locations that contain high CVOC concentrations. The design of the system at this stage will focus on bringing contamination back towards the Site while reducing contamination. This strategy will remove mass at a higher rate than hydraulic containment alone. The extracted groundwater will be conveyed to a new groundwater treatment plant to be built in a new location on the Site.

Wells may experience failure or increasingly more difficult pumping conditions due to encountering high pH and high silica in the groundwater while pumping for mass removal. If technical difficulties occur that impede extracting or treating groundwater efficiently, strategic groundwater pumping will continue by moving specific mass reduction extraction wells to specific secondary locations identified as contingency wells in the approved EDR. Once each well cluster has been moved to the approved secondary locations to avoid high pH and high silica conditions, then these wells will continue to pump for mass removal until they fail or conditions impede extraction.

When OCC is unable to continue extraction at specific secondary locations the remedy will transition to the next phase of the remedy, hydraulic containment.

Hydraulic Containment

The hydraulic containment element of the cleanup action will control Site groundwater within specified hydraulic control boundaries. The hydraulic containment system must impose an inward hydraulic gradient and perform to a specific set of performance standards. These requirements must be maintained irrespective of aquifer conditions within the control boundaries, including high pH and high dissolved silica concentrations. If it becomes technically infeasible to maintain these hydraulic containment requirements, an equivalent level of containment must be achieved and maintained using an alternative technology or approach and implemented using an adaptive management approach with active Ecology oversight.

Vertical Barrier Wall Adjacent to the Hylebos Waterway

To achieve containment of shallow groundwater containing high pH and other sources of contamination a vertical barrier wall will be constructed. The vertical barrier wall would be installed with a top elevation of approximately 15.6 ft NAVD 88 and a base elevation of approximately -58.7 ft NAVD 88, a few feet below the base of the Hylebos. Methods for protecting the wall from corrosion will be identified during the design phase. The design will address sea level rise and any identified impacts from climate change expected or predicted for the lifespan of the barrier wall.

Cover

A barrier will be constructed on the 605 E. Alexander Avenue property and adjacent properties where contamination must be contained. The vertical barrier wall along the Hylebos Waterway will be backfilled and will also be covered. This cover can consist of a membrane liner, reinforced concrete, asphalt, clay soil, or a combination of these materials. The specifications for the cover will be developed in the design phase in the Engineering Design Report.

Ex situ Groundwater Treatment

The existing groundwater treatment plant will be used for treating groundwater and soil vapor from dewatering and vapor extraction activities associated with the early removal actiont. A new groundwater treatment plant will be designed and the design submitted in the EDR. The design will include a study to evaluate the expected types and concentrations of constituents that will be in the groundwater and sent to the plant for treatment. OCC will provide the study to Ecology as part of a National Pollutant Discharge Elimination System (NPDES) permit application.

According to Ecology's analysis Alternative E meets the cleanup objectives and provides for a permanent solution to the maximum extent practicable while protecting human health and the environment.

Alternative E is selected over all other alternatives for the following reasons:

- It scores better on short-term risk management, meaning there is less risk - lower health and safety concerns for implementation of the technologies proposed
- It achieves a higher score for technical and administrative implementability, meaning it will be easier to implement and will have less impact on the adjacent Port of Tacoma property
- It has a higher degree of permanence, meaning there is more up-front mass removal
- It is more protective because it allows early removal of TCVOC mass from shallow soil without delaying implementation of the long-term cleanup actions
- It effectively addresses the vapor intrusion pathway by removing significant amount of mass early in the remedial action and therefore reduces risks sooner
- It has a smaller carbon footprint (less energy is used)
- It responds to input from the public that asked for the selected remedy to be protective and comprehensive
- It provides the greatest degree of benefit for the costs

The responsiveness summary prepared by Ecology (2018) stated that the preferred alternative will "Remove as much of the contaminant mass from groundwater and soil using permanent solutions to the maximum extent practicable using acceptable engineering means." Alternative E is technically practicable under this definition. Alternative E provides more permanence because of mass removal early in the cleanup process. It is the most effective alternative of the seven at reducing risk associated with soil vapor and indoor air exposures. Alternative E provides for the early mass removal without delaying implementation of the long-term cleanup actions.

6.0 Ensuring the Remedy Achieves the Cleanup Objectives

Ecology recognized the technical and regulatory challenges of this complex cleanup and the need to ensure the selected remedy meets the cleanup objectives. Contaminated groundwater from the Site impacts surface water. Consequently, the cleanup action must comply with cleanup standards and also provide a permanent groundwater cleanup action at a standard POC (WAC 173-340360(2)(c)(i)) to protect surface water in the Hylebos Waterway and Commencement Bay. By protecting surface water the remedy will protect human health and the environment.

6.1 Requirement for the Remedy to Meet Standards

The Site must meet CUL at the standard POC for groundwater, utilizing non-permanent actions and engineered controls such as barriers and hydraulic control through groundwater pumping to avoid lateral and vertical expansion of the groundwater contaminant plume. The selected remedy combines both permanent and non-permanent components evaluated on an on-going basis by Ecology under an adaptive site management approach.

6.2 Use of Adaptive Site Management

Adaptive site management is an important tool for managing the cleanup at complex sites similar to the Site. The term "adaptive site management" refers to a comprehensive, flexible, and iterative process that is used to manage the remediation where there is significant uncertainty about the long-term effectiveness of a cleanup action or there are significant technical challenges due to site complexity[10]. Adaptive site management is used to make decisions in response to cleanup action performance, while considering changes in site conditions, the CSM as it may evolve over time with new data, technology performance, and technological advances during the life of the remedy.

The Adaptive Site Management process focuses on making informed decisions throughout the remediation process. Ecology's use of the process at the Site is based on the understanding that the response to cleanup actions cannot be fully understood at the outset of the action. Rather than delaying action to conduct more studies or tests, adaptive site management supports action even when there are uncertainties. 6.3 Steps for Initiating Adaptive Management Strategies

Ecology and OCC have identified specific decision points for certain elements of the remedy with specified contingencies based on our current understanding of Site conditions and the CSM. Planning for contingencies is one way to adaptively manage the cleanup process when implementation of the remedy design has specific technical challenges that can be anticipated. The process of initiating these specific contingencies is described in subsequent subsections and will be incorporated as part of the proposed

[10] ITRC (Interstate Technology & Regulatory Council). 2017. Remediation Management of Complex Sites. RMCS-1. Washington, D.C.: Interstate Technology & Regulatory Council, Remediation Management of Complex Sites Team. https://rmcs-1.itrcweb.org.

Agreed Order scope of work.

6.3 Steps for Initiating Adaptive Management Strategies

If Ecology is presented with new information that significantly changes the understanding of Site conditions or the Conceptual Site Model during the implementation of the cleanup action, Ecology and OCC will take the following general steps to develop additional contingencies:

1. Review and revise the Conceptual Site Model to reflect the new information
2. Determine whether additional work is needed to supplement either Site characterization or feasibility of additional remedial actions
3. Review and revise the Site RAOs if necessary
4. Develop interim revised objectives and an adaptive remedial strategy or strategies
5. Produce a supplemental EDR
6. Incorporate learning into future decisions
7. Outreach to stakeholders and inform the public about additional actions and documents available for review

6.4 Engineering Design Reports

All the cleanup action elements in the remedy focus on meeting the cleanup standards for protection of surface water and surface water CULs, with the exception of the air pathway driven by indoor air health-based standards. To design the final remedy OCC will be required to submit an EDR that details the specific elements of the cleanup actions, including contingencies for adapting the remedy. Two separate EDR's will be developed: one for the Early Action Source Treatments and one for the MSP and Hydraulic Containment System elements. The requirement to submit an EDR is part of the scope of work described in this CAP, and is incorporated with a schedule into the proposed Agreed Order between Ecology and OCC.

The EDR is expected to provide specific design elements for meeting the cleanup standards. The EDR will propose additional performance standards not specified in this CAP for cleanup action elements based on the design limits of the remedy's technologies, as well as factors for implementing contingencies that optimize performance.

Two possible scenarios introduced in 6.2 will require additional adaptive management strategies and revision of the EDR or submittal of a supplemental EDR:

1. If cleanup actions are not performing as originally designed or the technology does not meet performance standards as expected OCC will recommend or Ecology will require design changes to the EDR that improve the performance of the remedy.
2. If during remedy implementation new information changes Ecology's understanding of Site conditions or the CSM the adaptive management general steps in Section 6.2 are initiated either by OCC, or as

directed by Ecology. Under this scenario a supplemental EDR is required to be submitted to Ecology for review and approval.

6.5 Cleanup Elements that are Engineered Controls

Engineered controls are containment or treatment systems designed and constructed to prevent or limit the movement or exposure to hazardous substances. Prior to implementation, OCC must include engineered controls in the EDR with detailed design plans. Changes to the EDR will be submitted to Ecology for review and approval prior to implementation.

The following engineered controls are required at the Site and are presented in order of the implementation schedule as currently proposed.

6.5.1 Shallow Soil and Shallow Groundwater Early-Action Source Treatments

This cleanup element is first in the schedule for implementation.

The shallow soil and shallow groundwater early-action source treatments require dewatering soils above -6 ft NAVD 88 containing TCVOC concentrations greater than 500 mg/kg, and then treating the dewatered soils and soils above using soil vapor extraction (SVE). OCC will continue the action until 60,000 pounds are removed.

The EDR for the Earl-Action Source Treatments will provide engineering concepts and design criteria for the baseline SVE system and for potential future enhancements to the system. These future enhancements, which will be implemented if performance standards will not likely be met within the first three years after system startup, may include additional dewatering activities, additional SVE wells, and air sparging elements.

If it is clear that by the end of the first three years of operation that the overall performance objective will not be met within a five-year timeframe, even with the enhancements identified in the EDR for this work, OCC will assess the system operation and data collected from the operation of the system to determine the reason for the lack of sufficient progress and will initiate a focused feasibility study to evaluate practicable contingency actions. A Supplemental EDR will then be developed for the selected contingency action(s) necessary to achieve the overall performance objective within the five-year timeframe.

The areas targeted for shallow soil and shallow groundwater early-action source treatments are shown on Figure 5.2. Dewatering will be accomplished using shallow groundwater extraction wells. The SVE system may include vertical and horizontal pipes, gravel beds, and/or trenches and are developed during the design phase. Horizontal drilling will be used to access some locations. Groundwater from the dewatering system and vapors from the SVE system are treated using the on-Site- groundwater treatment facility.

The amount of contamination removed is calculated by measuring SVE air concentrations, extracted groundwater concentrations, air flow rates, and groundwater flow rates. The quantity of mass removed will be calculated using the flow rates and the difference in concentrations measured in the influents and effluents from the vapor and groundwater extraction systems. Flow rates are measured continuously and total TCVOC measurements will be collected on a weekly basis. Monthly average mass removal rates will be calculated from these data. Once this performance target is met OCC may propose to Ecology to cease the active source removal below the water table and cease operation of the dewatering system.

Continued monitoring must occur as part of compliance monitoring described in Section 8 (Compliance Monitoring Plan) to verify that sub slab and soil vapor monitoring points outside of the property boundary are meeting protective screening levels.

Soil vapor concentrations are monitored in the vadose zone at the locations shown on Figure 5.3. At each of these locations, a new soil vapor monitoring probe has beeninstalled between 5 and 6 feet bgs and above the water table consistent with Ecology's vapor intrusion guidance[11] Samples will be collected at 6-month intervals during the shallow soil and shallow groundwater early-action source treatments described above. Soil vapor sample analyses will include PCE, TCE, and VC.

Calculated soil-vapor screening levels are proposed in section 4.4 for continued monitoring. OCC is required to continue monitoring soil vapor as long as screening levels are exceeded. If the soil vapor data are above screening levels at the first periodic review OCC will initiate a focused feasibility study to evaluate practicable contingency actions to reduce soil vapor at the Earley Business Center.

To address the vapor intrusion at the OCC office building it will either be removed or mitigated within three years of completion of the earlyaction source treatment.

The shallow soil and shallow groundwater early action source treatments and the hydraulic containment and strategic groundwater pumping elements of the cleanup action must be designed so that none of the systems interfere with the implementation of the others. The groundwater containment and mass removal system described in Sections 6.4.2 and 6.4.3 will be designed so that they can operate simultaneously with the SVE system. The shallow soil and shallow groundwater early-action source treatments element will not cause delay in implementing the hydraulic containment and strategic groundwater pumping elements of the cleanup action.

6.5.2 Hydraulic Containment

The objective of hydraulic containment is to control the movement of the contaminant plume in groundwater so that it can no longer potentially expand or migrate away from the property. Hydraulic containment will also reduce the quantity of contaminants in the groundwater and the saturated soils. This is an important element for the long-term cleanup of groundwater.

OCC will design and operate a groundwater extraction system that pumps at a sufficient rate to pull the plume back towards the 605 E. Alexander Avenue property. Extraction wells will be placed at specific locations and at specific depths throughout the Site. These wells will be pumped at a rate sufficient to bring contaminated groundwater to within established hydraulic control boundaries.

Early in the process of implementing this part of the remedy additional cleanup elements will be implemented to remove contamination from specified targeted areas. This includes the early-action source treatments described in Section 6.5.1, and mass removal by strategic groundwater pumping described in Section 6.5.3. The process of containing contaminated groundwater begins when the pumping from extraction wells begins. When the early-action source treatments and mass removal by strategic groundwater pumping achieve the required objectives, the remedy may transition to focus solely on maintaining hydraulic containment. OCC will continue to pump groundwater to maintain hydraulic

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[11] "Guidance for Evaluating Vapor Intrusion in Washington State: Investigation and Remedial Action, March 202). Publication No. 09-09-047.

containment, and in the process the system will continue extracting contamination until cleanup standards are met.

The hydraulic containment element of the cleanup action will control Site groundwater within the hydraulic control boundaries shown on Figures 2.5 through 2.10. The hydraulic containment system must impose an inward hydraulic gradient. At least one foot of water level drawdown within these control boundaries is the performance standard that must be maintained until cleanup standards are met for groundwater.

These requirements apply irrespective of aquifer conditions within the control boundaries, including high pH with or without high dissolved silica concentrations. High dissolved silica concentrations in combination with specific geochemical conditions can cause fouling of extraction well and treatment systems. The design of hydraulic containment will factor in the areas where these conditions occur. The final locations and depths of the extraction wells will be detailed as part of the system design in the EDR.

An adaptive management approach to this element of the cleanup action is used to accommodate changing Site conditions. Ecology will be carefully monitoring this containment action and will require the identification of contingent extraction wells and/or adjustment to extraction rates if necessary to ensure that the required drawdown levels are achieved.

Well failure through fouling and deterioration from extraction may occur. OCC is to notify Ecology within 30 days that a well requires replacement and that a contingent well is planned for installation by a specific date. Specific contingencies for well replacement will be identified as part of adaptive management.

If it becomes technically infeasible to maintain these hydraulic containment requirements using only extraction wells, an equivalent level of containment must be achieved and maintained using an alternative technology or approach. This includes using extraction wells in combination with in-situ treatment of groundwater to reduce pH with or without dissolved silica concentrations. It is also possible that construction of cutoff walls may be necessary to control migration of high pH with or without high dissolved silica concentrations. The EDR will include a discussion of options for high pH and high dissolved silica concentrations as contingent elements of the remedy. A supplemental EDR will be developed if these contingent elements will be implemented due to failure of the system to achieve the required performance standards for containment.

Measurements will be required to monitor the drawdown within the control boundaries. Measurement method and frequency will be proposed by OCC for Ecology's review and approval in a draft Compliance Monitoring Plan.

Ecology requires that OCC evaluate progress in regular progress reports. These progress reports will evaluate Site conditions where pH, dissolved silica concentrations, aluminum concentrations, or other geochemical characteristics are factors affecting the performance of the containment system.

OCC will also provide for periodic reviews that include a detailed analyses of these conditions and their effects on the containment system every 5 years. Ecology will require, or OCC may initiate, a supplemental EDR should compliance monitoring data, progress reports, or periodic reviews indicate high pH or other geochemical conditions are causing difficulties in achieving and maintaining compliance with the performance standards for the containment system. Hydraulic containment wells may be moved to avoid high pH and high dissolved silica concentrations in groundwater to maintain containment.

The effects of biological degradation and other natural attenuation processes are also evaluated on an on-going basis during compliance monitoring. These evaluations will be important for potential adaptive management modifications of the cleanup action as well as providing important indicators of progress towards cleanup standards.

6.5.3 VOC Source Area Mass Reduction by Strategic Groundwater Pumping

This cleanup element involves extracting shallow and deep groundwater with high concentrations of VOC from locations outside of high pH and high dissolved silica areas to prevent fouling of the extraction systems and generation of gel and solids in the wells.[12] The extracted groundwater will be treated by a newly constructed groundwater treatment plant.

Shallow groundwater extraction wells will be placed in the vicinity of both the salt pad area and the area of the former settling ponds including those that will function as part of the early-action source treatments for reducing vapor intrusion. This means the design of the Site-wide groundwater extraction system will include wells at or near former WMU G and A. Specific extraction well locations for the MSP element will be finalized in the EDR. Transition from mass removal with containment pumping (hydraulic containment) to containment pumping alone may occur gradually as secondary mass removal extraction wells are deployed and then no longer functional.

The MSP element will remove CVOCs from groundwater at a higher rate than hydraulic containment alone. The design of the groundwater extraction system will be targeting mass removal with a transition to pumping groundwater to contain the plume within the hydraulic boundaries described in Section 6.5.2. The EDR will propose performance standards for the groundwater extraction system, propose criteria for decisions about decommissioning extraction wells and installing replacement extraction wells, and the transition process to hydraulic containment alone.

The complexity and uncertainties associated with predicting the amount of CVOC mass in the subsurface and the rates at which CVOC mass removal will occur presents specific challenges for setting a definitive schedule for the transition. OCC may propose to Ecology for review and approval a schedule for the transition from mass removal with hydraulic containment to hydraulic containment alone at any time that compliance monitoring data indicates a decline in the effectiveness of pumping for mass removal.

The locations of groundwater extraction wells for mass removal with hydraulic containment will be finalized in the approved EDR. Specifically, two types of locations are identified during the design phase. The first type will be in locations where high CVOC concentrations are anticipated. These mass removal wells will be installed as part of the initial system construction. The second type will be hydraulic containment wells (Section 6.5.2) to be installed in the event any of the initial mass removal wells become inoperable due to clogging or other causes.

Identifying the number and general locations of replacement mass removal extraction wells in the EDR is part of identifying the design limits for the mass-removal phase of the groundwater extraction system. The MSP element fully transitions to hydraulic containment when all original mass removal wells and

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[12] Studies conducted by the University of Washington have shown that gel formation and associated clogging are the result of elevated pH in combination with concentrations of silica and/or aluminium. Locations for extraction wells aimed at mass removal will be selected based on the spatial distribution of pH, dissolved silica, and aluminium. Shallow groundwater is defined as groundwater between the ground surface and -56 ft NAVD 88 and deep groundwater as groundwater from -56 ft NAVD 88 to the bottom of the impacted aquifer.

replacement secondary mass removal wells approved in the EDR are deemed inoperable or unproductive in terms of extraction or operational performance.

The hydraulic containment portion of the overall cleanup action will remain in operation after Ecology agrees that the MSP element complete. The hydraulic containment performance measures (i.e., the required drawdowns) must be met even if significant modifications are required to the hydraulic containment wells and/or the treatment system because of high pH or high dissolved silica concentrations. Hydraulic containment must continue until CULs are met at the standard POC.

6.5.4 Ex situ- Groundwater Treatment

The existing groundwater treatment plant will be used for treating groundwater and soil vapor from dewatering and vapor extraction activities associated with the early-action source treatment component described in Section 6.4.1

A new groundwater treatment plant design at a new location within the 605 E. Alexander Avenue property boundary is required to be submitted to Ecology per the schedule in Section 11. Construction will begin within 90 days of approval of the final design. The ex situ treatment system may include components such as building, controls, equalization tank, clarifier, filter press, filters, air stripper, thermal oxidizer, scrubber, pumps, and meters.

The location of the treatment system and the new treatment system capacity will be proposed during the design phase and provided in a separate EDR developed for the purpose of a new NPDES permit application.

New extraction wells will be developed and sampled to evaluate the type and concentrations of constituents to be sent to the plant for treatment (6.4.3). OCC will provide influent and effluent studies to Ecology as part of the National Pollutant Discharge Elimination System (NPDES) permit application.

The design of the treatment plant will include a contingency that allows for modifications necessary to treat 1-4 dioxane if a surface water standard for this constituent is established by EPA or Ecology. If a new surface water standard is established an update to the system and the NPDES permit will follow the process and timeline set out by Ecology under administrative procedures for permit updates.

The ex situ treatment system design will include pH treatment as a contingency for the scenario that high pH and silica water are drawn into the system by mass removal or hydraulic containment. The decision point for implementation of the contingency is when the pH level in the influent exceeds the design limits identified in the EDR for the plant design.

The contingency proposed in the FS is based on diluting up to 50 percent of the extracted groundwater with City of Tacoma potable water at a ratio of 1:1 prior to pH adjustment within the treatment system. The EDR for the treatment plant will identify all contingencies, including adding treatment to maintain the mass removal and hydraulic containment as well as support meeting the required performance standards for the continuous treatment of contaminated groundwater. OCC will propose performance criteria and factors for implementing contingencies in the treatment plant EDR.

Inability of the treatment plant to adequately treat influent and meet effluent limits is not an acceptable reason for failing to meet performance standards for the remedy.

6.5.5 Vertical Barrier Wall Adjacent to the Hylebos Waterway

The vertical barrier wall will be approximately 2,200 feet long and will be installed with a top elevation of approximately 15.6 ft NAVD 88 and a base elevation of approximately -58.7 ft NAVD 88, a few feet below the base of the Hylebos. The approximate alignment is shown in Figure 6.1. Discussions about the vertical barrier wall concept assumed that it is constructed of steel. A specific description of the materials used to construct the barrier wall, including wall thickness and joint sealants, will be part of the EDR. Methods for protecting the wall from corrosion will be identified during the design phase.

Rate of corrosion and measures taken to extend the life of the vertical barrier wall are considerations when identifying performance limits. The design must identify the expected lifespan of the wall as a design limit. The Compliance Monitoring Plan and Operation and Maintenance Plan are important to the long-term efficacy of this part of the remedy. Inspections of the condition of the barrier wall will take place every 5 years from the date construction is complete and will be conducted by an independent qualified registered professional engineer licensed in the State of Washington (IQRPE). Inspection reports by the IQRPE will be submitted to Ecology within 90 days of the inspection date, and will include a detailed assessment and recommendations for repairs and re-inspections. As-built design plans will be submitted to Ecology for the record, and changes, repairs, or alterations will require updated plans. The EDR will propose the replacement of the wall as needed to meet performance standards.

Figure 6.1 Barrier Wall Alignment

Figure 6.2 PDCE Barrier

In the event that a significant seismic event occurs during the lifespan of the barrier wall an integrity inspection by the IQRPE will be required to evaluate any changes and recommended actions. A significant seismic event in the area includes localized earthquakes from nearby shallow faults that cause shifting or liquefaction of the soil during the event, or an area-wide event such as the Cascadia earthquake.

Because the vertical barrier wall is critically important for the containment of shallow high-pH groundwater it must be either repaired or replaced during the span of the remedy unless at the time of expected failure the shallow high-pH groundwater is no longer migrating to surface water because of changed Site conditions or other factors.

Unless specifically designed to a higher standard it is assumed for the scope and schedule in the proposed Agreed Order that a new EDR and replacement wall will be necessary within 30 years. This time frame can be extended if periodic assessments in the O&M plan for the vertical barrier wall conclude the structure is capable of meeting performance standards beyond the original design lifespan.

During the lifespan of the vertical barrier wall the O&M Plan requires inspections by an IQRPE registered in the State of Washington. A report with recommendations will be submitted directly to Ecology under the MTCA requirements for periodic review no later than every 5 years from the final date of construction. Required or recommended repairs will conform to established engineering standards. Work conducted on the vertical barrier wall are under the supervision and certification of the IQRPE.

The decision point for adaptive management strategies for this cleanup element is when the wall is no longer expected to meet performance standards within its design lifespan identified in the EDR. The schedule in the proposed Agreed Order requires OCC to submit a supplemental EDR two calendar years prior to the end-life of the vertical barrier wall. Prior to this date OCC may propose changes to the CSM to Ecology under the conditions of Section 6.2 if an alternative to a new vertical barrier wall is an option. The adaptive management steps described in Section 6.2 will be incorporated into the proposed Agreed Order.

6.5.6 PDCE Barrier

The PDCE barrier will be constructed on the 605 & 709 E. Alexander Avenue properties, Navy Todd Dump, N Landfill, and 709 E. Alexander Avenue Embankment Fill Area. These areas are shown on Figure 6.2. The former intertidal zone on the upland side of the vertical barrier wall along the Hylebos Waterway will be backfilled and also covered by the PDCE barrier.

PDCE barriers can consist of a membrane liner, reinforced concrete, asphalt, clay soil, or a combination of these materials. The specifications for the PDCE barrier for the Site will be identified during the design phase and submitted in the EDR.

Unless specifically designed to a higher standard it is assumed for the scope and schedule in the proposed Agreed Order that a new EDR and replacement PDCE barrier will be necessary within 30 years. This time frame can be extended if periodic assessments in the O&M plan for the vertical barrier wall conclude the structure is capable of meeting performance standards beyond the original design lifespan.

During the lifespan of the PDCE barrier the O&M Plan requires inspections by an IQRPE. A report with recommendations is submitted directly to Ecology under the MTCA requirements for periodic review no later than every 5 years. Required or recommended repairs will conform to established engineering standards or design specifications from the manufacturer of the PDCE materials.

The decision point for adaptive management strategies for this cleanup element therefore is 30 years, or the designed lifespan identified in the EDR. The schedule in the proposed Agreed Order requires OCC to submit a supplemental EDR one calendar year prior to the end-life of the PDCE barrier. Prior to this date OCC may propose changes to the CSM to Ecology under the conditions of Section 6.2 if an alternative to the PDCE barrier is proposed.

If Site development occurs during the remedy it will conform to the required covenants (Cite) identified in the proposed Agreed Order and in compliance with identified use restrictions.

6.6 Institutional Controls (ICs)

ICs refer to both physical actions taken to restrict the use of a site or limit exposure to hazardous substances (fences, signs, etc.), and the legal and administrative mechanisms used to ensure that these restrictions are maintained over time (restrictive covenants, health advisories, water well drilling prohibitions, etc.). ICs should demonstrably reduce risks to ensure a protective cleanup action.

Under a containment cleanup action, ICs are implemented to prohibit or limit activities that could interfere with the long-term integrity of the containment system.

ICs must satisfy both MTCA WAC 173-340-440 and Dangerous Waste requirements in Chapter 173-303 WAC. The following ICs will be implemented at the Site:

1. Physical barriers to control access to the Site, including a constructed and routinely maintained fence
2. A restrictive covenant according to the requirements in WAC 173-340-440(9) and the requirements in the Uniform Environmental Covenants Act (Chapter 64.70 RCW). This will include:
    - Restrictions on future buildings with basements or crawlspaces unless vapor intrusion pathways are mitigated (e.g., VI barriers or other active engineering controls [pressurized buildings or depressurized subslab- systems] and monitoring)
    - Restrictions on groundwater use restrictions recorded under the deed except when used as part of a cleanup action
    - Restrictions on excavation or below grade construction without appropriate worker health and safety plans and training as detailed in an Ecology-approved soil and groundwater management plan
    - Restrictions on excavation or below grade construction without the proper handling, characterization, and disposal of the excavated soil/materials as detailed in an Ecology-approved soil and groundwater management plan
3. Plans with maintenance requirements for engineered controls including the inspection and repair of monitoring wells, treatment systems, caps (direct contact barriers), and groundwater barrier systems
4. Educational programs including signs, postings, public notices, health advisories, mailings, and similar measures that educate the public and/or employees about site contamination and ways to limit exposure. This will include Washington Industrial Safety and Health Act and United States Occupational Safety and Health Administration (WISHA/OSHA) compliant worker health, safety, and training program to address current and future health and safety issues related to indoor air in the existing buildings on the 605 E. Alexander Avenue property
5. Financial assurance according to the requirements in WAC 173-340-440(11) and WAC 173-303-64620(5). (See Section 9.0 **Financial Assurance Required**.)
6. Monitoring plans requiring reporting on the effectiveness of ICs

7. Restoration Time Frame

The restoration timeframe is based on the CSM, the DCA, analysis of the groundwater plume, and the potential impacts from source removal using various treatment alternatives.

7.1 Requirements for setting a restoration time frame

WAC 173-340-360(2)(b)(ii) requires selected cleanup actions to provide for a reasonable restoration time frame. The requirements and procedures for determining whether a cleanup action provides for a reasonable restoration time frame are found in WAC 173-340-360(4)(b). Factors to be considered include:

- Potential risks posed by the Site to human health and the environment
- Practicability of achieving a shorter restoration time frame

- 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 ICs
- 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 documented to occur at the Site or under similar Site conditions

If the cleanup action selected has a greater degree of long-term effectiveness than on-site or off-site disposal, isolation, or containment options, then, a longer period of time may be used for the restoration time frame for a site to achieve CUL at the POC, WAC 173-340-360(4)(c).

7.2 Applicability of Restoration Time Frame to the Site

Ecology selected a 100-year restoration time frame to assist the evaluation and comparison of alternatives based on 100-year mass removal rates.

Discussion of Site Factors Concerning Restoration Time Frame

Potential risks posed by the Site to human health and the environment.

The proposed remedy for the Site is based on limiting three potential exposure pathways: 1) direct contact with soil, 2) inhalation of indoor air, and 3) groundwater discharge to surface water, which impacts marine sediments and aquatic life and human consumption of biota.

The proposed remedy includes removing contaminant mass from shallow soils to reduce potential exposures of individuals working outdoors in shallow soil to soil vapor or shallow groundwater contamination and of indoor workers to contaminated indoor air. The proposed remedy also includes hydraulic containment to eliminate, reduce, or otherwise control risks posed by contaminated groundwater. The potential discharge of contaminated groundwater via seeps adjacent to the Hylebos Waterway will be addressed through the installation of the vertical barrier wall.

7.2.2 Current use of the Site, surrounding areas, and associated resources that are, or may be, affected by releases from the Site.

The current use of the Site is industrial. There are no residential properties currently existing on or near the Site.

It is assumed that the future land use of the Site will remain industrial/commercial. There are no residential properties planned to be located on or near the Site.

7.2.3 Availability of alternative water supplies.

Ecology determined that groundwater at the Site is non-potable. This non-potability designation is based on two criteria within WAC 173-340-720(2):

- Site groundwater contains naturally occurring saltwater levels, which renders it naturally unfit for human consumption.
- Site groundwater is not a current source or future source of drinking water.

This groundwater non-potability designation means the exposure pathway of human ingestion of groundwater does not apply to the Site.

7.2.4 Likely effectiveness and reliability of institutional controls.

Until CULs are met at the Site, the proposed remedy requires human direct contact risks to be addressed through institutional controls. The proposed remedy includes the following ICs:

- Physical barriers, including a maintained fence, will control access.
- An environmental covenant will restrict activities on the Site, including:
- Future buildings with basements or crawlspaces unless barriers to vapor intrusion are included and monitored.
- Groundwater use except when used as part of a cleanup action.
- Excavation or below grade construction without appropriate worker health and safety plans and training.
- Excavation or below grade construction without the proper handling, characterization, and disposal of the excavated soil/materials.
- Plans with maintenance requirements for engineered controls including the inspection and repair of monitoring wells, treatment systems, caps, and groundwater barrier systems.
- Educational programs including signs, postings, public notices, health advisories, mailings, and similar measures that educate the public and/or employees about Site contamination and ways to limit exposure.
- Financial assurance according to the requirements in WAC 173-340-440(11) and WAC 173-303-64620(5).
- Monitoring plans requiring reporting on the effectiveness of ICs.

7.2.5 Ability to control and monitor migration of hazardous substances from the site.

To contain contamination, the proposed remedy will require installing a vertical barrier wall adjacent to the Hylebos Waterway, maintaining hydraulic containment through groundwater pumping, and installation of a cover over the site and adjacent properties. OCC will be required to monitor and maintain these engineered controls. OCC will also continue to monitor groundwater at the Site.

7.2.6 Site Factors Affecting Restoration Time Frame Estimates

Site characteristics that make it technically difficult to be certain about achieving the 100-year restoration time frame include the following:

- The estimated mass of CVOC in the subsurface is approximately 780,000 pounds. While this estimate was derived using the best available data and analyses, there is considerable uncertainty associated with it and the actual value is more likely to be higher than lower.
- The volume of subsurface materials with CVOC concentrations greater than 100 mg/kg exceeds 1.3 million cubic yards. Much of this contamination occurs at depths greater than 100 feet.
- Groundwater concentrations exceed 100,000 ug/L of CVOC throughout much of the Site and to depths greater than 150 feet. These concentrations exceed CULs by more than five orders of magnitude.
- The aquifer materials at the site are comprised of interbedded layers of silty sand, silts, and clays. Rates of groundwater extraction from these materials are limited because of relatively low permeability and preferential pathways.
- Subsurface contamination at the Site dates to 1929, with TCE and PCE contamination dating to 1947. This long period of subsurface contamination allowed contaminants to diffuse into low permeability silts and clays within the subsurface. These contaminants, which will slowly diffuse back into the active groundwater system (back diffusion), are not accessible to available groundwater treatment actions.
- Areas with high pH and high dissolved silica limit locations where groundwater is extracted or injected using currently available technologies. Wells located in these areas are prone to failure due to plugging from silica precipitation.

The groundwater model developed for the Site was used to estimate mass removal rates for different treatment scenarios over different time periods. The comparison looks at the effectiveness of different alternatives over time periods in the range of 10, 100, and 1,000 years. The most aggressive cleanup action removes approximately 99.4% of the mass in 100 years and 99.8% in 1,000 years. This still leaves approximately 5,000 pounds of CVOC in the subsurface after 100 years and 1,600 pounds after 1,000 years if the effects of degradation are not considered. This amount of mass would result in subsurface concentrations that continue to exceed CULs.

7.2.7 Using Adaptive Management

Ecology is using adaptive management strategies with specific planned contingencies to account for these uncertainties and provide a process for adjusting the remedy as we learn more through implementation. The proposed remedy is adaptable and provides contingencies and strategies to adjust mass removal based on performance over time. Utilizing adaptive management allows these adjustments to be made during the restoration time frame that could optimize removal and provide more certainty as data collection and periodic reviews inform the process. Current data collected during the baseline study indicated that chemical and biological degradation is occurring, a factor difficult to quantify but that could improve the mass calculations over the restoration time frame.

7.2.8 Conclusion

Ecology recognizes that the Site groundwater may remain contaminated above cleanup standards at the end of 100 years. The estimated rate of TCVOC mass removal during the first 100 years of Site remediation was used in the DCA as one means for comparing the effectiveness of remediation alternatives and selecting the remedy that provides the greatest risk reduction as early as possible in the cleanup.

The relatively long restoration time frame for the Site for each of the cleanup alternatives was another factor in selecting the proposed remedy because the early-actions to remove shallow mass occurs in the first decade of the cleanup action. Removing this shallow mass provides the greatest risk reduction by reducing potential exposure through vapor intrusion. Mass removal through strategic pumping also provides greater risk reduction early in the remedy by removing mass at a higher rate than hydraulic containment alone and has the greatest potential for shortening the time frame with adaptive management strategies. Attenuation by chemical and biological processes is an additional factor that potentially improves the time frame for the reduction of contamination.

Even Alternative G, with the most aggressive and extensive removal or treatment elements, will result in areas with groundwater and soil contamination exceeding cleanup standards. While none of the alternatives achieve full permanence in the 100-year time frame because of technical limitations of available technologies, alternatives with more up-front mass removal are more permanent than those with less up-front mass removal. Alternatives D and E are expected to remove approximately the same amount of mass over the long-term and are similar for permanence, although Alternative D may remove shallow mass more quickly. However, Alternative E is more implementable, is less of a short-term risk, and has a higher benefit/cost ratio. Therefore Alternative E ranked higher than Alternative D.

Estimates of restoration time frame will be re-evaluated on an ongoing basis as additional data are collected as part of performance and compliance monitoring. Data to assess plume stability and to better quantify rates of biological and chemical degradation are included in these monitoring programs. These data will be helpful in considering the natural degradation of the plume as a factor in model projections for CVOC mass removal and restoration time.

8. Compliance Monitoring Plan

Compliance monitoring is important to all aspects of the remedy. WAC 173-340-410 provides the requirements for Compliance Monitoring. The three types of compliance monitoring include protection, performance, and confirmational monitoring:

- **Protection monitoring** confirms that human health and the environment are adequately protected during construction and the operation and maintenance period of the cleanup action as described in a safety and health plan. OCC will be required to have a health and safety plan as part of the EDR.

- **Performance monitoring** confirms that the cleanup action has attained cleanup standards and remediation levels or other performance standards such as construction quality control measurements or monitoring necessary to demonstrate compliance with a permit or the substantive requirements of other laws.
- **Confirmation monitoring** confirms the long-term effectiveness of the cleanup action once cleanup standards and remediation levels or other performance standards have been attained.

The Compliance Monitoring Plan must be submitted to Ecology with the EDR (see schedule in Section 11 for design submittal). The Compliance Monitoring Plan will propose a schedule for frequency of monitoring for Ecology's review and approval.

OCC is required to propose a Compliance Monitoring Plan designed to evaluate the impact of remedy implementation, including further examination of natural attenuation. The plan will include groundwater quality monitoring, soil vapor and indoor air monitoring, porewater and sediment monitoring, and transition from mass removal to containment monitoring.

A groundwater quality sampling and analysis plan must be developed by OCC and submitted to the Ecology with the operation and maintenance plan (WAC 173-340-400) for review and approval. The sampling and analysis plan will specify the groundwater samples to be collected, the handling of the samples, and the analysis procedures to be performed per WAC 173-340-820. Soil Vapor and Indoor Air Monitoring

A soil vapor sampling and analysis plan must be developed by OCC and submitted to the Ecology with the operation and maintenance plan (WAC 173-340-400) for review and approval. The sampling and analysis plan will specify the soil vapor samples to be collected, the handling of the samples, and the analysis procedures to be performed per WAC 173-340-820.

The approved FS notes that some future monitoring of the concentration of constituents of concern in sediment and porewater may be appropriate to ensure that existing conditions of sediment and porewater quality do not change over time. As part of the post construction monitoring and during operation and maintenance of the cleanup action, Ecology will require periodic monitoring of the sediments and shallow porewater to evaluate any changes that occur where groundwater meets surface water.

9. Financial Assurance Required

Ecology received comments and concerns from stakeholders and the public about whether OCC would have sufficient financial resources necessary to complete the remedy and pay for the long-term cleanup of the Site. Because OCC held a RCRA hazardous waste permit in the past, additional financial assurance for the remedy is required in addition to the financial assurance requirements under MTCA.

Financial assurance under the Dangerous Waste Regulations, Chapter 173-303 WAC is required. The Dangerous Waste Regulations require an estimate of the costs of the remedy. [WAC 173-303-64620(5).] A financial assurance mechanism must be in place so that Ecology can implement the remedy if necessary. Additional financial assurance is required to cover the operation and maintenance costs for the long term.

OCC must comply with these requirements by using the final cost estimate for the selected remedy to provide financial assurance in accordance with the regulations. The financial assurance must include the entire cost of the remedy.

WAC 173-340-440 states that financial assurance shall be required at sites where the cleanup action includes engineering controls and/or ICs. Financial assurance under these MTCA provisions is also required because ICs are used to assure protection of human health and the environment. Financial assurance will be of sufficient amount to cover all costs associated with the operation and maintenance of the cleanup action, including ICs, compliance monitoring and corrective measures. Financial assurance requirements are specified in the Agreed Order.

10. Periodic review

Ecology received comments from stakeholders and the public with concerns about both the amount of time it will take to cleanup, and the thoroughness of the cleanup. Some of the concerns were focused on Ecology sustaining oversight of the cleanup over the long period of time it will take to achieve cleanup. WAC 173-340-420 states that, at sites where a cleanup action requires an IC or requires financial assurance, a periodic review will be completed at least every 5 years after the initiation of a cleanup action.

10.1 Content of Periodic Review

A primary goal for periodic review is to determine whether the cleanup action is still protecting human health and the environment.

In addition to being a requirement for the cleanup of the Site, periodic review is an important component for adaptive management and contingent cleanup strategies. It is important to the implementation of the remedy for Ecology to ensure sufficient progress is made towards meeting performance standards and to make adjustments based on new information. The periodic review will provide in-depth evaluations of performance based on compliance monitoring and will make recommendations for improvements.

10.2 Considerations for Requiring Further Action

In evaluating whether a cleanup action is still protective of human health and the environment, Ecology will consider the following:

- Monitoring data to assess the effectiveness of ongoing or completed cleanup actions.
- New scientific information or applicable state and federal laws for hazardous substances at a site.
- Current and projected site or resource uses.
- The availability and practicability of higher preference technologies.
- The availability of improved analytical methods that lower PQLs in situations where the CUL is below the PQL.

As part of the periodic reviews, Ecology will require compliance with ICs established at the Site.

10.3 Public Consultation on Period Review

Ecology will notify the general public about the results of periodic review through the Site Register.

Ecology's evaluation and the data used to perform the evaluation will be available for public review and comment consistent with the Public Participation Plan for the Site. In instances where the periodic review results in a substantial change in the cleanup action, a revised CAP will be prepared and opportunities for public review and comment provided, consistent with the provisions of WAC 173-340-600 and the Public Participation Plan for the Site.

11. Scope Summary and Schedule for Implementation

This Scope of Work implements the CAP, Exhibit B to the Agreed Order to address soil and groundwater contamination at the Occidental Chemical Corporation Site (Site) in Pierce County, Washington. Occidental Chemical Corporation (OCC or Occidental), Mariana Properties, Inc., and Glenn Springs Holdings. Occ will implement this SOW to implement this CAP.

Implementation of the CAP, including reports, plans, specifications, and documentation of actions are required to conform to the requirements of WAC 173-340-400. All aspects of construction must be performed under the oversight of a professional engineer registered in the State of Washington or a qualified technician under the direct supervision of a professional engineer registered in the State of Washington.

11.1 Summary of Scope as Tasks

A summarized description organized into tasks is presented as follows:

Task 1: Early Action Source Treatments and Cover

a. Early Action Source Treatments.

This portion of the remedy includes a series of early actions that will remove shallow contamination from groundwater and soil by dewatering the groundwater in soils about 10 feet below surface using shallow extraction wells. Once dewatered, the dewatered soils will be treated using soil vapor extraction (SVE) to remove 60,000 pounds of total chlorinated volatile organic compound mass, which is the performance standard for this work. If performance standards are not met within a specific time frame, additional treatment will be implemented.

The SVE system may include vertical and horizontal pipes, gravel beds, and/or trenches and will be developed and specified during the design phase. Groundwater from the dewatering system and vapors from the SVE system will be treated using the on-Site groundwater treatment plant. Continued periodic monitoring must occur to verify that the system is achieving the performance standards identified in the CAP.

A separate engineering design report (EDR) will be developed for the Early-Action Source Treatments. The EDR will be adequate to obtain the necessary permits or meet the substantive provisions of laws for which there is a permit exemption in MTCA for Site remediation. The EDR will comply with the requirements of WAC 173-340-400(4)(a).

The EDR will provide engineering concepts and design criteria for the baseline SVE system and for potential future enhancements to the system. These future enhancements, which will be implemented if the 60,0000 pound performance standard is not met within a specific time frame, may include additional dewatering activities, additional SVE wells, and air sparging elements.

Following completion of the EDR and approval by Ecology, Construction Plans and Specifications will be completed and submitted to Ecology for review and approval. The Construction Plans and Specifications will comply with WAC 173-340-400(4)(b).

An Operations and Maintenance Plan (OMP) will be developed in accordance with WAC 173-340-400(4)(c) for the Early Action Source Treatments. The OMP will be completed prior to start-up of the system. The OMP shall identify the person(s) responsible for each task outlined in the OMP and relevant contact information.

The Compliance Monitoring Plan (CMP) for the Early Action Source Treatment element will be developed prior to installation of the Early Action Source Treatments. The CMP will include performance monitoring. The CMP will also include a Sampling and Analysis Plan (SAP) and a Quality Assurance Project Plan (QAPP). Each plan will meet the requirements of WAC 173-340-410. Raw data shall be submitted to Ecology within 30 days following receipt of the data from the analytical laboratory.

Performance monitoring for the Early Action Source Treatments will include protocols for evaluating the effectiveness of the cleanup and discontinuation criteria. If the rate of mass removal does not meet the levels specified in the CAP, Ecology will require OCC to implement the system enhancements that are included in the EDR. These enhancements may include additional dewatering activities, additional SVE wells, and air sparging elements.

OCC will prepare and submit to Ecology Compliance Monitoring Reports after implementing the Early Action Source Treatments in accordance with the schedule in the approved CMP.

If it is clear by the end of the first three years of operation that the overall 60,0000 pound performance objective will not be met within a five-year timeframe, even with the enhancements identified in the EDR for this work, OCC will assess the system operation and data collected from the operation of the system to determine the reason for the lack of sufficient progress and will initiate a focused feasibility study to evaluate practicable contingency actions. A Supplemental EDR will then be developed for the selected contingency action(s) necessary to achieve the overall performance objective within the five-year timeframe.

Calculated soil-vapor screening levels are proposed in section 4.4 of the CAP for continued monitoring. OCC will monitor soil vapor as part of compliance monitoring. OCC is required to continue monitoring soil vapor as long as screening levels are exceeded. If the soil vapor data are above screening levels at the first periodic review OCC will initiate a focused feasibility study to evaluate practicable contingency actions to address or reduce soil vapor at the Earley Business Center.

To address the vapor intrusion at the OCC office building it will either be removed or mitigated within three years of completion of the early action source treatment if soil vapor readings exceed screening criteria.

b. Cover

A cover will be constructed over the Site property to prevent potential direct contact with shallow soil contamination. The sloped area between the vertical barrier wall along the Hylebos Waterway and the upland will be backfilled and will also be covered. This cover can consist of a membrane liner, reinforced concrete, asphalt, clay soil, or a combination of these materials. The specifications for the cover will be developed during the design phase and document in the EDR.

An Operations and Maintenance Plan (OMP) will also be developed in accordance with WAC 173-340-400(4)(c) for the cover. The OMP will be completed prior to installation of the system. The OMP shall also describe and provide for continued implementation of the institutional controls for the Site as developed in the EDR. The OMP shall identify the person(s) responsible for each task outlined in the OMP and relevant contact information.

Task 2: Develop and Design the Long-term Treatments

a. Volatile Organic Compound (VOC) Source Area Mass Reduction by Strategic Groundwater Pumping (MSP)

Shallow and deep groundwater with high concentrations of VOC will be extracted to remove mass from the existing plume of contamination that has travelled beyond the Site property boundary. The design of the system at this stage will focus on reversing the limits of the plume to bring contamination back towards the Site while removing mass. The extracted groundwater will be conveyed to a new groundwater treatment plant to be built in a new location on the Site.

The locations of the initial groundwater extraction wells for mass removal will be finalized in an approved EDR. If necessary due to difficulties in extracting or treating groundwater from these initial locations, strategic groundwater pumping will continue by moving specified mass reduction extraction wells to specific secondary locations identified as contingency wells in the approved EDR. The EDR will specify secondary locations planned to avoid problem areas where high pH and high dissolved silica concentrations cause problems with pumping and/or treating groundwater. When OCC is unable to continue at the specific locations for the initial wells and the replacement wells, the remedy will transition to the next phase of hydraulic containment as approved in the EDR.

The EDR will be adequate to obtain the necessary permits or meet the substantive provisions of laws for which there is a permit exemption in MTCA for Site remediation

The EDR will comply with the requirements of WAC 173-340-400(4)(a). The report will provide engineering concepts and design criteria for the MSP. The EDR will also include a section describing the institutional controls for the Site and a Soil and Groundwater Management Plan.

Following completion of the final EDR and approval by Ecology, Construction Plans and Specifications will be completed and submitted to Ecology for review and approval. The Construction Plans and Specifications will comply with WAC 173-340-400(4)(b).

b. Hydraulic Containment

The hydraulic containment element of the cleanup action will control Site groundwater within the specified hydraulic control boundaries. These hydraulic control boundaries, which are described in the CAP, enclose areas with highest concentrations of CVOC at different depths. The hydraulic containment system must impose an inward hydraulic gradient and at least one foot of water level drawdown within these control boundaries. These requirements must be maintained irrespective of treatment plant requirements or aquifer conditions within the control boundaries, including high pH and high dissolved silica concentrations. The design for Hydraulic Containment will include an approved EDR.

If the containment system does not meet the performance standards specified in the CAP and EDR, Ecology will require OCC to evaluate contingency remedial actions necessary to achieve an equivalent level of containment. Ecology will select a contingency action and OCC will prepare a contingency work plan for Ecology's review and approval. After Ecology's approval, OCC will implement the selected contingency action.

If it becomes technically infeasible to maintain these hydraulic control boundaries as evidenced by the compliance monitoring program, either Ecology or Occidental may initiate the adaptive management strategies process detailed in the CAP. If additional design is needed to maintain the hydraulic control boundaries, an equivalent level of containment must be achieved and maintained using an alternative technology or approach. A supplemental EDR will be submitted to Ecology for review and approval.

c. OMP

An OMP will also be developed in accordance with WAC 173-340-400(4)(c) for the MSP and Hydraulic Containment System. The OMP will be completed prior to installation of the system. The OMP shall also describe and provide for continued implementation of the institutional controls for the Site as developed in the EDR. The OMP shall identify the person(s) responsible for each task outlined in the OMP and relevant contact information.

d. CMP

The CMP will be developed prior to installation of the MSP and Hydraulic Containment System. The CMP will include protection monitoring, performance monitoring, and confirmational monitoring plans. The CMP will also include a SAP and a QAPP. Each plan will meet the requirements of WAC 173-340-410. Raw data shall be submitted to Ecology within 30 days following receipt of the data from the analytical laboratory.

Performance monitoring in the CMP for the MSP and Hydraulic Containment System will include protocols for evaluating the effectiveness of the cleanup and discontinuation criteria for each treatment element. Performance monitoring for the MSP and Hydraulic Containment System will include data and information describing expected individual well performance, including groundwater extraction rate, groundwater elevation, anticipated mass removal rate, and estimated water quality for each extraction well.

The CMP will also describe plume stability analyses to be conducted based on water quality data from the groundwater monitoring system. Protocols will be defined for evaluating whether the MSP and Hydraulic Containment System are achieving the overall objective of preventing plume expansion and plume migration.

The CMP will reference the approved groundwater studies that provide a baseline of existing conditions before the treatments start providing a reference point for the performance monitoring.

e. Groundwater Treatment Plant

The existing groundwater treatment plant will be used for treating groundwater and soil vapor from dewatering and vapor extraction activities associated with the early-action source treatments element.

A new groundwater treatment plant will be designed, and the design submitted in a separate EDR provided as part of the National Pollutant Discharge Elimination System (NPDES) permit application process. The design will include a study to evaluate the expected types and concentrations of constituents that will be in the groundwater expected to be treated by the new treatment plant. Occidental will provide the study to Ecology as part of a NPDES permit application process.

An OMP will also be developed in accordance with WAC 173-340-400(4)(c) for the treatment plant. The OMP will be completed prior to installation of the system. The OMP shall identify the person(s) responsible for each task outlined in the OMP and relevant contact information.

Task 3: Vertical Barrier Wall

A vertical barrier adjacent to the Hylebos Waterway will be constructed to achieve containment of shallow groundwater containing high pH and other sources of contamination. The vertical barrier wall will be approximately 2,200 feet long and approximately 75 feet deep. Methods for protecting the wall from corrosion will be identified during the design phase. The design will address sea level rise and any identified impacts from climate change expected or predicted during the lifespan of the barrier wall.

The design for the barrier wall will be included in the EDR required in Task 2. Occidental will plan for the procurement of the required permits and build into the schedule the time needed to apply and get approval for construction.

An OMP will also be developed in accordance with WAC 173-340-400(4)(c) for the Vertical Barrier Wall. The OMP will be completed prior to installation of the system. The OMP shall also describe and provide for continued implementation of the institutional controls for the Site as developed in the EDR. The OMP shall identify the person(s) responsible for each task outlined in the OMP and relevant contact information.

A CMP will be developed prior to installation of the vertical barrier wall based on the design and will meet the requirements of WAC 173-340-410. The CMP will include protection monitoring, performance monitoring, and confirmational monitoring plans. The CMP will also include monitoring activities and methods for periodically assessing wall integrity.

Task 4: Environmental Covenants

Land use restrictions are required to be recorded in the form of Environmental Covenants for protection of human health. Restrictions are based on site conditions, risks, and protection of the remedy at completion of the remedy construction. In consultation with OCC and neighboring property owners Ecology will prepare the Environmental Covenants consistent with WAC 173-340-440, RCW 64.70, and any policies or procedures specified by Ecology. The Environmental Covenants will restrict future activities and uses of the Facility.

The Environmental Covenants will be recorded with Pierce County once agreement is reached and construction is complete.

Task 5: Periodic Reviews

WAC 173-340-420 requires periodic review at critical points throughout a long cleanup period, but at minimum every 5 years. Ecology will publish a notice of the periodic review results in the Site Register to provide an opportunity for public comment.

A periodic review consists of an evaluation by Ecology of site conditions and monitoring data after remedy construction to assure human health and the environment are being protected. These reviews are in addition to the on-going oversight and reports that will be submitted to Ecology by OCC throughout the project.

Ecology will provide OCC the results of the periodic review at completion. Review criteria consists of evaluating the effectiveness of ongoing or completed cleanup actions, engineered controls, and institutional controls, as well as new information about hazardous substances, current and projected site and resource uses, the availability and practicability of more permanent remedies, and the availability of improved analytical techniques to evaluate compliance with cleanup levels. (WAC 173-340-420(4))

Task 6: Construction Completion Report

The EDRs will be used to develop a detailed project schedule that identifies the sequence of actions and identifies critical paths for implementation. The project schedule will be used to track progress and will be submitted to Ecology as part of project reports.

The cleanup action to be implemented at the Site includes construction of the Early Action Source Treatments and Cover, Vertical Barrier Wall, MSP and Hydraulic Containment System, and implementation of plans for institutional controls, operation and maintenance, and compliance monitoring. For each required EDR there is a requirement to submit the plans and specifications when the specific construction is completed.

Once the remedy construction is complete OCC is required to submit a Construction Completion Report in accordance with WAC 173-340-400(6)(b). This report summarizes all of the construction under the CAP into one document.

Task 7: Cleanup Completion Report

OCC will prepare a Cleanup Completion Report upon meeting the Site-wide cleanup standards for groundwater and soil vapor, including summary of all project elements from inception to meeting performance goals. The Cleanup Completion Report will be submitted with graphical representations of the work performed. The report will also provide documented evidence that institutional controls have been implemented.

11.2 SCHEDULE

Each of the documents required below are subject to Ecology's review and approval. Ecology will approve, approve with conditions, or disapprove of such documents. If Ecology disapproves of a document, Ecology will provide comments to OCC and the parties will establish a mutually agreed upon date for OCC's resubmittal of the document, not to exceed forty-five (45) days after OCC's receipt of Ecology's comments. OCC will then submit a revised document that addresses Ecology's comments. The project schedule is meant to accommodate adaptively managing the technologies as information and data inform the processes. OCC and Ecology will coordinate if and when adjustments to the schedule are appropriate.

Table 11.1 Implementation Schedule

Performance or Deliverable	Schedule
Task 1	
Engineering Design Report (EDR) for Early-Action Source Treatments to Address Potential Sources of Vapor Intrusion—including construction plans and specifications, and separate operation and maintenance plan (OMP), and compliance monitoring plan (CMP)	Draft EDR, OMP, and CMP: submit within 180 calendar days of final signature of Agreed Order Final EDR: submit within 30 calendar days of receipt of Ecology's final comments Final OMP: submit within 30 calendar days of receipt of Ecology's final comments Final CMP: submit within 90 days of receipt of Ecology's final comments
Begin construction of the Early Action Source Treatments	Within 30 calendar days of approved Final EDR—contingent on obtaining necessary permitting
Construction Completion Report for the Early-Action Source Treatments	Submit within 90 calendar days of achieving the 60,000-pound removal objective
If necessary, Focused Feasibility Study (FFS) to evaluate practicable contingency actions if after 3 years of operation the monitoring data indicate that the 60,000-pound objective will not be met in 5 years.	Draft FFS: submit within 90 calendar days of Ecology's determination Final FFS: submit within 30 calendar days of receipt of Ecology's final comments on the draft FFS

Performance or Deliverable	Schedule
Upon determination by Ecology, Supplemental EDR for Early-Action Source Treatments if 60,000-pound objective will not be met in 5 years—including construction plans and specifications, and separate OMP, and CMP	Draft Supplemental EDR, OMP, and CMP: submit within 90 calendar days of receiving Ecology's selection of contingency remedial action based on the Final FFS and criteria outline in the CAP Final Supplemental EDR: submit within 30 calendar days of receipt of Ecology's final comments on the draft Supplemental EDR Final Supplemental OMP: submit within 30 calendar days of receipt of Ecology's final comments Final Supplemental CMP: submit within 30 calendar days of receipt of Ecology's final comments
EDR for Physical Direct Contact Exposure Barrier (PDCEB)—including construction plans and specifications, and separate OMP, and CMP	Draft EDR, OMP, CMP: submit within 505 calendar days of final signature of Agreed Order Final EDR: submit within 30 calendar days of receipt of Ecology's final comments on the draft EDR Final OMP: submit within 30 calendar days of receipt of Ecology's final comments Final CMP: submit within 30 calendar days of receipt of Ecology's final comments
Begin construction of the PDCEB	Within 30 calendar days of approved Final EDR, —contingent on obtaining necessary permitting
Construction Completion Report for the PDCEB	Submit within 90 calendar days of completing the construction of the PDCEB

Performance or Deliverable	Schedule
Task 2	
EDR for Groundwater Extraction System—including construction plans and specifications, and separate OMP, and CMP	Draft EDR, OMP, and CMP: submit within 600 calendar days of final signature of Agreed Order Final EDR: submit within 45 calendar days of receipt of Ecology's final comments on the draft EDR Final OMP: submit within 45 calendar days of receipt of Ecology's final comments Final CMP: submit within 45 calendar days of receipt of Ecology's final comments
Begin construction of the Groundwater Extraction System	Within 30 calendar days of approved Final EDR
Construction Completion Report for the Groundwater Extraction System and Treatment Plant	Submit within 90 calendar days of completing construction of the groundwater extraction system and treatment plant

Performance or Deliverable	Schedule
Concurrent with the Groundwater Extraction System EDR, provide a separate EDR for the Groundwater Treatment system and NPDES Permit Application	Within 600 days of final signature of Agreed Order submit the Draft EDR and NPDES permit application to Ecology. Final EDR: submit within 45 calendar days of receipt of Ecology’s final comments on the draft EDR Final OMP: submit within 45 calendar days of receipt of Ecology’s final comments Final CMP: submit within 45 calendar days of receipt of Ecology’s final comments
Begin construction of the Groundwater Extraction System	Within 30 calendar days of approved Final EDR
Task 3	
EDR for Vertical Barrier Wall—including construction plans and specifications, and separate OMP and CMP	Draft EDR, OMP, and CMP: submit within 835 calendar days of final signature of Agreed Order Final EDR: submit within 45 calendar days of Ecology’s final comments on the draft EDR Final OMP: submit within 45 calendar days of Ecology’s final comments Final CMP: submit within 45 calendar days of Ecology’s final comments

Performance or Deliverable	Schedule
Begin construction of Vertical Barrier Wall	Within 30 calendar days of approved Final EDR—contingent on obtaining necessary permitting and marine construction window
Construction Completion Report for the Vertical Barrier Wall	Submit within 90 calendar days of completing construction of the Vertical Barrier Wall
Task 4	
Agreement on Environmental Covenant (EC)(s) prepared by Ecology.	At completion of all remedial construction and in consultation with OCC and affected landowners, Ecology will develop appropriate land use restrictions for draft Environmental Covenants. Final EC: OCC will review and submit comments to Ecology within 30 calendar days of receipt of the draft EC(s)
Task 5	
Periodic Reviews	Minimum every 5 years from the anniversary date of the construction completion. OCC will provide supplemental information such as post-remedy construction conditions and monitoring data, as needed for Ecology to apply the review criteria in WAC 173-340-420(4).

Task 6	
Remedy Construction Complete Report (RCCR)	Within 60 days of completion of construction of all elements of the remedy submit a comprehensive RCCR Final RCCR: submit within 30 calendar days of receipt of Ecology's comments
Task 7	
Cleanup Completion Report (CCR)	Draft CCR: submit within 90 calendar days of receiving Ecology's letter concurring Site-wide cleanup standards are met for groundwater and soil vapor Final CCR: submit within 30 calendar days of receipt of Ecology's final comments on the draft CCR

12. Public Participation

A separate Public Participation Plan was prepared for public comment along with this CAP. It is available on Ecology's Occidental website.

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Ridolfi, 2015. Technical Memorandum, Review and Evaluation of Risk Assessment Documents for the Occidental Chemical Corporation Corrective Action Site.

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The link provided below provides policies and guidance related to MTCA requirements:
https://ecology.wa.gov/Regulations-Permits/Plans-policies/Toxics-cleanup-policies