Second Five-Year Review Report

For

McCormick and Baxter Creosoting Company Superfund Site
Portland, Multnomah County, Oregon

ORD009020603

September 2006

Prepared by:

Oregon Department of
Environmental Quality (DEQ)

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Portland, Oregon

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Issuance by: Date:

Dick Pedersen, Administrator
Northwest Region
Oregon Department of Environmental Quality

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Concurrence by: Date:

for Daniel D. Opalski, Director
Office of Environmental Cleanup
U.S. Environmental Protection Agency

9/26/06

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Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name ***(from WasteLAN)*****: McCormick & Baxter Creosoting Company**		
EPA ID ***(from WasteLAN)*****: ORD009020603**		
Region: 10	**State: WA**	**City/County: Portland / Multnomah**

SITE STATUS	
NPL status: X Final ☐ Deleted ☐ Other (specify)	
Remediation status (choose all that apply): ☐ Under Construction ☐ Operating **X** Complete	
Multiple OUs?* **X** YES ☐ NO	**Construction completion date:** 09 / 27 / 2005
Has site been put into reuse? ☐ YES **X** NO	

REVIEW STATUS	
Lead agency: ☐ EPA **X** State ☐ Tribe ☐ Other Federal Agency ____________________	
Author name: Kevin Parrett	
Author title: Project Manager	**Author affiliation: ODEQ**
Review period:** 09 /26/ 2001 to 09/ 26 /2006	
Date(s) of site inspection: 09/26/2005 and 09/11/2006	
Type of review: **X** Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site **X** NPL State/Tribe-lead ☐ Regional Discretion	
Review number: ☐ 1 (first) **X** 2 (second) ☐ 3 (third) ☐ Other (specify) __________	
Triggering action: ☐ Actual RA Onsite Construction at OU #____ ☐ Actual RA Start at OU#____ ☐ Construction Completion **XX** Previous Five-Year Review Report ☐ Other (specify)	
Triggering action date ***(from WasteLAN)*****:** 09/26/2001	
Due date ***(five years after triggering action date)*****:** 09 /26 /2006	

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form, cont'd.

Issues:

1. Lack of Post-Construction Performance Data: Limited performance data are available for the current five-year review.
2. Alternate Concentration Limits: The EPA has determined that ACLs are not valid as substitutes for MCLs in groundwater at this Site.
3. Implementation of Institutional Controls: Several Institutional controls remain to be implemented: the Easement and Equitable Servitude and the Restricted Navigational Area.
4. Minor Erosion of Soil Cap: Initial inspections of the soil cap following construction in Summer 2005 have discovered minor erosion of topsoil at two discrete locations by the infiltration pond.
5. Erosion of Sediment Cap Armoring and Release of NAPL sheens: Initial inspections of the sediment cap following construction in Summer 2004 have identified several areas requiring additional armoring and several areas required additional sorptive capping material (i.e., organoclay). Additional monitoring is needed.
6. Incorrect Sediment Cleanup Goal for Dioxin Provided in the ROD: The sediment cleanup goal for dioxins and furans provided in the ROD ($8x10^{-3}$ mg/kg) is 100 times higher (i.e., less stringent) than the cleanup goal established in the 1992 baseline risk assessment ($8x10^{-5}$ mg/kg).

Recommendations and Follow-up Actions:

1. Perform extensive monitoring through December 2010; use data for updating protectiveness determination in 2008; use data for conducting third five-year review in 2011.
2. Revise the O&M plan to address the invalidation of ACLs. Address alternate approaches to groundwater ACLs.
3. Implement remaining Institutional Controls.
4. Perform continued inspections soil cap.
5. Perform extensive inspections of cap armoring, inspections for releases of NAPL sheens, and chemical monitoring of sediment pore water, flux, and surface water through December 2010; use data for updating protectiveness determination in 2008; use data for conducting third five-year review.
6. No follow-up actions are necessary on dioxin cleanup goal since this issue was addressed during design of the sediment cap.

Protectiveness Statement(s):

A protectiveness determination of the remedies for all Operable Units (i.e., soil, sediment and groundwater) cannot be made at this time until further information is obtained. It is expected that it will take approximately two years to complete the necessary sampling and analysis, at which time a protectiveness determination will be made.

Other Comments:

The Operational and Functional period for the sediment operable unit has been extended to September 2007.

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I. INTRODUCTION

The Oregon Department of Environmental Quality (DEQ) has conducted this five-year review of the remedial actions implemented at the McCormick and Baxter Creosoting Company Superfund Site (Site), located in Portland, Multnomah County, Oregon. This review was supported by DEQ's Contractor, Ecology and Environment, Inc. (E & E).

The purpose of a five-year review is to determine whether the selected remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify issues found during the review (if any) and make recommendations to address these.

This review is required by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, and Section 300.430(f)(4)(ii) of the National Oil and Hazardous Substances Contingency Plan (NCP). CERCLA Section 121(c), as amended, states:

> *If the President selects a remedial action that results in hazardous substances, pollutants, or contaminants remaining at the Site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.*

The NCP part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

This is the second five-year review for the Site. The first five-year review was issued on September 26, 2001. Five-year reviews are required at this Site because hazardous substances, pollutants, or contaminants remain above levels that allow for unlimited use and unrestricted exposure.

II. SITE CHRONOLOGY

A chronology of major Site events is provided in Table 1. Attachment 1 provides a pictorial overview of the Site from historic operations through remedy implementation, including a comparison of before and after pictures of remedial action construction.

III. BACKGROUND

Site Description

The Site is a former wood treating facility located on the east bank of the Willamette River in Portland, Oregon. The Site encompasses approximately 41 acres of land and an additional

23 acres of contaminated river sediments. Figure 1 is the Site location map. Figure 2 shows the current Site layout and features from an aerial photograph. Figure 3 depicts the current Site layout and features on a topographic map of the sediment and terrestrial surface elevations.

The upland portion of the Site is on a terrace of imported sand fill (dredged material placed in the early 1900s) within the historic flood plain of the Willamette River. This upland area is generally flat and lies between a 120-foot-high bluff along the northeast border and a 25- to 30-foot-high bank along the Willamette River to the southwest. Currently, the Site is vacant except for a paved parking area, small shop building, two field office trailers, and associated utilities which are used to support ongoing creosote extraction.

Inactive industrial properties border the Site to the southeast, and a residential area is located above the Site on the adjacent bluff. A Burlington Northern Santa Fe railway track crosses the northwest portion of the property, and Union Pacific Railroad tracks border the Site to the southeast below the bluff. Beyond the Burlington Northern Santa Fe railway tracks, toward the northwest, is a former industrial property that likely will be developed as a public green space. Additionally, the 115-acre University of Portland college campus is located approximately 0.5 mile east of the Site. The perimeter of the Site property is fenced and posted with warning signs.

Three hydrostratigraphic units are present at the Site: the shallow, intermediate, and deep aquifer zones, which are interconnected to varying degrees depending upon the location within the Site. The shallow zone consists of poorly-graded dredge fill sand and wood debris; it ranges in thickness from 5 to greater than 30 feet. In parts of the Site, the shallow zone consists mostly of sawdust and wood chips up to 20 to 25 feet thick. The shallow zone acts as an unconfined aquifer that is in hydraulic connection with the river. This connection, however, significantly diminishes toward the bluff and within the barrier wall area. Depth to groundwater ranges from approximately 20 to 25 feet below ground surface (bgs). In much of the Site, the shallow zone is underlain by a silt aquitard, ranging in thickness from zero near the river to greater than 100 feet closer to the bluff.

The intermediate aquifer zone is composed of fine to medium grained alluvial sand and is present below the silt aquitard over most portions of the Site. This zone varies in thickness from zero to greater than 50 feet. In the north-central portion of the Site, the intermediate zone is approximately 12 feet thick and hydraulically separated from the shallow aquifer. In the south-central portion of the Site, the silt aquitard is greater than 100 feet thick, and no intermediate aquifer zone is present. Along the beach adjacent to the river, the intermediate zone is up to 50 feet or more thick and is separated from the shallow zone by a discontinuous, thin silt layer.

The deep aquifer zone is present in all portions of the Site. The deep zone consists of alluvial sands and is directly connected with the intermediate and shallow zones along the river margin. Near the center of the Site, the deep zone is separated from the shallow zone by more than 100 feet of low-permeability silt. Near the bluff, the deep zone is composed of gravel and sands of the Troutdale Formation and Catastrophic Flood Deposits.

Shallow groundwater gradients generally exist from the bluff toward the river. Intermediate and deep zone groundwater surface elevations and gradients have been inferred to flow toward the river in these zones.

The Willamette River is the only surface water body at the Site. Near the Site, the river is approximately 1,550 feet wide, with a typical maximum depth of about 45 to 55 feet below the National American Vertical Datum [NAVD]. Average flow rates in the river near the Site range from 8,300 cubic feet per second (cfs) in summer to 73,000 cfs in winter.

Site History

Much of the Site was created from dredged materials in the early 1900s. At that time, a sawmill operated in the southeast portion of the property. McCormick & Baxter Creosoting Company was founded in 1944 to produce treated wood products, including lumber, piling, timbers, and railroad ties during World War II. The wood treating operations continued until October 1991.

Four retorts were located in the central processing area (CPA) at the Site and were used for various pressure treating processes, which included the use of creosote, pentachlorophenol (PCP), chromium, ammoniacal copper arsenate, ammoniacal copper zinc arsenate (ACZA), and Cellon (PCP in diesel oil, liquid butane, and isopropyl ether). Also present at the Site were a 750,000-gallon creosote product storage tank and a tank farm area (TFA) with several additional tanks for storing wood-treatment chemicals.

From 1950 to 1965, waste oil containing creosote and/or PCP was applied to the Site soil for dust suppression in the CPA. Liquid process wastes were reportedly discharged to a low area near the tank farm prior to 1971.

The Site included a wastewater discharge outfall that was used to discharge cooling water to the river when the plant was operating. Contact wastewater also was discharged from this outfall in the early years of operation. Three stormwater outfalls were also present along the river. Two of the outfalls were permitted under the National Pollutant Discharge Elimination System. Following plant shutdown, DEQ placed earthen berms around stormwater collection sumps at the Site as an early response action to minimize off-site discharge. The stormwater outfalls were removed as part of the first phase of the soil remedial action in 1999.

Two major spills have reportedly occurred at the Site: a 50,000-gallon creosote release in the tank farm area in approximately 1950; and a large spill of an unspecified volume of creosote from a tank car near the tank farm in 1956.

Sludge from on-site processes was disposed of at an unknown off-site location until 1968. From 1968 to at least 1973, residues from the retorts, oil/water separator, and evaporators were disposed of on Site in the former waste disposal area (FWDA) in the western portion of the Site. Beginning in 1972, wood preservative sludge was placed in metal containers that were stored on Site in the FWDA. After 1978, wood preservative sludge was shipped to Chem-Security System, Inc., a permitted hazardous waste disposal facility near Arlington, Oregon. In 1981, the hazardous waste storage area was secured with a fence and lock, and a manifest system was implemented to comply with hazardous waste regulations.

Concrete walls and slabs were built around the ACZA process and storage facilities in 1980 to prevent spills from entering the soil. The retorts and retort openings were lined with concrete, but the integrity of the concrete was not verified. The creosote lines and other pipelines passed through a concrete underground walkway that extended from the tank farm to the retort building. In 1985, 2 feet of soil and sludge were excavated from the tank farm and were shipped to a hazardous waste landfill. Visibly contaminated soil remained at the tank farm.

Site investigations have revealed many releases of wood-treating chemical compounds to soils, groundwater, and sediments as a result of these operations. Contaminants detected include polynuclear aromatic hydrocarbons (PAHs, comprising 85% of the creosote), PCP, arsenic, chromium, copper, zinc, and dioxins/furans. Three main contaminant sources existed at the Site: the FWDA, which was located in the western corner of the Site adjacent to the Willamette River and was characterized by a large depression where waste oils, retort sludges, and wastewater were disposed of over a period of several years; the CPA, which was located in the center portion of the Site and was where retorts, PCP mixing shed and ACZA storage areas were formerly located; and the TFA, which was located in the south-central portion of the Site and was the former location of the main tank farm, creosote storage tank, and several other wood treatment process-related tanks or process areas. Releases from these source areas (particularly in the TFA and FWDA) in the form of insoluble wood-treating contaminants or non-aqueous phase liquids (NAPL) have significantly impacted subsurface soils, groundwater, and sediment. Remedial investigations identified two large NAPL plumes migrating to the river and impacting surface water and sediments. Subsequent monitoring identified another NAPL plume migrating under the Burlington Northern Santa Fe railway right-of-way toward Willamette Cove.

Additional investigation was recently performed in the northern corner of the Site to determine the nature and extent of NAPL associated with monitoring well MW-1s. This investigation, documented in a January 2006 report, found only trace amounts of NAPL apparently comprised of weathered crude or bunker oil.

Regulatory History

The McCormick & Baxter Creosoting Company began environmental investigations of their property in 1983. Based on those investigations, DEQ entered into a Stipulated Order with McCormick & Baxter Creosoting Company in 1987 requiring the implementation of corrective actions. Corrective actions included the installation and operation of a groundwater extraction and treatment system, construction of drip pads in retort areas, construction of covered storage areas for treated wood, and collection and treatment of stormwater. In December 1988 the McCormick & Baxter Creosoting Company filed for Chapter 11 bankruptcy; and, in 1990 DEQ assumed responsibility for completing the investigations and cleanup activities at the Site. In October 1991 the McCormick & Baxter Creosoting Company ceased operations.

DEQ began the Remedial Investigation and Feasibility Study in 1990 and issued a public notice of a proposed cleanup plan in January 1993. DEQ elected not to finalize the proposed remedial actions at the Site due to the proposed addition of the Site to the National Priorities List (NPL) by U.S. Environmental Protection Agency (EPA) in June 1993. The Site was added to the NPL on June 1, 1994. DEQ completed a revised Feasibility Study in 1995.

DEQ and EPA entered into a Superfund State Contract (SSC) in May 1996. The SSC documents the responsibilities of DEQ as the lead agency and EPA as the support agency during the remedial action. Among other items, the SSC specifies cost sharing between DEQ and EPA. The SSC was most recently amended in February 2005.

Additional regulatory background information on the McCormick & Baxter Superfund Site can be found in the following documents:

- *Record of Decision*, McCormick and Baxter Creosoting Company Portland Plant, Portland, Oregon, EPA and DEQ, March 1996.
- *Amended Record of Decision*, McCormick and Baxter Creosoting Company Portland Plant, Portland, Oregon, EPA and DEQ, March 1998.
- *First Five-Year Review Report,* McCormick and Baxter Creosoting Company Superfund Site, Portland, Multnomah County, Oregon, EPA and DEQ, September 2001.
- *Explanation of Significant Difference (OU3 – Final Groundwater)*, McCormick and Baxter Creosoting Company Superfund Site, Portland, Multnomah County, Oregon, EPA and DEQ, August 2002.
- *Preliminary Close-Out Report*, McCormick and Baxter Creosoting Company Superfund Site, Portland, Multnomah County, Oregon, EPA, September 2005.

Removal Actions

Removal Actions were completed by DEQ under State of Oregon cleanup regulations prior to listing on the NPL and under CERCLA authority between Site listing and issuance of the Record of Decision (ROD). A list of these Removal Actions is provided in the document titled *Preliminary Close-Out Report* (EPA, September 2005).

Remedy Selection

In March 1996 EPA and DEQ issued one ROD for the Site to address several different media: contaminated soil, groundwater, stormwater, and Willamette River sediment. The selected remedy required the following media-specific actions to mitigate the principal threats at the Site:

- Excavation, consolidation and biological treatment/stabilization of the most highly contaminated soils.
- Soil capping.
- Enhancement of the existing groundwater and NAPL extraction and treatment system.
- As a contingency remedy, installation of a vertical subsurface barrier wall in the event that mobile NAPL cannot be reliably controlled.
- Sediment capping.

Monitoring.
- Institutional controls.

In March 1998 an Amended ROD was issued by EPA and DEQ to change a component of the selected remedial action for contaminated soil. The soil remedy in the ROD called for excavation and on-site biological treatment. After the ROD was signed, DEQ initiated additional soil sampling for remedial design. This sampling found dioxin contamination was more widespread than previous analyses indicated. Accordingly, DEQ and EPA reevaluated the remedy and subsequently selected an alternative that called for removal and off-site disposal of shallow soil with concentrations above designated action levels and capping the remaining contaminated soil.

In August 2002 EPA and DEQ issued an "Explanation of Significant Differences" (ESD) explaining the decision to implement the contingency remedy for groundwater as specified in the 1996 ROD. The groundwater remedy selected in the ROD included a contingency for installing an impermeable subsurface barrier wall in the event that either: (1) NAPL could not be reliably contained using hydraulic methods; or (2) the barrier wall improves the overall cost-effectiveness of the groundwater remedy. DEQ and EPA determined that NAPL had not been contained using groundwater/NAPL extraction and recovery measures, and concluded that hydraulic control of NAPL or groundwater had not been established in either the TFA or the FWDA. To implement the contingency plan, DEQ and EPA selected a fully encompassing, impermeable subsurface barrier wall alignment surrounding the TFA, CPA and the FWDA, and a riverfront alignment located along the ordinary high-water mark of the Willamette River.

Redevelopment Potential

A Site Re-Use Assessment was conducted between February 2000 and June 2001 by the City of Portland Bureau of Planning under a grant from EPA. In developing reuse recommendations the City analyzed the Site's redevelopment potential and engaged stakeholders and the interested public in learning about, proposing and jointly considering what uses would best fit the Site. The City's findings were presented in a final report dated June 2001 and endorsed by the Portland City Council on July 25, 2001.

In conducting the assessment, the City developed a list of reuse criteria that would need to be balanced in order to arrive at the most feasible land reuse, such as minimizing traffic impacts, ensuring adequacy of infrastructure, being compatible with cleanup remedies, serving an identified market or community needs and being consistent with the City of Portland Comprehensive Plan. Using these criteria, the City developed, presented and discussed a variety of reuse ideas and conceptual site plans. Four reuse scenarios were further studied and reviewed at public open houses: an open space demonstration site, recreational use, industrial use and mixed use (residential, commercial and university facilities). Project consultants prepared market feasibility and traffic analysis reports for these four scenarios. The City concluded that the Site is best suited for recreational use.

IV. REMEDY DESCRIPTION AND IMPLEMENTATION

Soil Remedy

The soil remedy is composed of three primary components: institutional controls[1], removal of highly contaminated soil within 4 feet of the ground surface, and capping. The Remedial Action Objectives for the soil remedy are:

- Prevent human exposure through direct contact (ingestion, inhalation, or dermal contact) to contaminated surface and near-surface soil that would result in an excess lifetime cancer risk above $1x10^{-6}$ for individual compounds, above $1x10^{-5}$ for additive carcinogenic compounds, or above a Hazard Index (HI) of 1 for noncarcinogenic compounds in an industrial land use scenario; and
- Prevent storm water runoff containing contaminated soil from reaching the Willamette River.

<u>Soil Removal</u>

The purpose of the soil remedy was to eliminate the potential for future human contact with soil less than 4 feet in depth that has contaminant concentrations above removal action levels. Removal action levels for contaminated soils were defined for excavation and off-site disposal for arsenic, PCP, and total carcinogenic PAHs. These action levels indirectly address the removal of dioxins/furans due to their presence predominantly in areas where elevated concentrations of PCP or PAHs were found in soil.

Soil excavation activities were performed from February through May 1999 and effectively eliminated the presence of the contaminated soils above removal action levels in the surficial 4 feet. In several major source areas, excavation proceeded to depths of 8 to 10 feet; although, large volumes of deeper soil still contain NAPL and high concentrations of Site contaminants. Approximately 32,604 tons of contaminated soil and debris were excavated and disposed off-site at permitted landfills. A total of 33,128 tons of clean sand were imported from an off-site quarry to backfill the excavation pits.

Documentation, record drawings, and a detailed summary of the soil removal construction activities are provided in the document titled *Phase 1 Soil Remedial Action Summary Report* (E & E, November 1999).

<u>Upland Soil Cap</u>

The selected soil remedy requires capping upland areas where residual soil contamination remains above human health and ecological risk-based protective levels. Documentation, record drawings, and a detailed summary of the upland soil cap construction activities are provided in the document titled *Upland Soil Cap Construction Summary Report* (E & E, May 2006).

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[1] To improve readability in this five-year review the institutional controls for the soil, sediment and groundwater remedies have been consolidated.

Construction activities for the upland soil cap were performed between March and September 2005 and included the following major components: demolition and off-site disposal of existing structures and infrastructure; reinstallation of key support facilities; construction of an impermeable cap within a 15-acre portion of the 18-acre subsurface barrier wall; and construction of an earthen soil cap outside of the impermeable cap.

Demolition and removal were conducted from May through June 2005 and included the removal of all remaining structures and disposal of the generated waste in a State-approved disposal facility. All existing water, gas, and electrical utilities were removed or abandoned. Most fire hydrants were removed, any associated piping was grouted to prevent preferential flow paths, and water lines were capped. Demolition items were salvaged, scrapped, or disposed of as non-hazardous waste or hazardous waste. Concrete, creosote-contaminated steel, and asbestos-containing water pipe were also buried on site. All on-site burial locations were surveyed. Twenty groundwater monitoring wells were abandoned.

Support facility construction was conducted from March to July 2005 and included the reinstallation of a 1-acre paved entrance road and parking area, construction of a 25-foot by 40-foot shop building, and reinstallation of electrical, telephone, and water services.

A Resource Conservation and Recovery Act-type impermeable cap was constructed over the entire 15-acre area inside of the barrier wall, excluding the riparian zone bordering the river. Capping of the riparian zone with an earthen cap had been completed in 2004 as part of the sediment cap construction.

The purpose of the impermeable cap is to minimize infiltration of rainwater into the contaminated areas within the wall. The impermeable cap is composed of the following materials, listed in order from bottom to top:

- 8,000 cubic yards of sand used as a leveling layer about 4 inches thick.
- 72,000 square yards of high density polyethylene (HDPE) geomembrane liner which prevents water from flowing vertically into the contaminated aquifer.
- 72,000 square yards of a geocomposite plastic ‘fabric’ that allows water to flow laterally.
- 47,000 cubic yards of sand of varying depths to allow for drainage.
- 12,000 cubic yards of 4”-minus crushed rock, forming a screened biotic barrier layer approximately 6 inches thick.
- 72,000 square yards of geotextile filter fabric.
- 24,000 cubic yards of topsoil placed approximately 9 to 12 inches in depth.
- 20 species of native grasses to provide a diverse and sustainable herbaceous cover, thus minimizing surface erosion.

The impermeable cap has a minimum thickness of 29 inches; the thickness varies because of varying subgrade and the final grade of the Site. The sand drainage layer increases in depth to create the grades necessary to achieve Site drainage. The maximum thickness of the cap is approximately 7 feet, which includes a 4-inch sand leveling layer, a 62-inch sand drainage layer, a 6-inch rock biotic barrier, and 12 inches of topsoil.

The impermeable cap also consists of a subsurface drainage system above the HDPE liner to collect stormwater percolating through upper soil, rock, and sand layers of the cap. Stormwater is collected in the geocomposite fabric and perforated piping and conveyed by gravity flow through conveyance piping to an outfall structure, which daylights at approximately the Ordinary High Water (OHW)[2] level of the Willamette River.

An earthen soil cap, consisting of a 2-foot layer of imported topsoil, was installed over 19 acres of the Site outside of the barrier wall area, excluding the gravel entrance road and parking area (1 acre). An additional 6 acres of earthen cap were installed over the riparian zone during construction of the sediment cap. The total area of earthen cap is 25 acres. The purpose of the earthen cap is to prevent direct contact with low-level contamination remaining in the soils throughout the rest of the Site. The soil layer is underlain with a demarcation layer consisting of orange HDPE safety fencing to provide a distinction between the clean soil cap and contaminated soil. The earthen soil cap was seeded with native herbaceous vegetation.

A stormwater management system was constructed to minimize stormwater runoff from the Site to neighboring properties and the Willamette River. This system consists of a swale that conveys stormwater directly to an on-site retention/infiltration pond. Except for the 6-acre riparian zone, the surface of the upland soil cap (including both the earthen and impermeable caps) is constructed with sloped surfaces (approximately 1 percent slope) to direct surface water runoff towards the drainage swale. Rainwater falling onto the riparian zone, which generally has a slope of 25 percent slope, flows overland toward the river and/or infiltrates into Site soil and groundwater.

A 6-foot high, chain-link fence topped with barbed wire was also reinstalled along the Site perimeter. Along the riverfront, the fence is located 35 feet inland from the top of bank. Gravel access ways and roads were constructed around the perimeter of the Site (except along the north side where the drainage swale is located), with spurs that cross the interior area to allow monitoring and maintenance of the Site. Warning signs were placed along the perimeter of the Site.

Several thousand native trees and shrubs were planted throughout the drainage swale and riparian zone in February 2006, and a temporary, above-ground irrigation system was installed in May 2006. The purpose of this vegetation, along with the native grasses, is to help stabilize the soil against stormwater erosion and river flood erosion and to reduce rainwater percolation into groundwater by evapotranspiration.[3]

Sediment Remedy

The sediment remedy is composed of two primary components: institutional controls and a sediment cap. The Remedial Action Objectives for the sediment cap are:

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[2] OHW at the Site is +20 feet NAVD.

[3] Restoration and maintenance of the riparian zone is required by the Biological Opinion issued by the National Marine Fisheries Service, pursuant to Section 7 of the Endangered Species Act.

- Prevent humans and aquatic organisms from direct contact with contaminated sediments; and
- Minimize releases of contaminants from sediment that might result in contamination of the Willamette River in excess of federal and state ambient water quality criteria.

The first RAO is designed to prevent human exposure under a recreational scenario from direct contact with contaminated sediments and to prevent exposure of benthic organisms to sediment contamination above known toxicity levels[4].

The selected sediment remedy consists of capping areas that contain contaminant concentrations above human health and ecological risk-based protective levels or that exhibit significant toxicity to benthic organisms within the upper sediments. Construction of the sediment cap occurred in two separate phases: June through November 2004[5] and August through October 2005. Documentation, record drawings, and a detailed summary of the sediment cap construction activities are provided in the documents titled *Remedial Action Construction Summary Report Sediment Cap (June 2004 through November 2004)* and *Remedial Action Construction Summary Report Sediment Cap Completion (August 2005 through October 2005)*, both issued by E & E in May 2006.

Construction activities in 2004 consisted of the following major components:

- Removal of approximately 1,630 pilings, bulkhead, dock remnants, in-water debris, a derelict barge in Willamette Cove, and other Willamette Cove features;
- Construction of a multi-layer sediment cap using sand, organoclay, and armoring;
- Monitoring well abandonment and modification;
- Bank regrading and capping; and
- Disposal and demobilization.

The sediment cap footprint constructed in 2004 encompassed approximately 22 acres. Its shoreward boundary extends along the shoreline from the south end of the property downstream into Willamette Cove to the north. Its riverward boundary at the furthest offshore location extends into the Willamette River to an approximate elevation of -40 feet NAVD, outside of the limits of the United States Army Corp of Engineers-designated navigational channel, and to -16 feet NAVD in Willamette Cove. The cap consists of a 2-foot thick layer of sand over most of the cap footprint with a 5-foot thick layer of sand over several more highly contaminated areas. Approximately 131,000 tons of sand were placed from July 7 through October 28, 2004.

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[4] At the time of the ROD, no State or Federal sediment quality criteria existed. However, bioassay results indicated that a substantial area of near-shore sediment contamination was toxic to sedentary benthic invertebrates (bioassay testing measured organism survival and weight, see Sediment Cap Basis of Design). These areas coincided with areas that exceeded human risk-based goals. Verification of cleanup goals for protection of benthic organisms were based on sediment bioassay tests resulting in impaired survival and growth (i.e., weight).

[5] This phase of the sediment cap construction also included regrading and capping of the riverbank to create the 6-acre riparian zone. Although construction of the riparian bank cap is described as part of the sediment cap remedy, long-term operation and maintenance of the riparian zone will be conducted as part of the upland soil cap.

Within the cap footprint were areas of known NAPL migration (e.g., seep areas). In the Willamette Cove and TFA NAPL seep areas, the cap incorporated 600 tons of organoclay to prevent breakthrough of NAPL through the cap. Organoclay is bentonite or hectorite clay that has been modified to be hydrophobic and to have an affinity for organic compounds.

The sediment cap incorporated different types of armoring to prevent erosion of the sand and organoclay layers. The specific armoring material and where it was installed depended on the expected hydraulic and physical environments (e.g., currents, wave energy, erosive energies, etc.). Articulating concrete block (ACB) mats were installed along the shore and in shallow water where erosive forces would be the greatest due to wave action. ACB is composed of individually formed, interlocking concrete blocks. Rock armor included 6-inch-minus, 10-inch-minus, and riprap. All shallow water 10-inch-minus and ACB armoring layers were underlain with a woven geotextile fabric and a 4-inch thick layer of 3-inch-minus filter rock. This fabric and rock layer was installed to hinder the migration of the sand through the larger and more porous armoring layer or layers.

ACB installation began on July 7, 2004, and proceeded from the downstream end of the Site in Willamette Cove to the upstream work limits. Installation of ACB mats was allowed only after the subgrade, including sand cap and gravel filter layer, was verified by DEQ's construction oversight contractor. The ACB installation was completed on October 28, 2004.

The 6-inch-minus rock was basalt and/or andesite. Approximately 23,250 tons of 6-inch-minus cobble were placed over the sand cap and as edge treatment where the 6-inch-minus cobble areas abutted the ACB. The 10-inch-minus rock used as armoring is also composed of angular basalt and/or andesite. Approximately 23,300 tons of 10-inch-minus rock were placed in the near-shore embayment. The riprap material used for construction of the boulder clusters and the rock mound is composed of durable angular boulders less than 3 feet in diameter.[6] Approximately 558 tons of riprap were placed along the shoreline and on an offshore shoal between the embayment and the river at the Site. Each boulder cluster consisted of six to seven boulders.

Eighteen monitoring wells located within the 6-acre riparian zone were abandoned, and 36 monitoring wells were modified in accordance with Oregon Water Resources Department requirements (e.g., boreholes were overdrilled and grouted with bentonite).

The 6-acre riparian zone was created by regrading of the riverbank, placement of a demarcation layer, placement and grading of 2 feet of imported clean fill (topsoil), placement of a turf reinforcement mat, and hydroseeding with native grasses.

During initial construction of the sediment cap, two City of Portland pressurized sewer lines were found exposed within the sediment capping area. The City of Portland was informed of the situation, and a no-work zone was established along a 120-foot swath of the sewer lines. These lines were stabilized by the City of Portland in July 2005. Construction of this remaining 1-acre sediment cap was resumed in August 2005, completed in September 2005, and consisted of

[6] The boulder clusters are intended to provide aquatic habitat diversity while the rock mound is intended to lower hydraulic energy within the shallow water embayment area.

placement of the following major components[7]: 8,950 tons of sand; 460 tons of 3-inch-minus filter rock; 1,711 tons of riprap; 2,850 tons of 6-inch-minus rock; and 1,240 tons of 10-inch-minus rock. The riprap material was used in place of the ACB to provide stability against wave action along steep portions of the shoreline, between elevations of approximately +8 NAVD to -2 NAVD.

Construction activities in 2005 also included the installation of 24,150 square feet of organoclay mats as a corrective measure to address releases of NAPL sheens discovered during weekly inspections following cap construction in 2004. These corrective measures are discussed in later sections of this five-year review. The organoclay mats were placed in three areas along the shoreline: under the Burlington Northern Santa Fe railway Bridge (6,000 square feet); downstream of the previously organoclay capped TFA seep (150 square feet); and upstream of the previously organoclay capped TFA seep (18,000 square feet). The organoclay mats were covered with sand and rock armoring.

Groundwater Remedy

The groundwater remedy is composed of three components: institutional controls, a subsurface barrier wall, NAPL recovery, and evaluation of innovative technologies for NAPL recovery. The Remedial Action Objectives for the groundwater remedy are:

- Prevent human exposure to or ingestion of groundwater with contaminant concentrations in excess of Federal and State drinking water standards or protective levels;
- Minimize further vertical migration of NAPL to the deep aquifer;
- Prevent groundwater discharges to the Willamette River that contain dissolved contaminants that would result in contaminant concentrations within the river in excess of background concentrations[8] or in excess of water quality criteria for aquatic organisms;
- Minimize NAPL discharges to the Willamette River beach and adjacent sediment; and
- Remove mobile NAPL to the extent practicable to reduce the continuing source of groundwater contamination and the potential for discharge to Willamette River sediment.

<u>Creosote Recovery</u>

Creosote (i.e., NAPL) recovery began in 1989 as a Removal Action. Approximately 450 gallons were recovered between July 1989 and November 1991. By February 1995, more extraction wells had been added to the system, and approximately 1,800 additional gallons of NAPL had been removed.

NAPL recovery continued following issuance of the ROD in March 1996. Through March 2004, monthly extraction volumes of NAPL from extraction wells in the former TFA and FWDA ranged from 0.4 to 73 gallons, with some periods of no extraction. As of July 21 2006, approximately 6,135 gallons of NAPL have been removed from groundwater (see Figure 4).

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[7] These quantities include construction associated with the corrective measures performed in August and October 2005 as discussed in the following paragraph.

[8] Issues associated with this Remedial Action Objective (i.e., relating to Alternate Concentration Limits) are further discussed in Section XIII and IX of this five-year review report

NAPL currently being recovered from extraction wells is transported to an off site Resource Conservation and Recovery Act Subtitle C facility for treatment and disposal as a listed hazardous waste.

Since the McCormick & Baxter Creosoting Company ceased operations in 1991, various extraction methods have been attempted to optimize NAPL recovery. The goal of the extraction is to remove and deplete NAPL pools to residual levels to minimize or prevent migration into the Willamette River. Key NAPL extraction activities are summarized below:

- 1998: The treatment system in the TFA was again modified. Previously, total fluids extracted from three wells were conveyed to the former pilot treatment system and treated by a dissolved air flotation system. This system required extensive oversight and was expensive to operate (e.g., chemical costs). The system operated 40 hours per week (Monday through Friday) when a technician was on site to perform operation and maintenance activities. To allow for continuous operation and to reduce costs and operator requirements, the system was replaced with one resembling that employed in the FWDA; this consisted of an oil/water separator, an in-line anthracite/clay filter, two granulated activated carbon units, and a metals treatment unit.
- 1999 & 2000: The volume of NAPL extracted by the automated systems was found to be similar to the volume removed via manual extraction using skimmers. In addition, it was determined that manual extraction could be conducted for approximately half the cost of operating the automated systems. Therefore, the FWDA and TFA NAPL extraction systems were shut down in September 2000, and NAPL extraction was continued manually.
- 2004 – Current: Select wells inside and outside the barrier wall are monitored weekly for the presence and thickness of NAPL. NAPL is extracted weekly from these wells if the NAPL thickness within the well is sufficient for recovery (i.e., 0.4 feet for LNAPL and 1.5 feet for DNAPL).

<u>Subsurface Barrier Wall</u>

As required by the ESD, a fully encompassing, impermeable subsurface barrier wall was designed and installed to meet the remedial action objective of minimizing NAPL discharges to the Willamette River. More specifically, the barrier wall was designed to cut off much of the upgradient sources of dense NAPL (DNAPL) and light NAPL (LNAPL) in the TFA and FWDA and to reduce NAPL migration from these areas to the river. The subsurface barrier wall was designed to surround as much of the TFA, former CPA, the FWDA as practical considering the presence of a high pressure sewer main along the Burlington Northern Santa Fe railway right-of-way and the location of the Willamette River. With respect to the Willamette River, the barrier wall was placed as close to the river as possible while not resulting in an (above ground) bulkhead nor an overly steep bank treatment when grading and capping the riverbank to cover the barrier wall. On average, following grading and capping of the riverbank, the river-front segment of the barrier wall is located at approximately 30 feet landward from OHW. The top elevation of the barrier wall along the river-front segment is approximately 23 feet NAVD (3 feet above OHW and 2 feet below the 10-year flood elevation).

The subsurface barrier wall was constructed from April through September 2003, with the exception of eight sheet piles that met refusal before achieving design depth. The resulting gaps were pressure grouted in July 2004. The construction of the barrier wall is documented in the report titled *Remedial Action Construction Summary Report, Combined Sheet Pile and Soil-Bentonite Barrier Wall* (E & E, July 2004).

The barrier wall was constructed to fully encompass 18 acres of NAPL-impacted groundwater and the main contaminant source areas at the Site, including the TFA and FWDA. The total length of the wall is 3,792 linear feet, and the depth varies from approximately -25 to -45 feet NAVD (45 to 80 feet bgs) to account for differences in the topography and soil profile at the Site.

A 1,440-foot segment of the barrier wall along the bank of the Willamette River was constructed using steel sheet piles. Installation methods involved a panel-driving technique, which consisted of setting and partially driving six to eight sheet pile pairs (a panel).

A 2,355-foot segment of soil-bentonite barrier wall was installed to depths of up to 80 feet bgs to the side and upgradient of the primary contaminant source areas. The excavated trench was held open using a slurry mix of bentonite and water, which was later displaced by the denser soil-bentonite mixture. The mixing operation occurred concurrently with excavation within the wall's perimeter. The soil-bentonite mixture consisted of soil excavated from the trench, slurry from the trench, imported clayey soil, and dry bentonite. The mixing and placement were accomplished by an excavator and bulldozer.

The segment of wall between the Willamette River and the TFA (approximately 900 linear feet) is keyed into a silt aquitard and extends to a depth of approximately 70 to 80 feet bgs. The segment of barrier wall between the Willamette River, Willamette Cove, and the FWDA (approximately 1,100 linear feet) is a "hanging wall" because deeper soil in this area consists of interbedded sand and silt lenses with no continuous, competent aquitard to key into. This segment of the wall extends to a depth of 70 to 80 feet bgs. The segment of the wall located upgradient and cross-gradient of the TFA and FWDA (1,800 linear feet) is keyed into the silt aquitard and has a depth of 45 feet bgs.

Although the barrier wall segment located downgradient of the FWDA does not key into a continuous, competent aquitard, the depth of this segment of the wall serves to increase the distance between the DNAPL source and the river thereby reducing the potential for continued flow mobile NAPL.

<u>Review of NAPL Recovery Innovative Technologies</u>

The ROD required pilot testing to evaluate innovative technologies, such as surfactant flushing, to increase the effectiveness of NAPL removal. This requirement was modified in the ESD because NAPL accumulations on site (at that time) appeared to be decreasing and there were concerns that, in the absence of containment, pilot tests could mobilize NAPL and increase discharges to the river.

Through its contractors, DEQ prepared a technical memorandum that developed and evaluated several innovative technologies and presented a cost-benefit analysis of the most promising innovative technology for enhanced NAPL extraction, the current method of NAPL recovery, and additional organoclay capping if continued NAPL flow were to exceed the sorption capacity of the existing organoclay caps. The evaluation of innovative technologies utilized two general criteria: effectiveness and implementability at the Site. The following technologies were developed and evaluated in the report: cold water flooding, hot water flooding, in situ chemical oxidation, and electrical resistive heating. The cost-benefit analysis considered: the cost to construct, operate and decommission these innovative technologies; the cost of the existing system for NAPL recovery; and a scenario where no further NAPL recovery would be performed and potential NAPL breakthrough of the organoclay caps would be contained by the targeted use of additional organoclay.

Additional construction of an innovative technology is not foreseen at the present time. This conclusion will be reconsidered if DEQ and EPA determine, based on ongoing performance monitoring, that the existing remedies are not meeting Remedial Action Objectives.

Engineering and Institutional Controls

The ROD specifies institutional controls for the soil, groundwater and sediment remedies:

- Physical restrictions (e.g., fencing), warning signs, and safety measures until completion of the remedies.
- Controls on future uses of the property that are inconsistent with the level of protectiveness achieved by the cleanup.
- Prohibition on any use of the shallow and intermediate aquifers and prohibition on drinking water use of the deep water aquifer.
- Prohibition on disturbance of the sediments.

DEQ currently maintains a site perimeter fence and warning signs and restricts public access to the upland portion of the Site. Public assess to the beach is not restricted; however, the public rarely accesses the beach due to the Site's remote location. Although not all monitoring wells are located within the fence, all wells have locked, steel monuments. These physical Site restrictions will be maintained into the foreseeable future. DEQ also has obtained a permanent easement for the sediment cap from the Oregon Department of State Lands. This easement prohibits the anchoring and grounding of non-recreational vessels and the use of all motor propelled vessels and specifies that the sediment cap may be closed to all public uses if DEQ determines that the area poses a threat to public health or the environment. DEQ has placed buoys along the perimeter of the sediment cap warning boaters of navigational hazards. DEQ also is working with the National Oceanic and Atmospheric Administration (NOAA) to establish a Regulated Navigational Area in and around the sediment cap pursuant to CFR Title 33, Part 165. DEQ anticipates this restriction will be in place by December 2007.

DEQ and EPA are currently developing an Easement and Equitable Servitude as part of a purchase agreement with a perspective purchaser. DEQ will require the Easement and Equitable Servitude to be recorded upon the sale of the property, which may occur within the next 12 months. At minimum these restrictions will prohibit development within the 6-acre riparian zone along the riverbank as required by the Endangered Species Act Biological Opinion issued by the National Marines Fisheries Service, prohibit use of Site groundwater as specified by the ROD and limit excavation of Site soils unless authorized by DEQ.

V. OPERATION AND MAINTENANCE

The DEQ will be conducting operation and maintenance activities according to an O&M Plan prepared by DEQ and approved by EPA. It is anticipated that the approved O&M Plan will be finalized in November 2006, following resolution of comments recently received by EPA and the project team on a proposed O&M Plan issued by DEQ in July 2006. The primary activities associated with the proposed O&M Plan are described below.

Soil Remedy

Soils beneath the soil cap remain contaminated with arsenic, PCP, PAHs, dioxins and NAPL, thus requiring the need for long-term monitoring and maintenance. The performance standards for the soil cap, as specified in the proposed O&M Plan, are:

- Maintain contaminant concentrations in surface soil below the following risk-based cleanup goals, as specified in the ROD:
  - Arsenic – 8 milligrams per kilogram (mg/kg)
  - Pentachlorophenol – 50 mg/kg
  - Total Carcinogenic PAHs – 1 mg/kg
  - Dioxins/furans – 0.00004 mg/kg
- Maintain the topsoil layer to within 50 percent of its design specification:
  - Area over impermeable geomembrane cap – maintain thickness of at least 6 inches
  - All areas except over impermeable geomembrane cap - maintain thickness of at least 12 inches
- Minimize infiltration of rainwater within the subsurface barrier wall by maintaining a subsurface stormwater conveyance system.
- Minimize stormwater erosion and ponding by maintaining Site grading, surface stormwater conveyance, and native vegetation.
- Maintain native vegetation within the 6-acre riparian zone for compliance with the National Marine Fisheries Service Biological Opinion.

Monitoring activities for the soil cap (including the riparian zone) include visual inspections of the cap surface, stormwater conveyance system, security fencing, and warning signs. The soil cap is designed to be generally maintenance free, except for maintaining the native vegetation. Routine maintenance will include irrigation of native vegetation through Summer 2008, mowing of open grass areas, manual removal of invasive plants, and targeted application of herbicides. Non-routine maintenance may include repairs of the fence, replacement of warning signs, repairs of the gravel roads, filling of potential animal burrows, removal of sediments from manholes and replanting of unsuccessful trees and shrubs. The frequency of these O&M activities over the first five years of O&M is provided in the proposed O&M Plan.

Sediment Remedy

Sediments beneath the sediment cap remain contaminated with arsenic, PCP, PAHs, dioxins and NAPL, thus requiring the need for long-term monitoring and maintenance. The performance standards for the sediment cap, as specified in the proposed O&M Plan, are:

- Maintain contaminant concentrations in surface sediments below the following risk-based cleanup goals, as specified in the ROD:
  - Arsenic – 12 mg/kg, dry weight
  - Pentachlorophenol – 100 mg/kg, dry weight
  - Total Carcinogenic PAHs – 2 mg/kg, dry weight
  - Dioxins/furans – $8x10^{-5}$ mg/kg, dry weight
  - Protection of benthic organisms based on sediment bioassay tests, resulting in impaired survival and growth (i.e., weight).
- Prevent visible discharge of creosote to the Willamette River.
- Minimize releases of contaminants from sediment that might result in contamination of the Willamette River in excess of the following federal and state ambient water quality criteria:
  - Arsenic (III)– 190 micrograms per liter (µg/l)
  - Chromium (III) – 210 µg/l
  - Copper – 12 µg/l
  - Zinc – 110 µg/l
  - Pentachlorophenol – 13 µg/l
  - Acenaphthene – 520 µg/l
  - Fluoranthene – 54 µg/l
  - Naphthalene – 620 µg/l
  - All other PAHs – background (i.e., baseline) concentrations in the Willamette River[9]
  - Total Carcinogenic PAHs – 0.031 µg/l
  - Dioxins/furans – $1.4x10^{-5}$ nanograms per liter (ng/l)
- Maintain the armoring layer to within 50 percent of the design specification:
  - 6" rock armoring – maintain thickness of at least 6 inches
  - 12" rock armoring – maintain thickness of at least 7.5 inches
  - 24" rock armoring – maintain thickness of at least 12 inches
- Maintain uniformity and continuity of articulated concrete block armoring.
- Maintain at least 20 percent excess sorption capacity of the organoclay cap.

Monitoring activities for the sediment cap include: visual inspections of near shore areas, aerial photography of the shoreline during extreme low river stages (late Sept or early October), multibeam bathymetric surveys and side-scan sonar surveys of deeper areas, and diver inspections of areas of concern identified from the bathymetry and sonar surveys. Monitoring

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[9] The ROD specifies this cleanup goal (i.e., no exceedance of surface water background levels) for the groundwater remedy; however, this cleanup goal is listed in the proposed O&M plan as a performance measure for the sediment remedy since contaminated groundwater passes through contaminated sediment and the sediment cap. Issues associated with this cleanup goal (i.e., relating to Alternate Concentration Limits) are further discussed in Section XIII and IX of this five-year review report.

activities also include collection of samples from surface water, subarmoring pore water, flux chambers and organoclay cores, and may include collection of crayfish, sculpins, and clams. Although the sediment cap is designed to be generally maintenance free, unplanned or non-routine maintenance may include: the replacement of warning buoys, placement of additional armoring due to erosion, and placement of additional organoclay if new releases of creosote are discovered or if the existing organoclay becomes saturated with creosote. Any new organoclay would require armoring. (Monitoring and maintenance of the riparian zone is addressed as part of the soil cap.) The frequency of these O&M activities over the first five years of O&M is provided in the proposed O&M Plan.

Groundwater Remedy

Groundwater both within and outside of the subsurface barrier wall remain contaminated with metals, PCP, PAHs, dioxins and NAPL, thus requiring the need for long-term monitoring and maintenance. The performance standards for the subsurface barrier wall and NAPL recovery, as specified in the proposed O&M Plan, are:

- Continue to recover NAPL until recovery rates become minimal, alternate pumping strategies have been examined and/or field tested with poor results, and remaining NAPL does not pose a threat to the Willamette River and its sediments.
- Maintain contaminant concentrations in shallow, downgradient compliance wells (or sediment pore water) below the Alternate Concentration Limits (ACLs)[10] set forth in the ROD:
    - Arsenic (III)– 1,000 µg/l
    - Chromium (III) – 1,000 µg/l
    - Copper – 1,000 µg/l
    - Zinc – 1,000 µg/l
    - Pentachlorophenol – 5,000 µg/l
    - Total PAHs – 43,000 µg/l
    - Dioxins/furans – 0.2 ng/l
- Minimize the transport of NAPL and communication of groundwater zones across the subsurface barrier wall.
- Minimize further vertical migration of creosote to the deep groundwater aquifer.
- Minimize visible discharge of creosote to the Willamette River.
- Maintain contaminant concentrations in the Willamette River below background concentrations or less than the Sediment Cap performance standards for surface water.

Monitoring activities for the groundwater remedy include groundwater elevation monitoring and groundwater sampling. DEQ and EPA are currently evaluating the need for continued NAPL recovery. Routine maintenance of equipment and providing for utilities service are also covered under the groundwater O&M. The frequency of these O&M activities over the first five years of O&M is provided in the proposed O&M Plan.

[10] ACLs were derived in the feasibility study (September 1995) using background concentrations, analytical method practical quantitation limits (PQLs), groundwater to surface water dilution and effective solubility limits. Issues associated with use of ACLs at this Site are further discussed in Section XIII and IX of this five-year review report.

Engineering and Institutional Controls

Engineering and Institutional Controls are an integral part of the Site remedies and require long-term monitoring and maintenance. Monitoring activities for the Engineering and Institutional Controls include visual inspections of the security fencing, monitoring well locks and warning signs and buoys. Additionally, verification of the Regulated Navigational Area will be performed by periodically reviews of the published navigational charts. The engineering and institutional controls are designed to be generally maintenance free. Routine maintenance will include periodical application of lubricant to monitoring well and gate locks. Non-routine maintenance may include repairs of the fence and replacement of warning signs damaged by vandalism or replacement of buoys lost during river flooding. The frequency of these O&M activities over the first five years of O&M is provided in the proposed O&M Plan.

VI. PROGRESS SINCE LAST FIVE-YEAR REVIEW

Since the last five-year review, approximately 2000 gallons of NAPL have been extracted from groundwater, construction has been completed for all remedies, post construction performance monitoring has been initiated and several institutional controls have been implemented as described in Section IV.

VII. FIVE-YEAR REVIEW PROCESS

Administrative Components

This CERCLA-statutory, five-year review is triggered by the issuance of the ROD and implementation of the groundwater remedial action in 1996. Construction was completed on the soil, sediment, and groundwater remedies in September 2005, and DEQ and EPA are in the process of determining whether the remedies are Operational and Functional. As such, limited performance data are available for the current five-year review.

As specified in the proposed O&M Plan, DEQ will perform extensive monitoring through the fall of 2010 to determine whether remedies are meeting the Remedial Action Objectives and performance goals in preparation for the next (third) five-year review that will be due in September 2011.

Additionally, remedy performance data collected through December 31, 2007, will be evaluated in order to update the protectiveness statement. DEQ and EPA will supplement this five-year review with the updated protectiveness statement.

When the remedies are determined to be meeting the Remedial Action Objectives and performance goals, EPA will prepare a Final Close-out Report which is the first step towards deleting the Site from the NPL. The O&M Plan will be updated in 2011 to address long-term monitoring and maintenance based on results of the initial five years of data collection (i.e., fall 2005 through fall 2010) and findings of the third five-year review.

This five-year review has been conducted by DEQ with support from its contractor, E & E. The five-year review is provided to EPA for concurrence. The primary author of the five-year review is Kevin Parrett (DEQ's project manager) with support provided by John Montgomery (E & E's project manager), Stephanie Pingree (E & E's toxicologist), and other E & E staff. Primary guidance and review support were provided by Nancy Harney (EPA's remedial project manager) with support provided by Rene Fuentes (EPA hydrogeologist). Comments on a draft version of this five-year review report were received from several member of the Site project team: Rob Neely (National Oceanic & Atmospheric Administration [NOAA]), Gayle Garman (NOAA contract support), Jean Lee (contract support to tribal trustees), Jennifer MacDonald (EPA attorney) and Rene Fuentes. Every effort was made by DEQ and EPA to incorporate reviewers' comments into this final five-year review report.

Community Involvement

Community involvement is ongoing via regular public meetings and distribution of public notices and media releases. Since construction of the subsurface barrier wall was initiated in 2003, the DEQ project manager or other project personnel attended meetings with and gave presentations to community groups on at least 25 occasions. Most recently, on February 11, 2006, DEQ hosted a community celebration and tree planting event involving approximately 300 volunteers, numerous media organizations, and state and federal officials including Oregon governor Ted Kulongoski, DEQ director Stephanie Hallock, EPA Region 10 administrator Michael Bogart and Portland city commissioner Sam Adams. At that time details of the remedial actions were discussed with the public, and a fact sheet was issued informing the public that DEQ and EPA were in the process of evaluating the effectiveness of the remedies (i.e., conducting a five-year review).

Because NAPL extraction is ongoing and weekly monitoring is being performed, an active presence is maintained at the Site and frequent interaction occurs between involved agencies. Therefore, no interviews were specifically scheduled for this review. However, input was sought from various personnel within DEQ who have been involved with the Site, including the former project manager Bruce Gilles and the project toxicologist Mike Poulsen. A formal Site inspection by DEQ and EPA project managers was not deemed necessary due to ongoing Site presence by DEQ's contractor and frequent Site visits by DEQ's project manager. Notice of the availability of this five-year review report will be provided to the community in a press release after the report is issued.

Document Review

The information reviewed for this report includes the ROD, Amended ROD, ESD, a series of reports produced during the remedial design and construction, and ongoing RA reporting. These documents are listed in Attachment 2.

Data Review

Soil Operable Unit

Construction of the soil remedy was completed in September 2005. This remedy was constructed in two phases. Phase I involved demolition and debris removal, and soil excavation and disposal. Phase II involved the placement of an impermeable cap within a substantial portion of the subsurface barrier wall and placement of an earthen soil cap over the remaining upland portions of the Site.

Weekly inspections of the impermeable and earthen caps have been performed since October 2005. These inspections have discovered minor erosion of topsoil at two discrete locations by the infiltration pond. These areas have been filled, and DEQ does not anticipate further erosion now that the vegetated cover has matured.

Sediment Operable Unit

Construction of the sediment remedy was completed in September 2005. This remedy was constructed over the summers of 2004 and 2005 and involved placement of an armored sand cap over 23 acres. More than one million pounds of a granular, oil adsorptive material know as organophyllic clay (organoclay) were placed over two locations[11] where NAPL seepage had not yet abated since construction of the subsurface barrier wall in 2003. The source of these NAPL seeps was the portion of the NAPL plume external (i.e., riverward) of the barrier wall.

Inspections of the sediment cap shoreline have been performed from November 2004 through the present time. Inspections through the summer of 2005 discovered minor erosion of rock armoring at several discrete areas where this armoring abuts an articulated concrete block armoring and limited amounts of creosote sheens along the shoreline in front of the TFA and underneath the railway bridge. Corrective actions consisting of the placement of heavier rock armoring and organoclay mats were implemented in September and October 2005 to address these issues, as described in the document titled *Remedial Action Construction Summary Report Sediment Cap Completion (August 2005 through October 2005)* (E & E, May 2006). Weekly inspections of the sediment cap shoreline between December 2005 and the present have discovered no additional erosion. However, these inspections discovered very minor amounts of creosote sheens periodically discharging from a discrete location adjacent to one of the organoclay mats installed in October 2005. This new sheen area was capped with an organoclay mat in July 2006.

Surface water sampling was performed in fall 2005 and spring 2006. Results of these sampling efforts and other data gathered since completion of construction in September 2005 along with data collected through December 31, 2006, will be provided in a report to be issued by February 2007. Extensive sampling is planned through 2010. Results of these sampling efforts will be used on an ongoing basis to determine whether the cap is meeting its performance objectives.

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[11] Not to be confused with the three areas where organoclay mats were used in October 2005 as a corrective measure.

Evaluations of deeper, off-shore locations are ongoing and consist of high resolution multibeam bathymetry, side-scan sonar, and diver inspections. Although no significant issues with the sediment cap have been identified at the present time, additional information will to be collected through December 2010 to determine whether the cap is meeting its performance objectives.

Groundwater Operable Unit

Construction of the subsurface barrier wall was completed in July 2003, although several locations along the sheet pile portion of the wall required pressure grouting, which was conducted in July 2004. Extraction of NAPL from Site groundwater has been ongoing since 1989, with over 6,100 gallons recovered to date. Since installation of the subsurface barrier wall in 2004, NAPL recovery has been performed from all recoverable wells located both on the interior and exterior of the wall. As shown in Figure 4, recovery yields for NAPL following construction of the subsurface barrier wall have substantially decreased since early 2005, following a substantial increase in recovery yields immediately after construction of the subsurface barrier wall. Although the cause of the post-construction NAPL yield increase is not well understood, it is speculated that subsurface shock waves generated during sheet pile driving may have reestablished NAPL flow paths around extraction wells where recovery yields had previously diminished.

Monitoring of groundwater levels, gauging of wells for NAPL and sampling of groundwater for dissolved contaminants have been ongoing since construction of the subsurface barrier. Data collected since October 2005 along with data to be collected through December 31, 2006, will be provided in a report that will be issued in February 2007. These data, as well as data to be collected through December 2010, will be used to help determine whether the groundwater remedy as well as the soil and sediment remedies are meeting their performance objectives.

VIII. TECHNICAL ASSESSMENT

As discussed previously, remedial action construction was completed in September 2005, and DEQ and EPA are in the process of determining whether the remedies are Operational and Functional. As such, limited performance data are available for the current five-year review. Extensive performance monitoring will be performed through the fall of 2010 to determine whether remedies are meeting the Remedial Action Objectives and performance goals in preparation for the next (third) five-year review that will be issued in September 2011.

Additionally, remedy performance data collected through December 31, 2007, will be evaluated in order to update the protectiveness statement. DEQ and EPA will supplement this second five-year review with the updated protectiveness statement.

When the remedies are determined to be meeting the Remedial Action Objectives and performance goals, EPA will prepare a Final Close-out Report which is the first step towards deleting the Site from the NPL. The approved O&M Plan will be updated in 2011 to address long-term monitoring and maintenance based on results of the initial five years of data collection (i.e., fall 2005 through fall 2010) and findings of the third five-year review. Given the currently limited performance data, the following technical assessment is limited in scope.

Is the remedy functioning as intended by the decision documents?

The review of documents, Applicable or Relevant and Appropriate Requirements (ARARs), risk assumptions, and results of the Site inspection have identified no information indicating the remedy is not functioning as intended by the ROD, as modified by the Amended ROD and ESD. However, additional monitoring is needed to determine whether the remedy is meeting the Remedial Action Objectives specified in the ROD.

<u>Soil Remedy</u>

The soil remedy has been fully implemented since September 2005 and consists of removing highly contaminated soils to a depth of at least 4 feet bgs and capping the entire upland portion of the Site. Although initial monitoring following construction in Summer 2005 identified minor erosion of topsoil at two discrete locations by the infiltration pond, DEQ does not anticipate further erosion as the vegetated cover has matured and the cap appears to be functioning as designed.

<u>Sediment Remedy</u>

The sediment remedy has been fully implemented since September 2005 and consists of capping 23 acres of contaminated sediments within the Willamette River. Initial monitoring following Summer 2004 construction identified several areas requiring additional armoring and sorptive capping material (i.e., organoclay). Corrective measures were implemented in September and October 2005 to address these issues. The cap currently appears to be functioning as designed, but additional data are necessary to confirm this conclusion. Additional monitoring is needed to determine the effectiveness of the sediment cap, especially during late summer, when low river conditions may produce hydraulic forces that favor NAPL migration and dissolved-phase chemical transport. The higher temperatures of late summer also reduce the viscosity and density of creosote, increase the solubility of organic contaminants, and favor the microbial activity that results in gases bubbling, which may carry NAPL to the surface.

<u>Groundwater Remedy</u>

The groundwater remedy has been fully implemented since October 2003 and consists of NAPL recovery and a subsurface barrier wall. The groundwater/NAPL extraction systems have been successful in removing NAPL, with over 6,100 gallons extracted to date. The systems have been enhanced to optimize recovery of NAPL and minimize the amount of groundwater extracted. A subsurface barrier wall has been constructed over an 18-acre area containing most of the NAPL sources. Performance monitoring of groundwater since fall 2003 indicate the barrier wall substantially impedes groundwater flow and NAPL transport toward the river. Attachment 3 provides the results of the barrier wall performance monitoring through August 25, 2006. Additional monitoring is needed to determine the barrier wall's effectiveness in conjunction with the impermeable cap, especially during extreme rainfall events and river conditions. In summary, the groundwater remedy appears to be functioning as designed, but additional data are necessary to confirm this conclusion.

Engineering and Institutional Controls

The engineering and institutional controls implemented so far are functioning properly. The controls which remain to be implemented are the execution of an Easement and Equitable Servitude with a future owner of the Site and the establishment of a Regulated Navigational Area in and around the sediment cap pursuant to CFR Title 33, Part 165.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of the remedy selection still valid?

EPA has determined that Alternate Concentration Limits (ACLs) are not valid as substitutes for Maximum Contaminant Levels in groundwater at this Site. Invalidation of ACLs at this Site also affects whether the groundwater Remedial Action Objectives derived from the provisions in CERCLA for using ACLs remain valid for the Site.

A review of site-specific risk assessment methodology identified recent changes in exposure assumptions and toxicity data. However, these changes do not result in significantly different baseline risks nor require changes in risk-based cleanup levels.

Changes in Standards and To-Be-Considereds

There have been no significant changes in the standards or "To-Be-Considereds" affecting the protectiveness of the remedy. There are still no promulgated standards for sediment that would be considered potential ARARs, although the EPA, DEQ, and other agencies are working on various criteria and sediment quality guidelines (e.g., as part of the Portland Harbor Superfund Investigation). In addition since issuance of the ROD, several of the Evolutionarily Significant Units (ESUs) of anadromous fish within the Willamette River have been listed under the ESA (50 CFR 17.11 and 17.12). These include ESUs of steelhead trout and chinook, chum, and coho salmon. These listings neither impose specific standards nor affect the Remedial Action Objectives established in the ROD.

EPA issued a compilation of revised National Recommended Water Quality Criteria in 2002. These revised criteria are currently relevant and appropriate for the Site in accordance with Section 121(d)(2). In addition, the DEQ's governing body, the Environmental Quality Commission, adopted revised ambient water quality criteria on May 20, 2004, to become effective February 15, 2005. However, EPA has not yet approved these criteria. These numeric criteria are derived from the National Recommended Water Quality Criteria (EPA, 2002). Following are the Current National Recommended Water Quality Criteria for freshwater, chronic exposure to site contaminants[12]:

- Arsenic (III)– 150 µg/l
- Chromium (III) – 74 µg/l
- Copper – 9 µg/l
- Zinc – 120 µg/l
- Pentachlorophenol – 15 µg/l

[12] See EPA's website at http://www.epa.gov/waterscience/criteria/wqcriteria.html

- Acenaphthene – not available
- Fluoranthene – not available
- Naphthalene – not available
- Total Carcinogenic PAHs – not available
- Dioxins/furans – not available

Neither the State of Oregon proposed ambient water quality criteria nor the Current National Recommended Water Quality Criteria are significantly different from the water quality criteria specified in the ROD.

On July 19, 2005, EPA issued guidance restricting the use of ACLs in Superfund cleanups (*Use of Alternate Concentration Limits in Superfund Cleanups*, OSWER 9200.4-39, July 19, 2005). This guidance clarifies that ACLs may only be used as substitutes for applicable groundwater standards (such as promulgated anti-degradation standards) in very limited circumstances as set forth in Section 121(d)(2)(B)(ii) of CERCLA. EPA Superfund guidance has clearly identified Safe Drinking Water Act Maximum Contaminant Levels (MCLs) as applicable at the tap where groundwater may be ingested (commonly after treatment), and as relevant and appropriate in sources or potential sources of drinking water in the environment. Section 121(d)(2)(A)(ii) has also identified MCL Goals (which are more stringent than MCLs for some contaminants) as well as Clean Water Act Ambient Water Quality Criteria (AWQCs) as minimum levels or standards of control for all final Superfund remedial action, where such goals are relevant and appropriate. ACLs therefore are not valid as substitutes for MCLs in groundwater at any site, MCLs are ARARs for this Site, and ACLs have no utility and will not be used at this Site. The DEQ and EPA anticipate that: 1) groundwater standards for the Site will be established following a rigorous analysis of Site conditions and all relevant data; and 2) (assuming MCLs cannot be met) the application of a waiver pursuant to Section 122(d)(4) of CERCLA for MCLs to comply with the threshold criterion (meeting ARARs) for all remedies implemented pursuant to all CERCLA final ROD.

Invalidation of ACLs at this Site also affects whether the groundwater Remedial Action Objectives, including no exceedance of background levels in surface water, as embodied in Section 121(d)(2)(B)(ii) remain valid for the Site.

<u>Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics</u>

In developing the ROD, DEQ and EPA determined that cleanup to protective levels for industrial uses was appropriate for this Site considering the former use (industrial) and the potential anticipated future use (industrial or recreational). Potential RAOs protective of exposure to hypothetical future onsite residents, provided in the 1992 RI, were not carried through to the ROD based on the current and future land use assumptions. The exposure assumptions used to develop the Human Health and Ecological Risk Assessment cleanup goals include:

- Exposure through direct contact (ingestion, inhalation, or dermal contact) of an industrial worker to contaminated surface and near-surface soil for arsenic, pentachlorophenol, carcinogenic PAHs, and dioxins/furans.

- Exposure through direct contact (ingestion or dermal contact) of a recreational user to contaminated sediments for arsenic, pentachlorophenol, carcinogenic PAHs, and dioxins/furans.
- Exposure of benthic organisms to contaminated sediments that would result in mortality as determined by bioassay tests.[13]

Attachment 4 provides the results of the risk assessment evaluation for this five-year review. The RAOs and cleanup goals for soil and sediment presented in the ROD are still valid and are protective of anticipated industrial and recreational use. Although changes in exposure assumptions and toxicity data did occur, these changes do not result in significantly different baseline risks nor require changes in cleanup levels for the industrial or recreational receptors.

Has any other information come to light that could call into question the protectiveness of the remedy?

During development of the sediment cap design, DEQ discovered that the sediment cleanup goal for dioxins and furans provided in the ROD ($8x10^{-3}$ mg/kg) was 100 times higher (i.e., less stringent) than the cleanup goal established in the 1992 baseline risk assessment ($8x10^{-5}$ mg/kg). This discrepancy appears to have resulted from a typo. This discrepancy is also discussed in the risk assessment evaluation provided in Attachment 4.

The correct dioxin value of $8x10^{-5}$ mg/kg was used to establish the sediment cap boundary as documented in the *Sediment Cap Basis of Design* report (E&E 2002).

IX. ISSUES, RECOMMENDATIONS AND FOLLOW-UP ACTIONS

As previously discussed, several issues have been identified since completion of the last five-year review in September 2001. These issues and DEQ's recommendations and follow-up actions to resolve these issues are discussed below and summarized in Tables 2 and 3.

Lack of Post-Construction Performance Data

Construction recently was completed on the soil, sediment, and groundwater remedies, and DEQ and EPA are in the process of determining whether the remedies are Operational and Functional. Substantial monitoring and sampling data have been collected following construction of the subsurface barrier wall; however, only one year of data have been collected since construction completion of all remedies was achieved in September 2005. These data include:

- Monthly groundwater assessments of water levels and flow directions from Site monitoring wells, including 42 new wells installed along the barrier wall alignment.
- Monthly assessments of NAPL occurrence and recovery from Site wells.
- Chemical analysis of surface water, sediment pore water and crayfish in the fall of 2003, immediately following construction of the subsurface barrier wall. (Similar sampling

[13] Bioassay testing for impaired growth was also applied as a conservative element during the sediment cap design.

was performed in the fall of 2002 to assess baseline condition prior to remedy construction.)

- Chemical analysis of surface water, armoring flow chamber water and sub-armoring pore water in the fall of 2005 and spring of 2006 following construction of the sediment cap and soil cap.
- High resolution bathymetry and side-scan sonar surveys and diver inspections of the sediment cap in the spring of 2005 and 2006.
- Chemical analysis of groundwater from Site monitoring wells in spring 2006 to assess dissolved-phase contaminant concentrations and verify DEQ's understanding of the conceptual site model.

A report providing the results of these monitoring activities (i.e., October 1, 2005 through September, 31 2006) as well as data to be collected through December 2006 will be provided in a report that will be issued in February 2007.

Given the complexity of the Site, the interrelated nature of the remedies and the uncertainties with the NAPL plume between the barrier wall and Willamette Cove (i.e., under the Burlington Northern Santa Fe railway right-of-way), these data are insufficient for the purpose of determining long-term protectiveness of the remedy. As specified in the proposed O&M Plan, DEQ will perform extensive monitoring through the fall of 2010 to determine whether remedies are meeting the Remedial Action Objectives and performance goals in preparation for the next (third) five-year review that will be issued in September 2011. Key data to be collected over the next four years including chemical analysis of surface water, armoring flow chamber water, sub-armoring pore water, crayfish, groundwater and organoclay; groundwater elevations and gradients; NAPL occurrence and accumulation in Site wells; NAPL recovery yields; bathymetry, side-scan sonar and diver surveys of the sediment cap; and inspections of the sediment cap for releases of NAPL sheen.

Additionally, remedy performance data collected through December 31, 2007, will be evaluated in order to update the protectiveness statement. DEQ and EPA will supplement this five-year review with the updated protective statement.

This issue could affect the protectiveness of the remedy if additional performance data indicate the remedies do not achieve the degrees of cleanup or protection specified in the ROD.

Alternate Concentration Limits

The EPA has determined that ACLs are not valid as substitutes for MCLs in groundwater at this Site. Invalidation of ACLs at this Site also affects whether the groundwater Remedial Action Objectives derived from the provisions in CERCLA for using ACLs remain valid for the Site.

The DEQ and EPA anticipate that: 1) groundwater standards for the Site will be established following a rigorous analysis of Site conditions and all relevant data; and 2) (assuming MCLs cannot be met) the application of a waiver pursuant to Section 122(d)(4) of CERCLA for MCLs to comply with the threshold criterion (meeting ARARs) for all remedies implemented pursuant to any final CERCLA ROD. Additionally, the O&M plan will be revised to address the invalidation of ACLs.

This issue could affect the protectiveness of the remedy if additional surface water data are determined by DEQ and EPA to pose an unacceptable risk to human health or ecological receptors.

Implementation of ICs

Several Institutional controls remain to be implemented: the Easement and Equitable Servitude and the Restricted Navigational Area. DEQ is currently developing these Institutional Controls and expects them to be implemented within the next year.

This issue will not affect the protectiveness of the remedy.

Minor Erosion of Soil Cap

Initial inspections of the soil cap following construction in Summer 2005 have discovered minor erosion of topsoil at two discrete locations by the infiltration pond. These areas have been filled, and DEQ does not anticipate further erosion now that the vegetated cover has matured. As specified in the proposed O&M Plan, continued inspections of the soil cap will be performed monthly to identify and repair any additional erosion areas.

This issue will not affect the protectiveness of the remedy.

Erosion of Sediment Cap Armoring and Release of NAPL sheens

Initial inspections of the sediment cap following construction in Summer 2004 have identified several areas requiring additional armoring and sorptive capping material (i.e., organoclay). Although corrective measures were implemented in September and October 2005 to address these issues, additional monitoring is needed to determine the effectiveness of these repairs and the potential for additional releases of NAPL sheens in areas not capped with sorptive materials. As specified in the proposed O&M Plan, extensive inspections of cap armoring, inspections for releases of NAPL sheens, and chemical monitoring of sediment pore water, flux, and surface water will be performed through December 2010. Inspections will be performed weekly during the low river period of August through October and monthly the remainder of the year. Chemical monitoring will be performed twice per year in fall and spring.

This issue could affect the protectiveness of the remedy if additional NAPL releases cannot be controlled by sorptive capping material or if NAPL releases become a widespread occurrence that raises into question the feasibility of the capping remedy.

Incorrect Sediment Cleanup Goal for Dioxin Provided in the ROD

The sediment cleanup goal for dioxins and furans provided in the ROD ($8x10^{-3}$ mg/kg) is 100 times higher (i.e., less stringent) than the cleanup goal established in the 1992 baseline risk assessment ($8x10^{-5}$ mg/kg). The correct dioxin value of $8x10^{-5}$ mg/kg was used to establish the sediment cap boundary as documented in the *Sediment Cap Basis of Design* report (E&E 2002).

Since this issue was addressed during design of the sediment cap, it does not affect the protectiveness of the sediment remedy.

X. STATEMENT OF PROTECTIVENESS

A protectiveness determination of the remedies for all Operable Units (i.e., soil, sediment and groundwater) cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions:

- Chemical analysis of Willamette River surface water, sediment cap armoring flow chamber water and sediment cap sub-armoring pore water.
- Inspections of near shore areas for the presence of NAPL releases from the sediment cap.

It is expected that these actions will take approximately two years to complete at which time a protectiveness determination will be made.

Additional monitoring to be performed by DEQ over the next four years, as specified in the proposed O&M Plan, include chemical analysis of surface water, armoring flow chamber water, sub-armoring pore water, crayfish, groundwater and organoclay; groundwater elevations and gradients; NAPL occurrence and accumulation in Site wells; NAPL recovery yields; bathymetry, side-scan sonar and diver surveys of the sediment cap; and inspections of the sediment cap for releases of NAPL sheen. To the extent available, the results of these monitoring activities also will be considered by DEQ and EPA in evaluating the protectiveness of the remedies.

Prior to the reevaluation of protectiveness in 2008, access controls will remain in place. These controls include a chain link fence and warning signs and buoys around the perimeter of the Site. Additionally, DEQ and its contractors will have an active presence on Site over the next five years as additional performance data are being collected.

Future use of the Site likely will involve recreational facilities, consistent with the land re-use assessment completed by the City of Portland in 2001. DEQ does not anticipate development of the recreational facilities prior to DEQ and EPA's reevaluation of protectiveness in 2008.

XI. NEXT FIVE-YEAR REVIEW

The remedy at this Site requires statutory five-year reviews. The next five-year review will be conducted prior to September 26, 2011. Additionally, remedy performance data collected through December 31, 2007, will be evaluated in order to update the protectiveness statement. DEQ and EPA will supplement this second five-year review with the updated protective statement.

Table 1 - Chronology of Major Site Events

Event	Date
EPA performs a site inspection which raises concerns about possible releases of hazardous substances.	1983
McCormick and Baxter Creosoting Company performs a preliminary site investigation and notifies DEQ of possible off-site releases near the former waste disposal area.	1983
McCormick and Baxter Creosoting Company completes site investigation concluding that soil and groundwater contamination exists at the Site.	1985
DEQ and McCormick and Baxter Creosoting Company sign a Stipulation and Final Order requiring the firm to perform specified remedial activities.	Nov 1987
McCormick and Baxter Creosoting Company files for bankruptcy protection.	Dec 1988
McCormick and Baxter Creosoting Company ceases operations.	Oct 1991
DEQ and EPA complete first five-year review.	Sept 26, 2001
DEQ conducts a Remedial Investigation and Feasibility Study under State cleanup regulations.	1990 to 1992
DEQ conducts Removal Actions, including NAPL extraction, under State of Oregon cleanup regulations.	1992 to 1996
The McCormick & Baxter Creosoting Company site is added to the NPL.	June 1994
DEQ revises Feasibility Study to comply with CERCLA.	Sept 1995
EPA issues ROD.	Mar 1996
NAPL extraction resumed as a Remedial Action.	Mar 1996
DEQ and EPA entered into a Superfund State Contract.	May 1996
EPA issues Amended ROD specifying off-site disposal of highly contaminated soils.	Mar 1998
Excavation and off-site disposal of highly contaminated soils completed.	Feb to May 1999
EPA issues an ESD for groundwater contingency remedy.	Aug 2002
The subsurface barrier wall is constructed.	Apr to Sept 2003
The sediment cap is constructed.	July 2004 to Sept 2005
The soil cap is constructed.	May to Sept 2005
Prefinal inspection of remedial actions is conducted by DEQ and EPA - Construction Completion is Achieved.	9/26/05
Preliminary Close Out Report is signed by EPA.	9/27/05
Operational and Functional (O&F) period begins.	Oct 2005

Event	Date
EPA performs a site inspection which raises concerns about possible releases of hazardous substances.	1983
DEQ and EPA complete second five-year review.	Sept 26, 2006
O&M Plan is approved by EPA.	October 2006 (anticipated)
DEQ issues report on O&F monitoring results for period of October 1, 2005 through September, 31 2006.	December 2006 (anticipated)

Table 2 – Issues Found During Five-Year Review

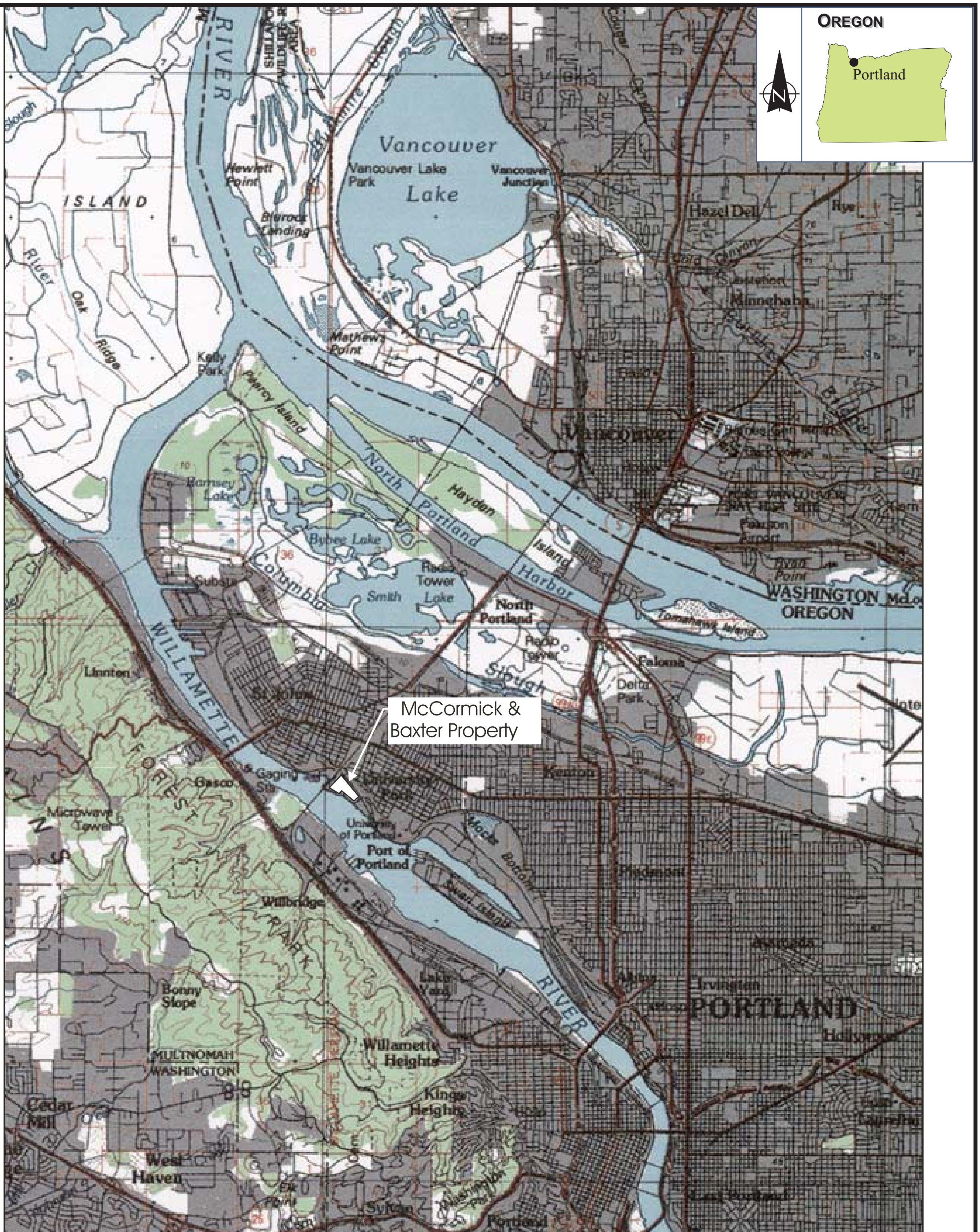
Issue	Affects Protectiveness? (Y/N)	
	Current	Future
Lack of Post-Construction Performance Data Construction recently was completed on the soil, sediment, and groundwater remedies, and DEQ/EPA are in the process of determining whether the remedies are Operational and Functional. As such, limited performance data are available for the current five-year review. This issue could affect the protectiveness of the remedy if additional performance data indicate the remedies do not achieve the degrees of cleanup or protection specified in the ROD.	Y	Y
Alternate Concentration Limits The EPA has determined that ACLs are not valid as substitutes for MCLs in groundwater at this Site. Invalidation of ACLs at this Site also affects whether the groundwater Remedial Action Objectives derived from the provisions in CERCLA for using ACLs remain valid for the Site. The DEQ and EPA anticipate that: 1) groundwater standards for the Site will be established following a rigorous analysis of site conditions and all relevant data; and 2) (assuming MCLs cannot be met) the application of a waiver pursuant to Section 122(d)(4) of CERCLA for MCLs to comply with the threshold criterion (meeting ARARs) for all remedies implemented pursuant to any final CERCLA ROD. This issue could affect the protectiveness of the remedy if additional surface water data are determined by DEQ and EPA to pose an unacceptable risk to human health or ecological receptors.	Y	Y
Implementation of Institutional Controls Several Institutional controls remain to be implemented: the Easement and Equitable Servitude and the Restricted Navigational Area. DEQ is currently developing these Institutional Controls and expects them to be implemented within the next year. This issue will not affect the protectiveness of the remedy.	N	N
Minor Erosion of Soil Cap Initial inspections of the soil cap following construction in Summer 2005 have discovered minor erosion of topsoil at two discrete locations by the infiltration pond. These areas have been filled, and DEQ does not anticipate further erosion now that the vegetated cover has matured. This issue will not affect the protectiveness of the remedy.	N	N

Issue	Affects Protectiveness? (Y/N)	
	Current	Future
Erosion of Sediment Cap Armoring and Release of NAPL sheens Initial inspections of the sediment cap following construction in Summer 2004 have identified several areas requiring additional armoring and several areas required additional sorptive capping material (i.e., organoclay). Although corrective measures were implemented in September and October 2005 to address these deficiencies, additional monitoring is needed to determine the effectiveness of these repairs, the potential for additional erosion in other areas of the sediment cap and the potential for additional releases of NAPL sheens in areas not capped with sorptive materials. This issue could affect the protectiveness of the remedy if additional NAPL releases cannot be controlled by sorptive capping material, if NAPL releases become a widespread occurrence that raises into question the feasibility of the capping remedy or if continued erosion exposes the contaminated, underlying sediments.	Y	Y
Incorrect Sediment Cleanup Goal for Dioxin Provided in the ROD The sediment cleanup goal for dioxins and furans provided in the ROD (8×10^{-3} mg/kg) is 100 times higher (i.e., less stringent) than the cleanup goal established in the 1992 baseline risk assessment (8×10^{-5} mg/kg). The correct dioxin value of 8×10^{-5} mg/kg was used to establish the sediment cap boundary as documented in the *Sediment Cap Basis of Design* report (E&E 2002). Since this issue was addressed during design of the sediment cap, it does not affect the protectiveness of the sediment remedy.	N	N

Table 3 - Recommendations and Follow-Up Actions

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Lack of Post-Construction Performance Data	Perform extensive monitoring through December 2010. Use data for updating protectiveness determination in 2008. Use data for conducting third five-year review in 2011.	DEQ as lead agency	State/EPA	9/30/2008 9/30/2011	Y	Y
Alternate Concentration Limits	Revise the O&M plan to address the invalidation of ACLs. Address alternate approaches to groundwater ACLs.	EPA	State/EPA	November 2006 December 2010	Y	Y
Implementation of Institutional Controls	Continue to implement remaining Institutional Controls	DEQ	State/EPA	9/30/2008	N	N
Minor Erosion of Soil Cap	Perform continued inspections soil cap	DEQ as lead agency	State/EPA	Not applicable	N	N

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Erosion of Sediment Cap Armoring and Release of NAPL sheens	Perform extensive inspections of cap armoring, inspections for releases of NAPL sheens, and chemical monitoring of sediment pore water, flux, and surface water through December 2010. Use data for updating protectiveness determination in 2008. Use data for conducting third five-year review in 2011.	DEQ as lead agency	State/EPA	9/30/2008 9/30/2011	Y	Y
Incorrect Sediment Cleanup Goal for Dioxin Provided in the ROD	No follow-up actions are necessary since this issue was addressed during design of the sediment cap.	DEQ as lead agency	State/EPA	Not applicable	N	N



ecology and environment, inc.
International Specialists in the Environment
Portland, Oregon

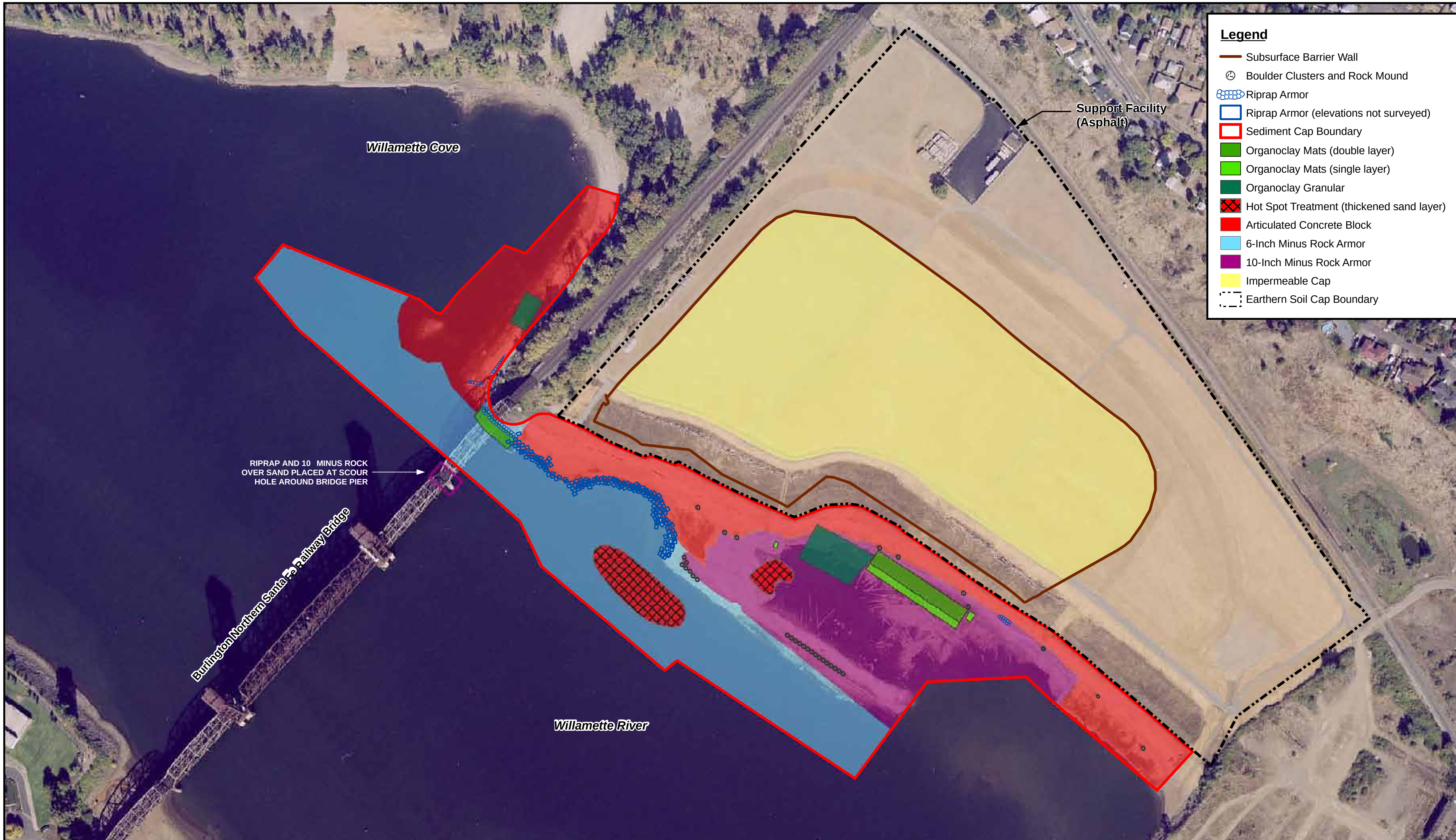
McCORMICK & BAXTER
CREOSOTING CO.
Portland, Oregon

Figure 1

SITE LOCATION MAP

Date:
2-21-03

10:001688OY021402\fig 1



N W E S

0 70 140 280 420 560 700
Feet
Approximate Scale

Map Reference: Orthorectified Photo Image, September 28, 2005 @ 12:30 pm.
River Stage at Time of Photo is 4.93 ft. NAVD at Morrison Street Bridge.

McCormick & Baxter
Creosoting Company

Portland, Oregon

Figure 2
CURRENT SITE LAYOUT AND FEATURES

Date:	GIS:	Job Number:
6/23/2006	avh	002688.OY25.30.03

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International Specialists in the Environment
Portland, Oregon

DESIGNED BY: C. NANCARROW
CHECKED BY:
DRAWN BY: S. STEVENS
APPROVED BY A. WHITMAN

FIGURE 3
CURRENT SITE LAYOUT AND FEATURES WITH SURFACE ELEVATIONS
McCormick & Baxter Superfund Site
Portland, Oregon

SCALE	DATE ISSUED	C.A.D. FILE NO.
NOTED	9-18-06	sitewidetopo.dwg

NO.	DATE	DSN	APP'D	DESCRIPTION
				REVISIONS

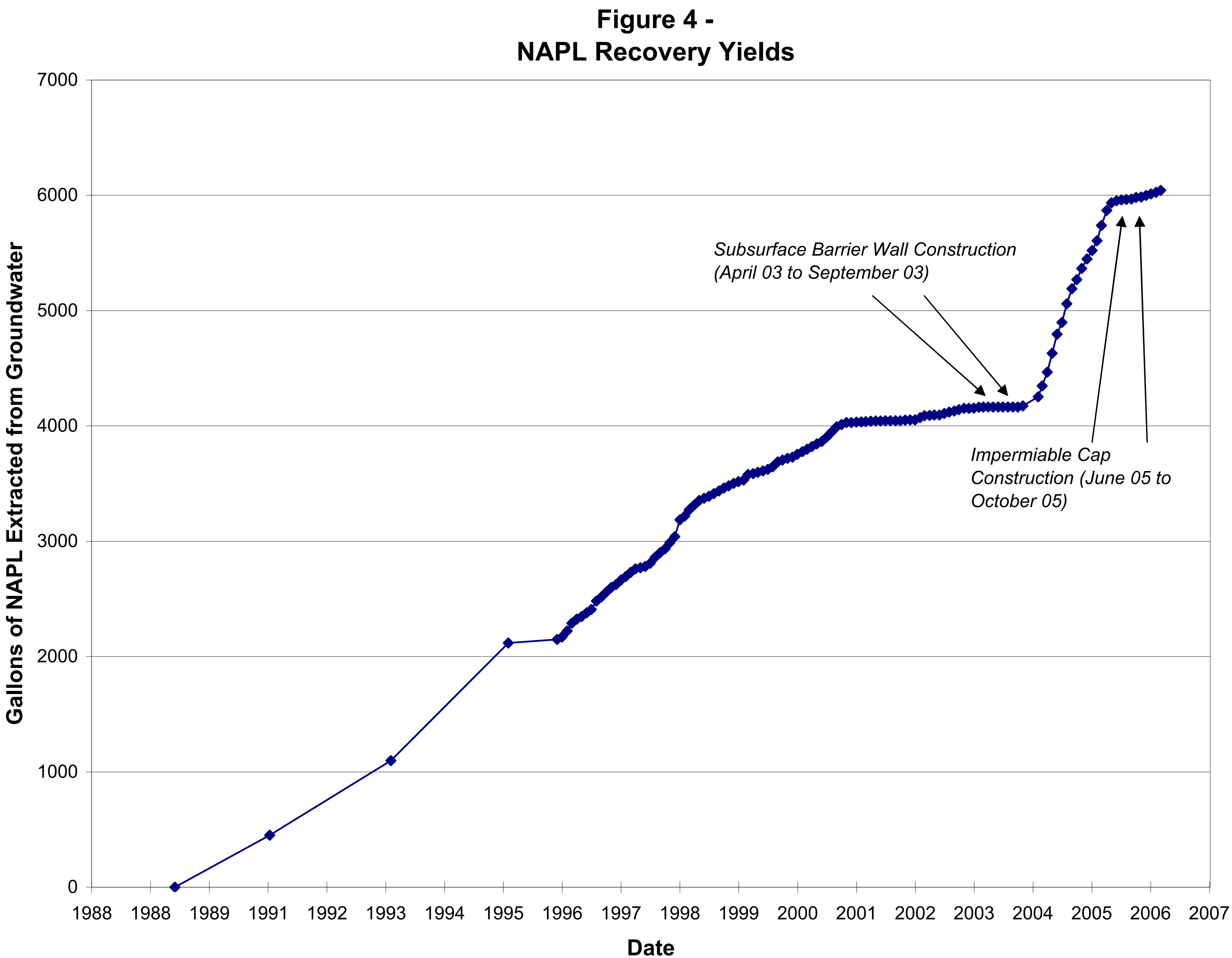
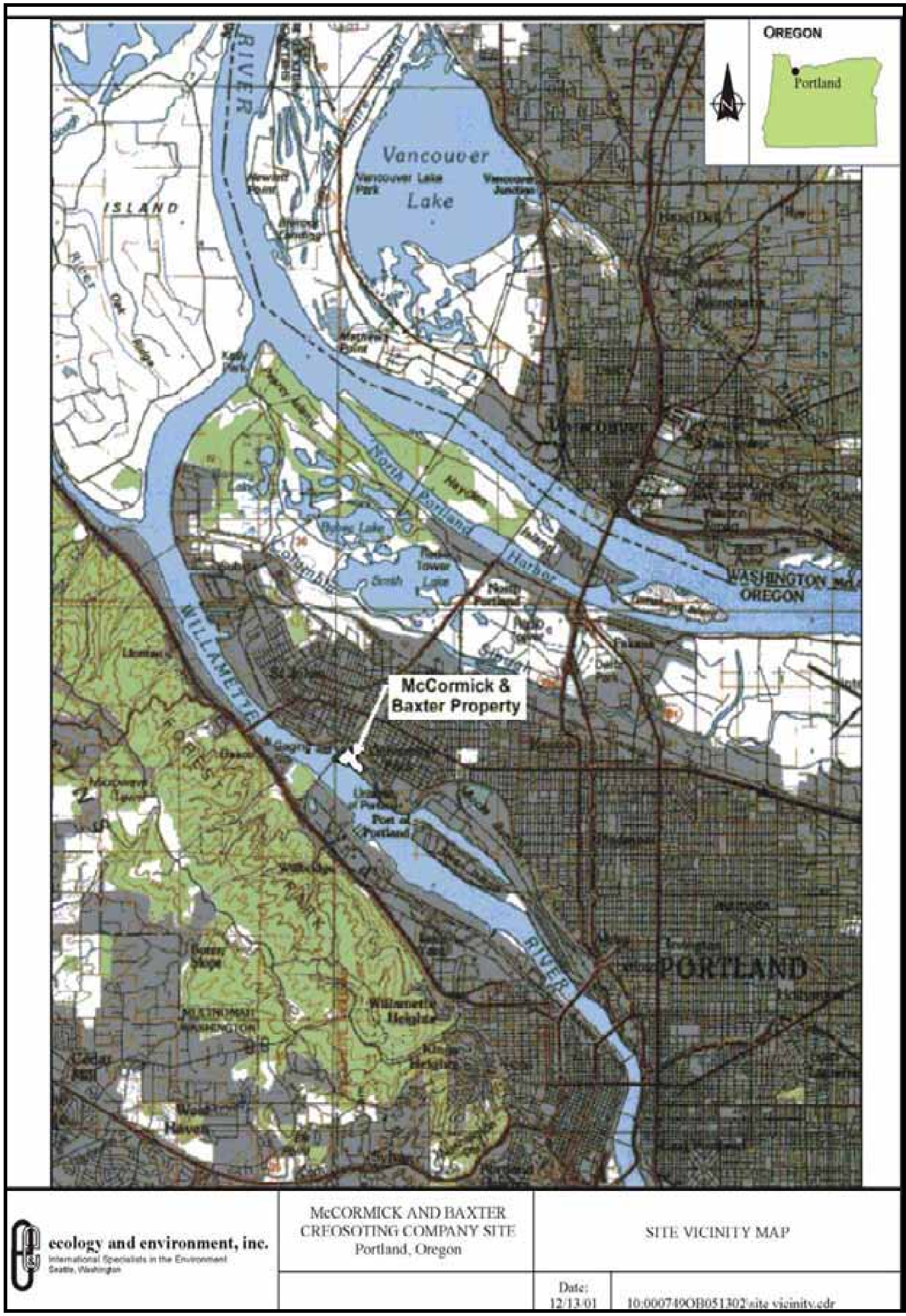


Figure 4 -
NAPL Recovery Yields
Gallons of NAPL Extracted from Groundwater
7000
6000
5000
4000
3000
2000
1000
0
1988
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Date
Subsurface Barrier Wall Construction
(April 03 to September 03)
Impermiable Cap
Construction (June 05 to
October 05)

Attachment 1 - Pictorial Overview

McCormick and Baxter Creosoting Company Superfund Site
Portland, Oregon

Excavation of Creosote Dock Bulkhead 2004



Roles and Responsibilities

DEQ – Lead Agency
- Project Manager – Kevin Parrett

EPA – Support Agency
- Project Manager – Nancy Harney

Consultations
- National Oceanic & Atmospheric Administration
- Native American Tribes
- National Marine Fisheries Service
- US Fish & Wildlife Service
- City of Portland

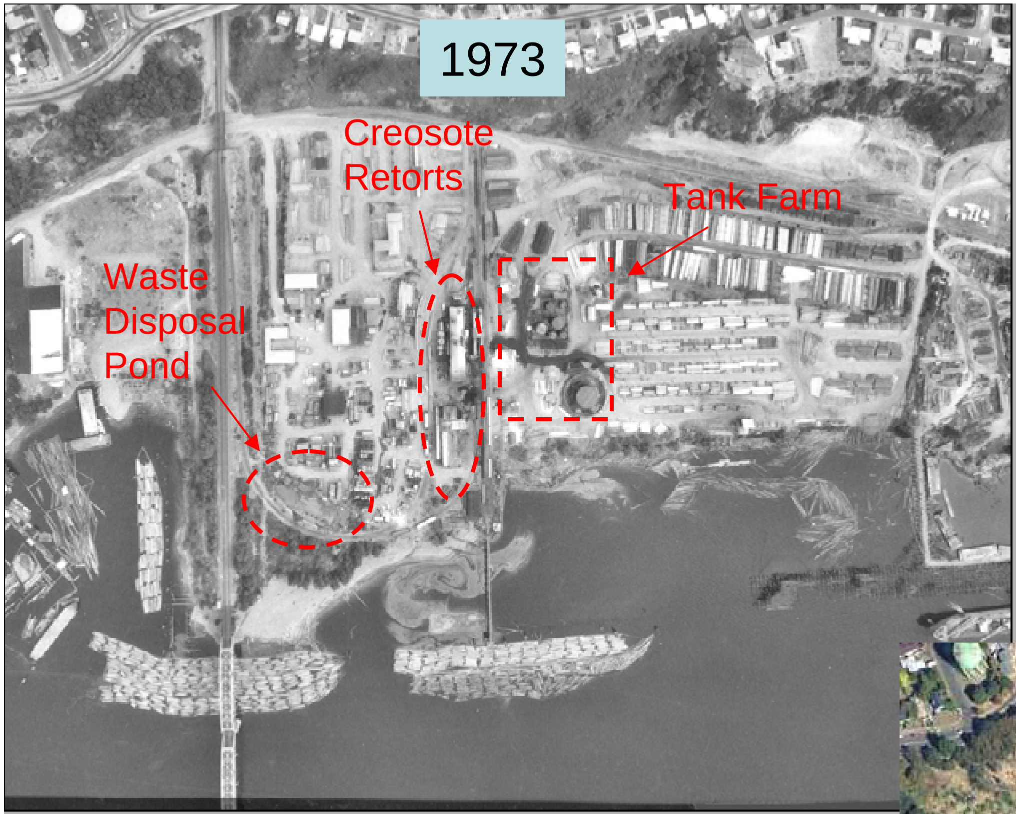
DEQ Consultants:
- Ecology & Environment, Inc. – 1996 to date
- PTI – 1990 through 1996

Additional Contracted Support:
- US Army Corp of Engineers
- Archaeological Investigations Northwest
- City of Portland
- University of Texas
- Oregon State University

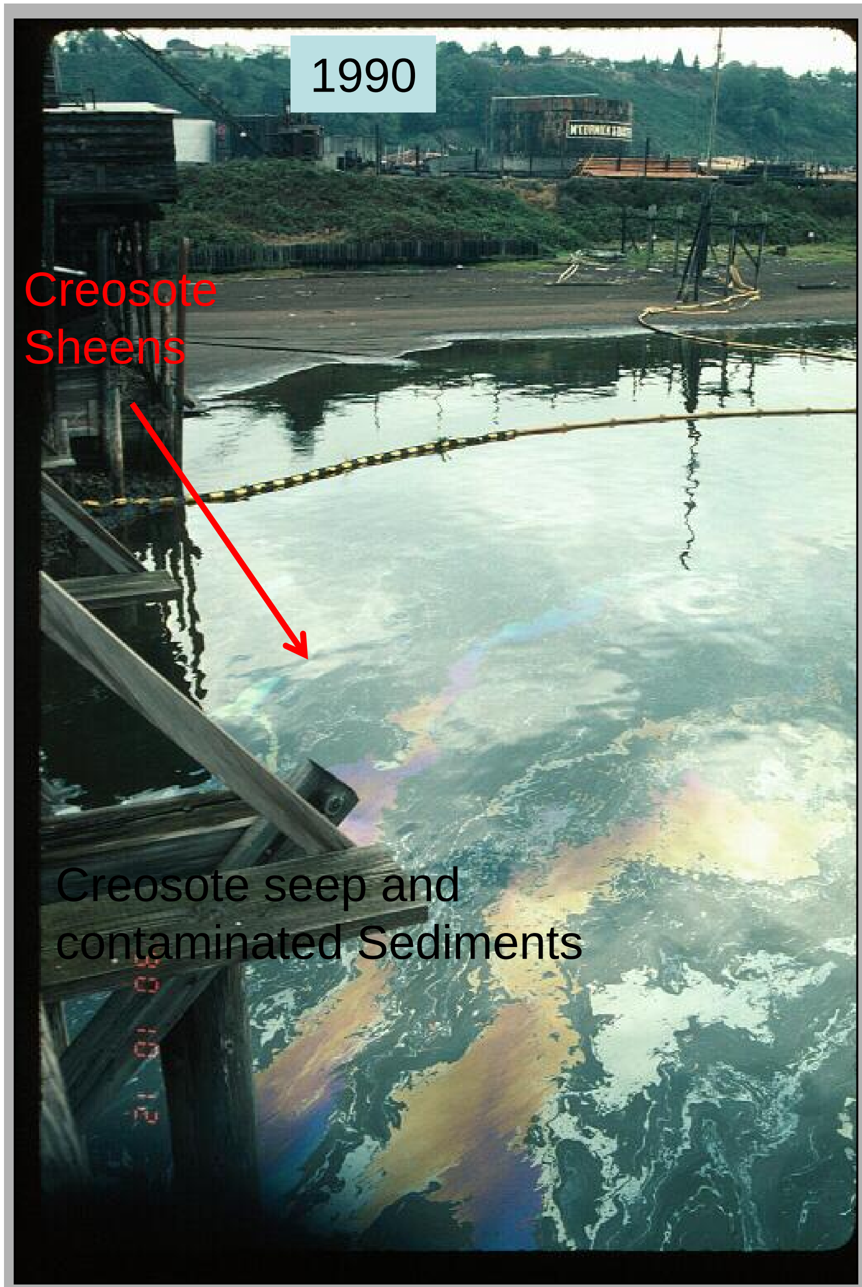
Construction Contractors:
- Wilder Construction Company
- Advanced American Diving/Construction
- Remtech

Project Web Site:
www.deq.state.or.us/nwr/mccormick.htm

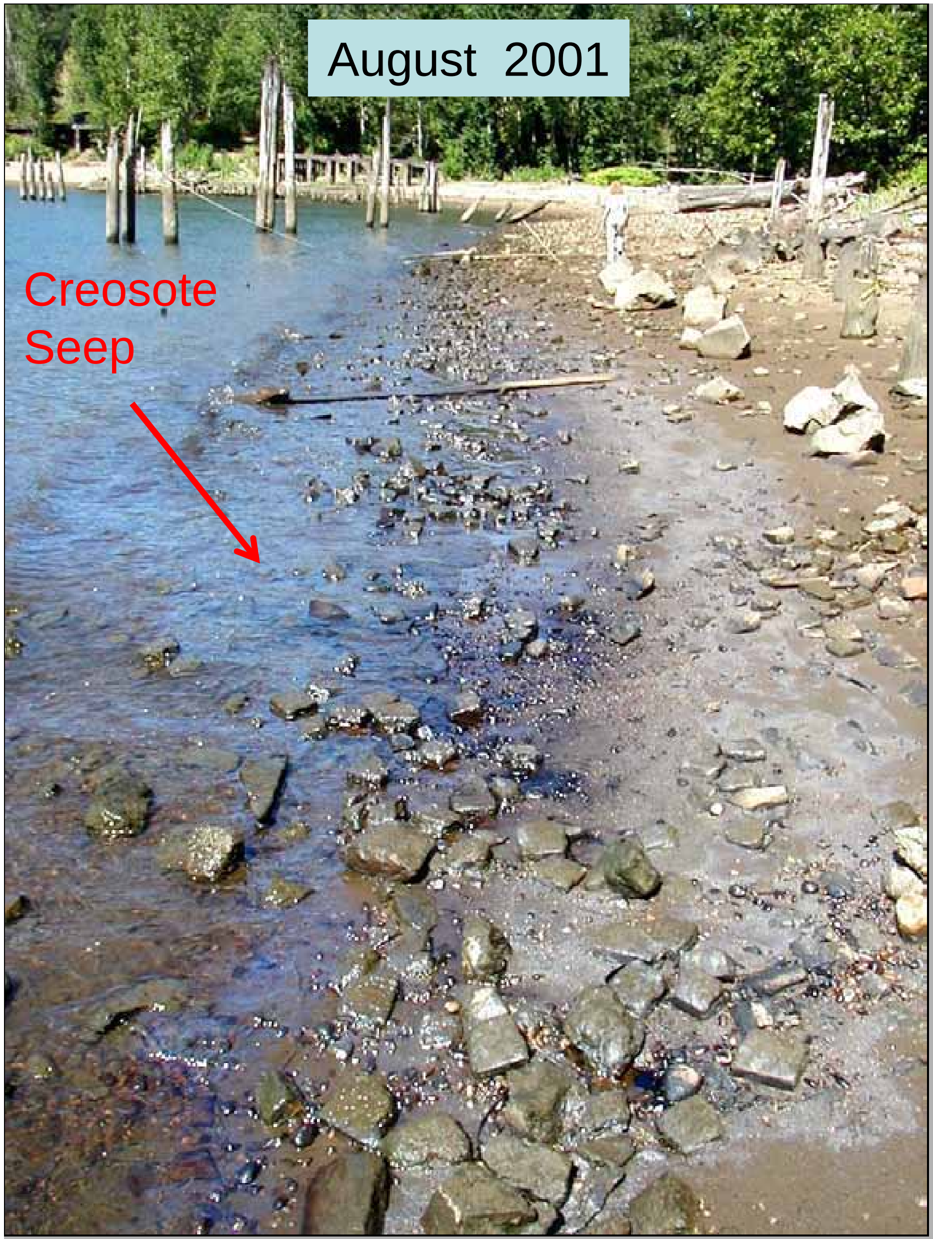
Before and After RA Construction

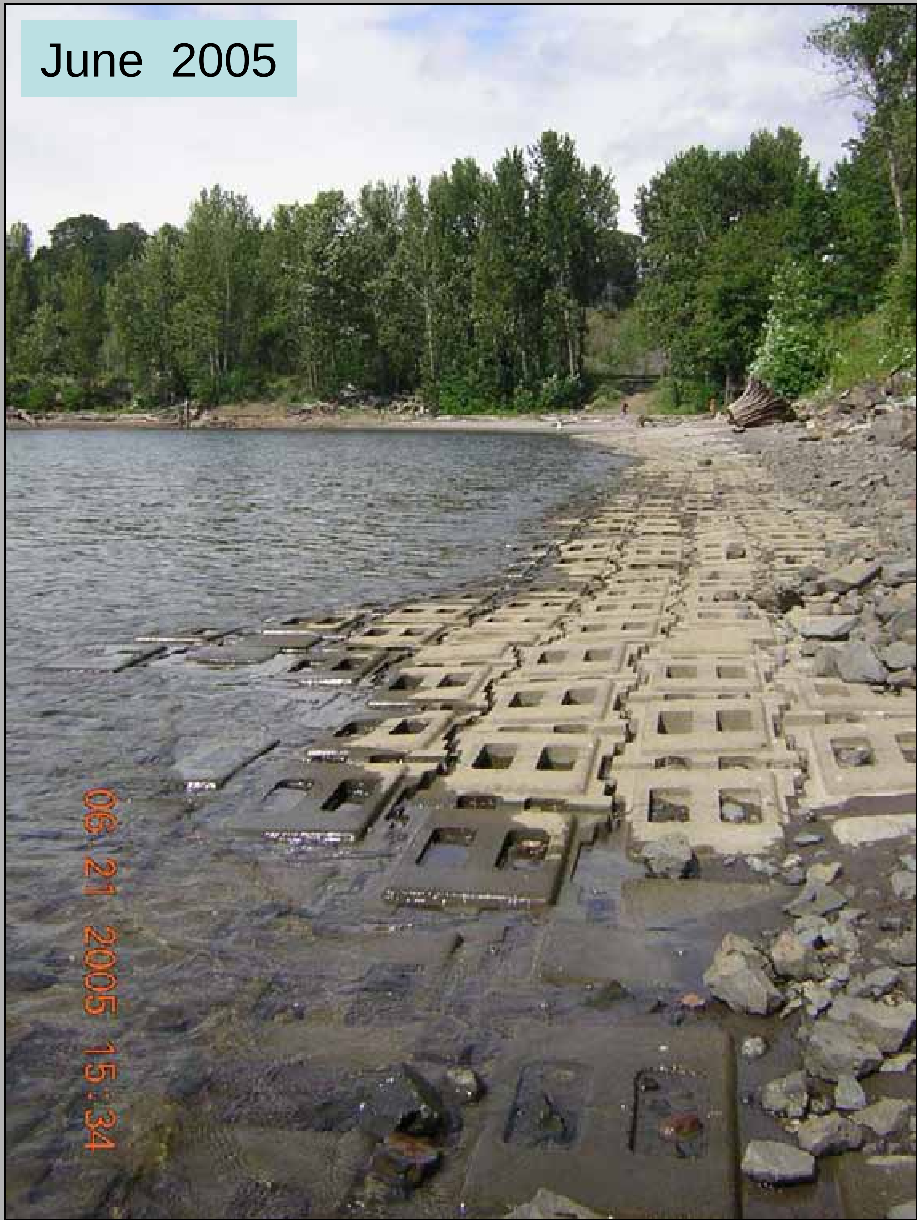


Before and After RA Construction

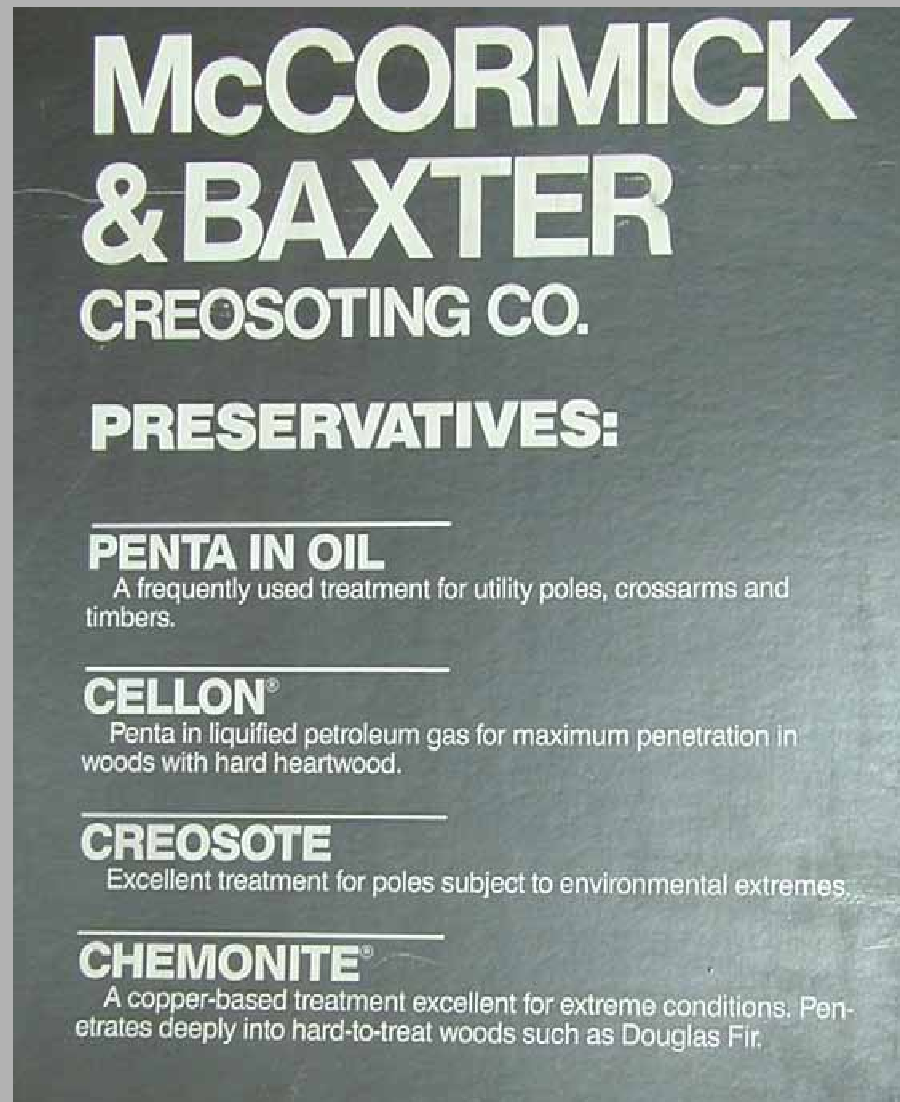


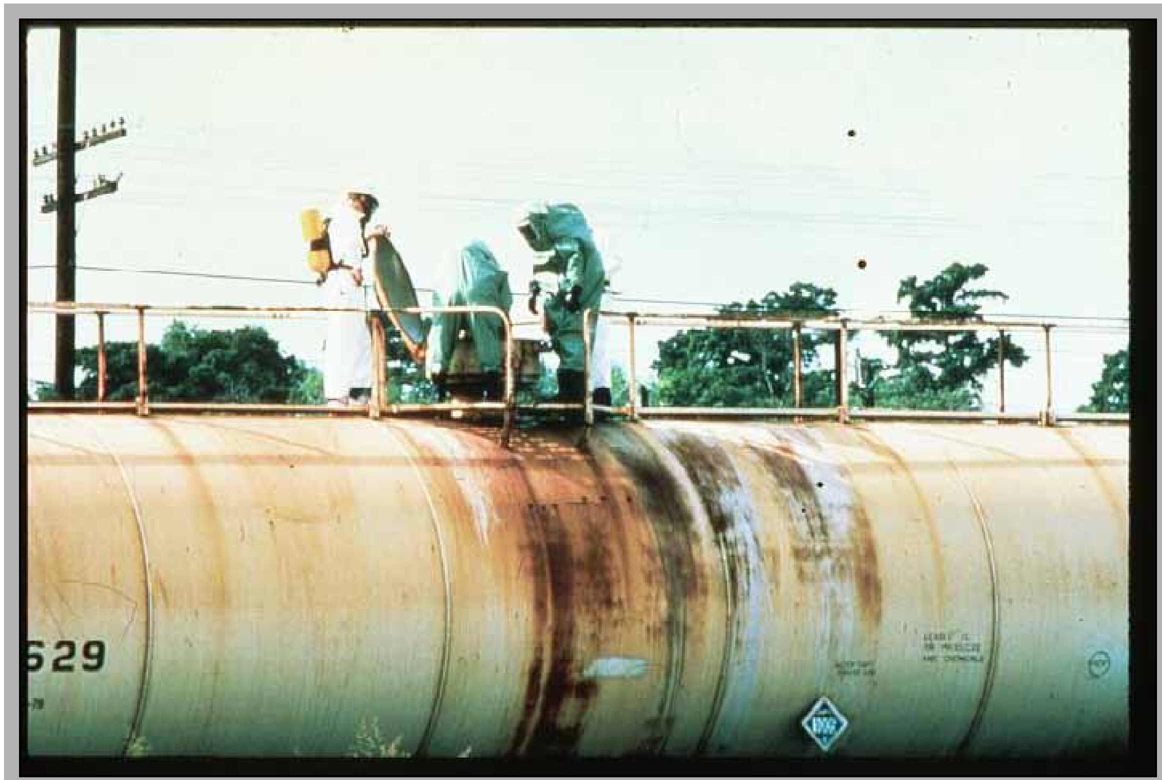
Before and After
RA Construction



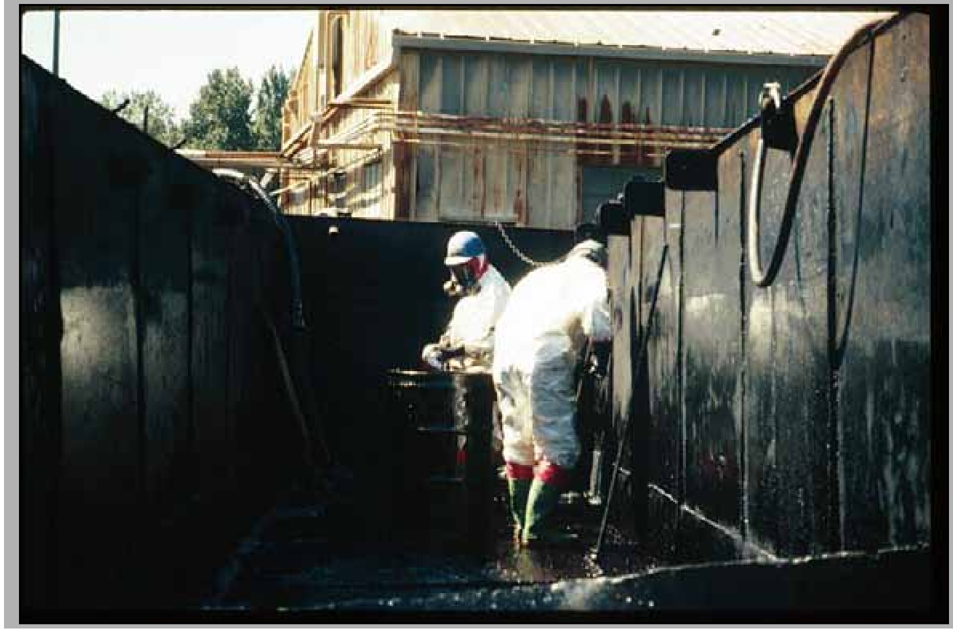


Historic Operations





Initial Response and Investigation (1989 to 1991)



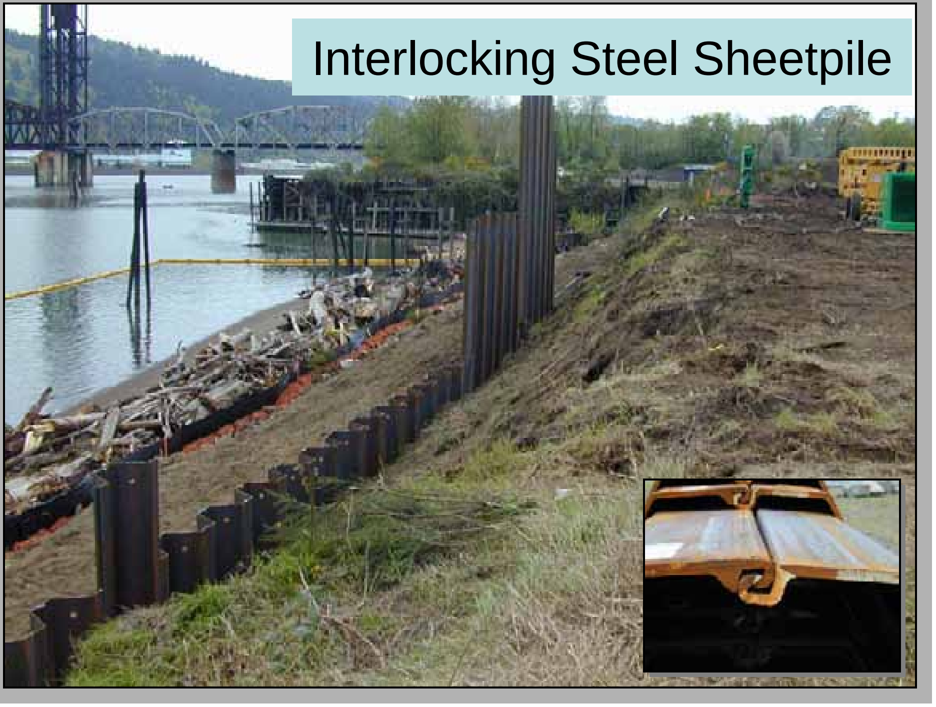
Groundwater Remedy - Creosote Extraction
(Over 6100 gallons extracted since 1989)

Manual Recovery

Automated Recovery

Groundwater Remedy - Subsurface Barrier Wall (2003)

Soil-Bentonite Slurry Trench



Interlocking Steel Sheetpile

Phase I Soil Remedy - Hot Spot Removal (1999)

Excavation of Creosote Contaminated Soils

Phase II Soil Remedy – Cap (2005)

Topsoil and Demarcation

Geomembrane Liner

Topsoil and Reinforcement Mats

Sand Drainage Layer Placement Over Geocomposite Drainage Layer

Sediment Cap Construction (2004/05)

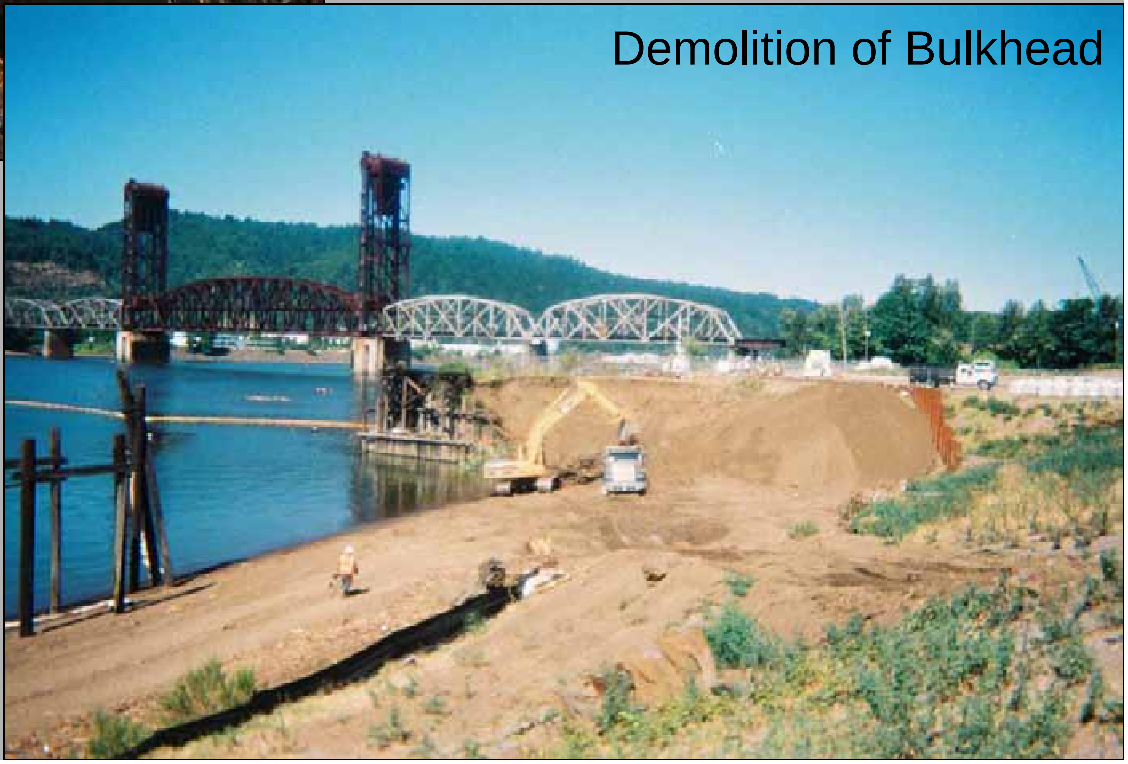
Fish Exclusion

Cutting Pilings

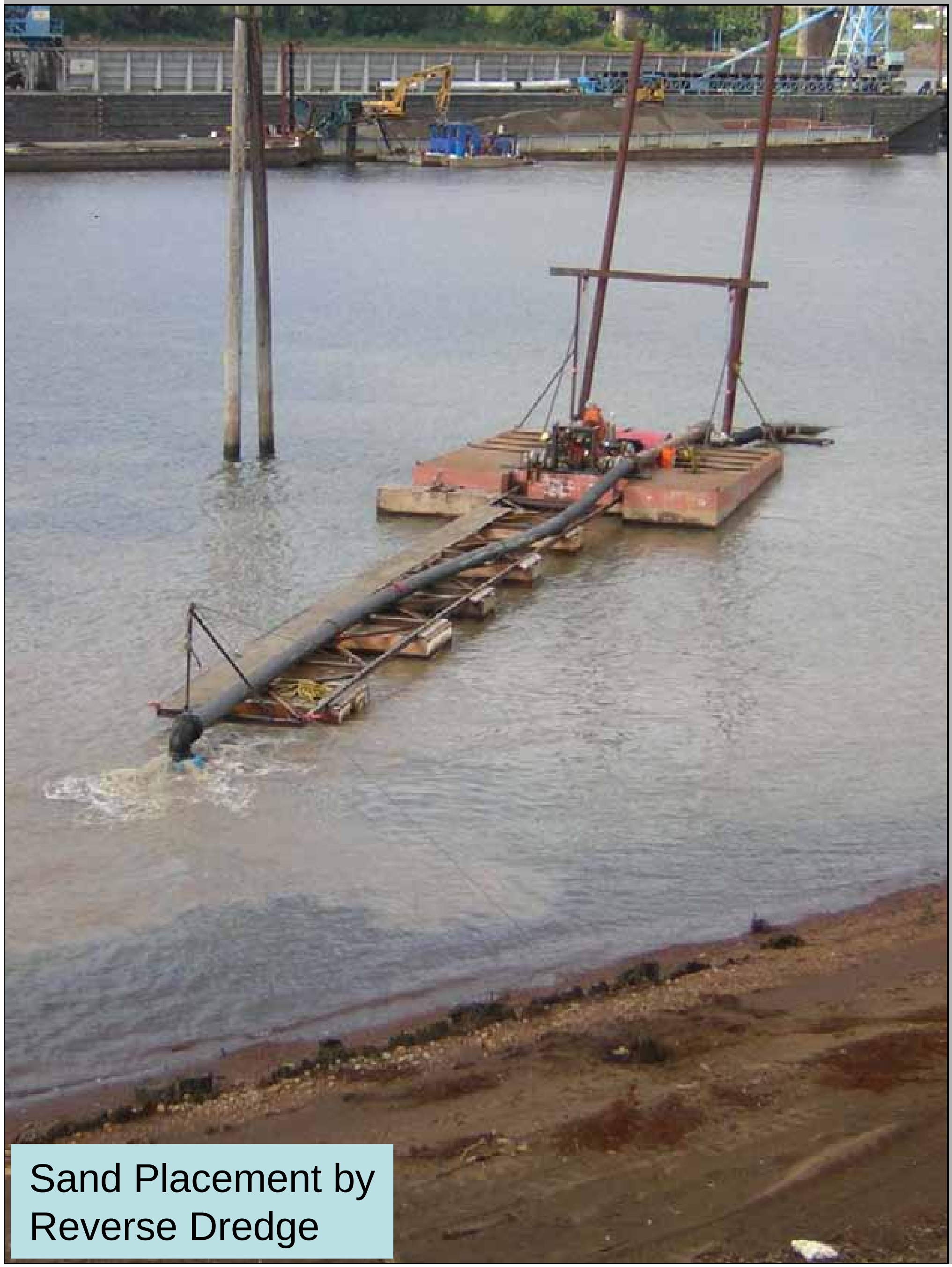
Pulling Pilings

Sediment Cap Construction (2004/05)


Demolition of Derelict Barge


Demolition of Bulkhead

Sediment Cap Construction (2004/05)



Sand Placement by Reverse Dredge

Sand Placement by Conveyor Barge

Sand Placement by Long-Reach Excavator

Sediment Cap Construction (2004/05)

Granular Organoclay Placement

Sediment Cap Construction (2004/05)

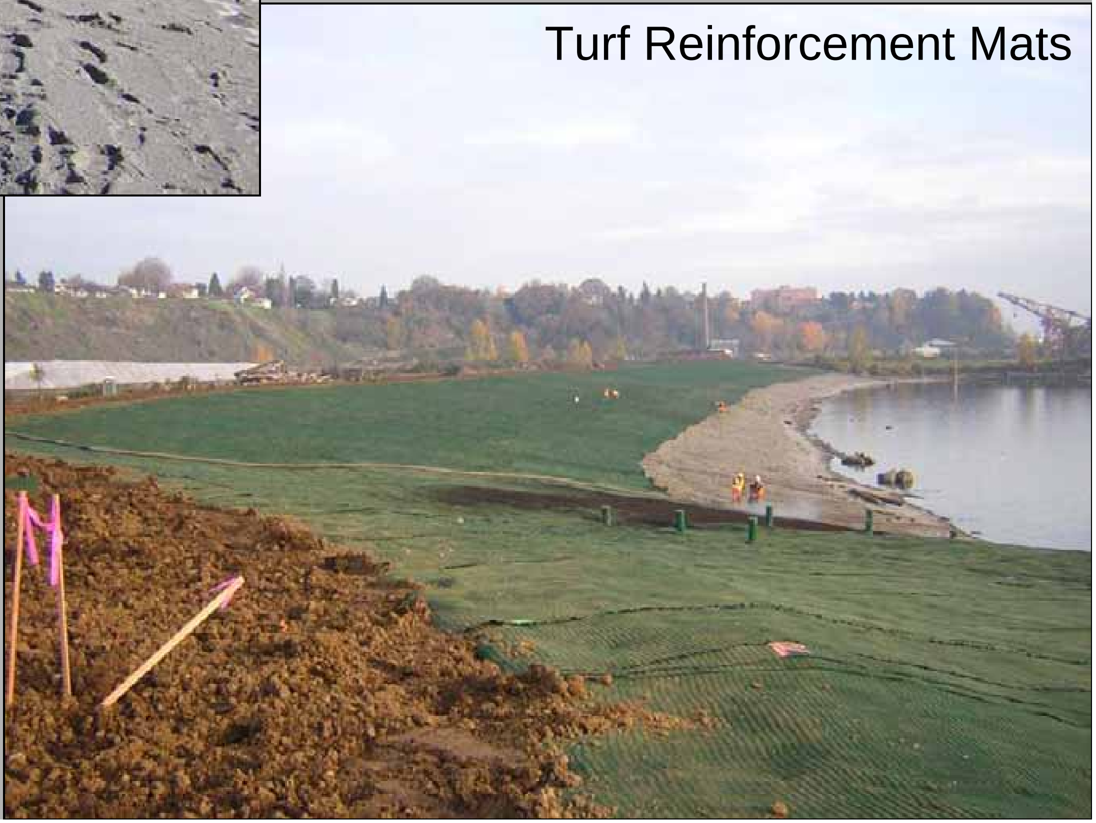

Armoring Placement by Skip Barge

Armoring Placement from Shore

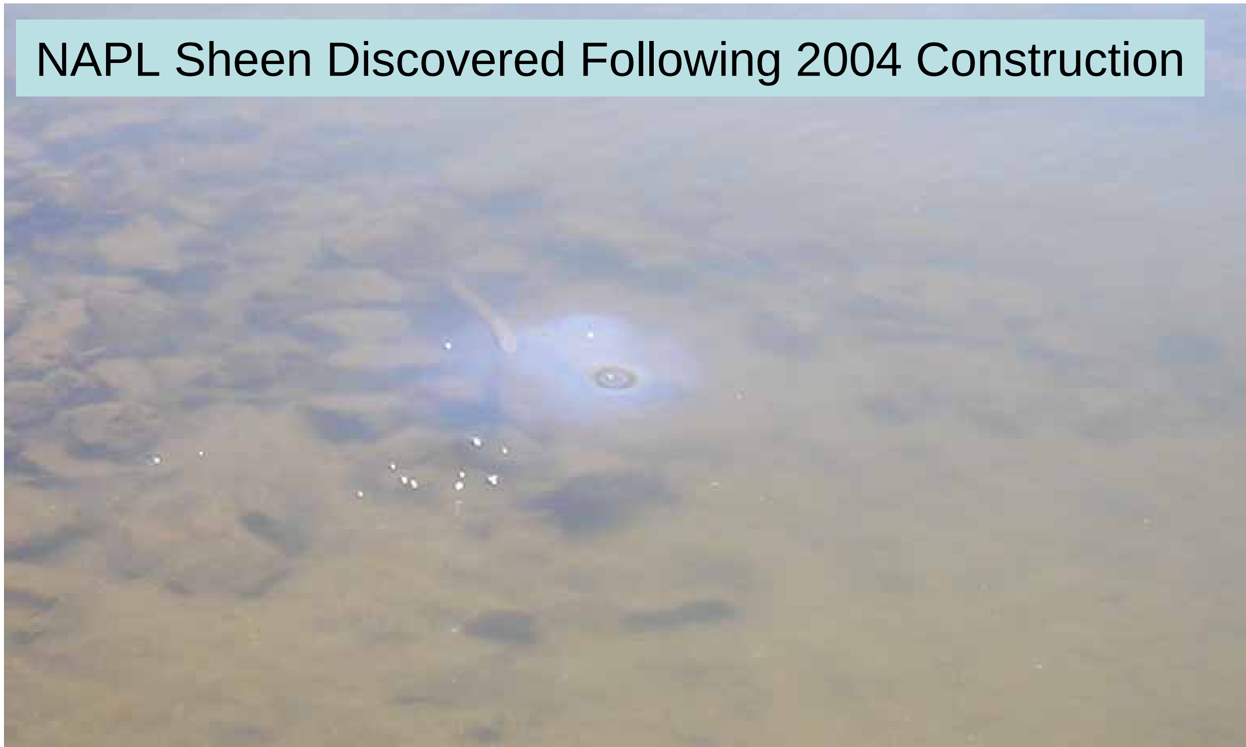
Sediment Cap Construction (2004/05)

Articulated Concrete Block Placement

Sediment Cap Construction (2004/05)



Corrective Measures Following 2004 Sediment Cap Construction



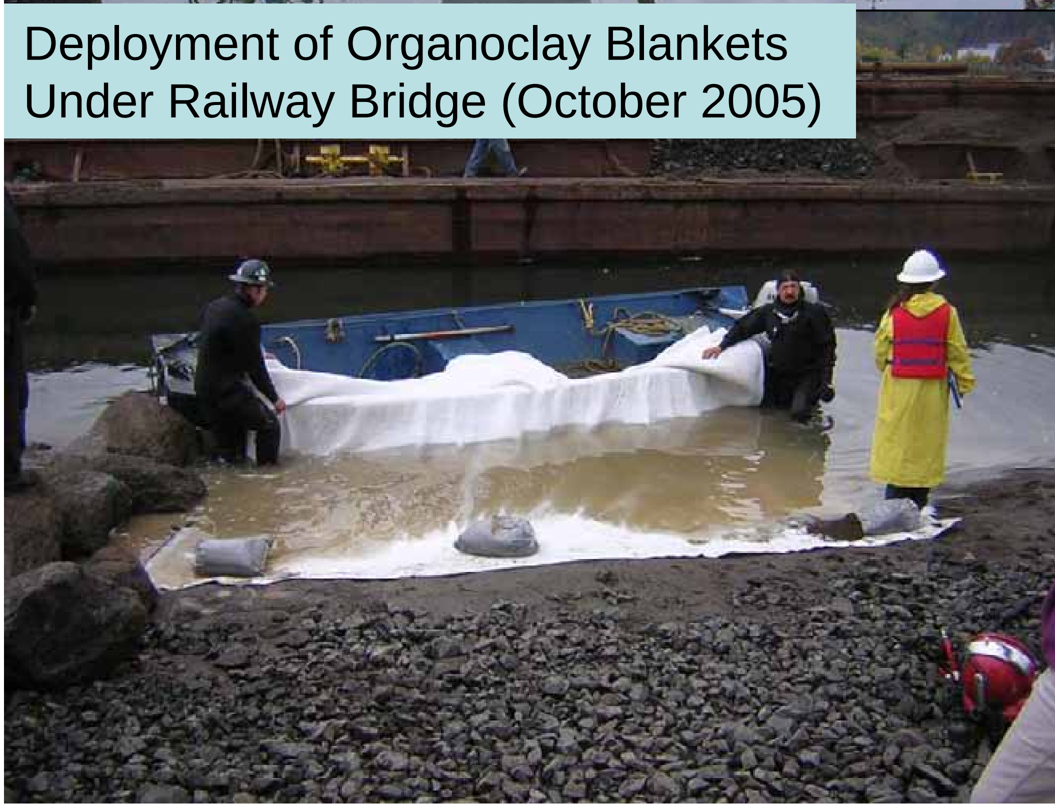
NAPL Sheen Discovered Following 2004 Construction

Sand and Armoring Overlay

Deployment of Organoclay Blanket
In September 2005

Organoclay Blanket

Corrective Measures Following 2004 Sediment Cap Construction



Deployment of Organoclay Blankets Under Railway Bridge (October 2005)

Sand and Armoring Overlay

Community Tree Planting & Celebration

SOLV Volunteer Wade Peerman
Governor Ted Kulongoski
City Commissioner Sam Adams
EPA R10 Administrator Michael Bogart
DEQ Director Stephanie Hallock
(February 2006)

Attachment 2 - Documents Reviewed for Second Five-Year Review

Attachment 2 - Documents Reviewed for Second Five-Year Review

Record of Decision, McCormick and Baxter Creosoting Company Portland Plant, Portland, Oregon, U.S. Environmental Protection Agency, March 1996.

Amended Record of Decision, McCormick and Baxter Creosoting Company Portland Plant, Portland, Oregon, U.S. Environmental Protection Agency, March 1998.

Phase 1 Soil Remedial Action Summary Report, McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., November 1999.

Sediment Cap Basis of Design, McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., May 2002.

Explanation of Significant Difference (OU3 – Final Groundwater), McCormick and Baxter Creosoting Company Superfund Site, Portland, Multnomah County, Oregon, U.S. Environmental Protection Agency, August 2002.

Response to Comments on Sediment Cap Basis of Design, McCormick & Baxter Superfund Site, DEQ, December 9, 2002.

Surface Water, Sediment, and Groundwater Sampling Report, September 2002, McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., February 2004.

Remedial Action Construction Summary Report, Combined Sheet Pile and Soil-Bentonite Barrier Wall, McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., April 2004.

Final Surface Water, Pore Water, and Crayfish Fall 2003 Sampling Event, McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., April 2005.

Organoclay Laboratory Study, McCormick and Baxter Creosoting Company, Portland, Oregon, University of Texas, September 2005.

Innovative Technology Evaluation (ITE) of McCormick and Baxter Portland, Oregon, McCormick and Baxter Creosoting Company Superfund Site, Portland, Multnomah County, Oregon, GeoEngineers, Inc., February 28, 2006.

Remedial Action Construction Summary Report, Upland Cap Construction Summary Report, McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., May 2006.

Remedial Action Construction Summary Report Sediment Cap (June 2004 through November 2004), McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., May 2006.

Remedial Action Construction Summary Report Sediment Cap Completion (August 2005 through October 2005), McCormick & Baxter Creosoting Company, Portland, Oregon, Ecology & Environment, Inc., May 2006.

Various Remedial Actions Semi-Annual Reports through December 2003, prepared by Ecology & Environment, Inc.

Various Barrier Wall Performance Monitoring Reports through May 2006, prepared by Ecology & Environment, Inc.

Attachment 3 - Barrier Wall Performance Monitoring

ecology and environment, inc.
International Specialists in the Environment
Portland Office
333 SW Fifth Avenue, Suite 608
Portland, Oregon 97204
Tel: (503) 248-5600, Fax: (503) 248-5577

Technical Memorandum

To: Kevin Parrett, Project Manager; -- McCormick and Baxter Superfund Site

Date: September 7, 2006

From: George Lukert, Task Manager (E & E)

Subject: Final July 22, 2006 through August 25, 2006 Barrier Wall Performance Monitoring Summary Report

1.0 Introduction

This technical memorandum presents a summary status report on non-aqueous phase liquid (NAPL) measurement and extraction results and groundwater elevation and gradient at the McCormick and Baxter Creosoting Company (McCormick and Baxter) site in Portland, Oregon. The monitoring program at the McCormick and Baxter site is used to evaluate the functional performance of the containment system (the barrier wall) and to document NAPL removal relative to the groundwater remedial action objective. Additionally, monitoring data provide information on the impact of the upland soil cap on groundwater flow at the site.

This report includes data for the monitoring period from July 22, 2006 through August 25, 2006. Monthly monitoring activities include collection of groundwater elevation data for 79 monitoring wells located onsite and on the adjacent Burlington Northern and Metro (Willamette Cove area) properties. Additionally, NAPL gauging and extraction activities are currently conducted on a weekly basis for 17 select monitoring wells. E & E also maintains a network of pressure transducers which monitor groundwater level fluctuations on a half hour basis at select monitoring wells surrounding the barrier wall. Monitoring well locations are shown in Figure 1. This report presents a summary of the following data collected during this barrier wall performance monitoring.

- NAPL gauging and extraction results,
- static water-level measurements (low tide event),
- hydraulic-head measurements (transducers), and
- vertical and horizontal gradients.

This report also presents the resulting groundwater contour map for the shallow unconfined aquifer and transducer plots of groundwater elevation.

2.0 NAPL Thickness and Extraction

Light non-aqueous phase liquid (LNAPL) and dense non-aqueous liquid (DNAPL) measurements were recorded at 17 site wells on a weekly basis during this reporting period. The wells monitored weekly for NAPL include EW-1s, EW-2s, EW-8s, EW-9s, EW-10s, EW-15s, EW-18s, EW-19s, EW-23s , MW-1r , MW-20i, MW-22i, MW-34i, MW-56s, MW-60d, MW-Ds, and MW-Gs. NAPL was detected in eight of the 17 wells during this reporting period and are shown on Figure 2. In addition, remaining wells were gauged for both LNAPL and DNAPL during the monthly groundwater gauging event; no LNAPL or DNAPL was detected in the remaining wells during the event.

If individual wells met the NAPL thickness criteria (0.4 feet for LNAPL and 1.5 feet for DNAPL) then extraction activities were conducted. Once extracted, NAPL is placed into 55-gallon drums corresponding to individual wells. Drum gauging is then conducted on a weekly basis to determine the actual volume of NAPL versus water extracted. Drum gauging of extracted NAPL is used to best estimate actual volume removed. However, water separation from week to week, slight variations in measurement, and instrument sensitivity can result in a negative volume change being calculated for an individual drum (e.g. a 0.01 foot change in measurement equals a volume of approximately 0.21 gallons). Table 1 summarizes the observed NAPL thicknesses and calculated extracted volumes based on drum gauging. For drum gauging where a negative volume was calculated, an extracted volume of zero is indicated and footnoted as such on Table 1.

LNAPL

During this reporting period, measurable LNAPL thickness (greater than 0.01 feet) was regularly detected in four FWDA wells (EW-10s, EW-15s, EW-23s, and MW-56s) with thicknesses ranging from a minimum of 0.24 feet in EW-23s to a maximum of 2.09 feet in MW-56s. Monitoring wells EW- 10s, EW-15s, EW-23s, and MW-56s all contained sufficient LNAPL during at least one week of the monitoring period to warrant extraction. LNAPL was also detected in the TFA in EW-18s at a maximum thickness of 0.44 feet. Based on drum gauging, a total of 27.37 gallons of LNAPL was extracted during this reporting period.

DNAPL

During this reporting period, measurable DNAPL thickness (greater than 0.01 feet) was regularly detected in three FWDA wells (MW-20i, MW-Ds, and MW-Gs) with thicknesses ranging from a minimum of 0.93 feet in MW-Gs to a maximum of 2.80 feet in MW-20i. Monitoring wells MW-20i and MW-Ds contained sufficient DNAPL during at least one week of the monitoring period to warrant extraction. DNAPL was not detected in the TFA during this reporting period. The volume of DNAPL removed each month is based on drum gauging measurements. During this reporting period, drum gauging measurements resulted in a negative total volume of DNAPL extracted. However, field estimates at the time of pumping show that approximately 6.75 gallons of liquid (water – DNAPL mixture) were removed during extraction. E&E conducted conductivity tests for several NAPL and water samples in an effort to evaluate potential reasons for negative DNAPL gauging measurements, the results were inconclusive. E&E will continue to evaluate alternatives for the current method of drum gauging. For consistency, the total DNAPL extracted shown on Table 1 continues to be based on drum gauging and therefore reflects the negative total for the month.

Both LNAPL and DNAPL thickness measurements for this reporting period are summarized in Table 1. Cumulative NAPL extraction is presented in Table 2, and shown graphically in Figure 3. As of July 21 a total of approximately 6,135 gallons of NAPL have been removed since February 1993.

3.0 Water-Level Monitoring (Manual and Automated Water-Level Data Collection)

3.1 Groundwater Flow and Gradients

Groundwater-level data collection is conducted both manually and using automated pressure transducers. Manual collection of groundwater-level data were conducted on August 17, 2006, during low tide. Based on the measured groundwater elevations, a shallow groundwater contour map was prepared (Figure 2). A summary of groundwater elevation data for the August monitoring event is included in Table 3.

3.1 Groundwater Flow and Gradients

Figure 2 presents a shallow groundwater contour map representing conditions on August 17, 2006. As shown in Figure 2, groundwater flow within the barrier wall has flattened significantly compared to monitoring events conducted prior to the upland cap completion, and is similar to that of the previous reporting period. Outside the barrier wall, shallow groundwater flow is diverted west towards Willamette Cove, or south along the eastern edge of the barrier wall. Groundwater that is diverted south along the edge of the barrier wall is diverted either slightly east toward the bluff or south towards the Willamette River.. This is generally consistent with previous reporting periods.

Horizontal gradients were calculated using the groundwater elevations at specific wells inside the barrier wall. The calculated horizontal gradient inside the wall for the current monitoring event is 0.0009 ft/ft in the TFA and 0.0065 ft/ft in the FWDA. Horizontal gradients were calculated for several different areas on site both inside and outside of the barrier wall, and are listed in Table 4. Horizontal gradients are similar to recent reporting periods.

Vertical gradients inside and outside the barrier wall along the river are best observed on Figures 6 for the FWDA and Figure 9 for the TFA. The shallow zone within the barrier wall in the TFA remained flat through the month while the shallow zone within the FWDA reacts subtly to changes in the river level and/or precipitation. The shallow zone outside the barrier wall follows the river stage closely with a lag which is greater at the FWDA where the shallow barrier wall well is further from the river. The intermediate and deep zones both inside and outside of the barrier wall closely mimic the river stage both in elevation and timing with a small vertical gradient which varies between upward and downward with the tidal changes. Vertical groundwater gradients were also calculated using manual data from the August 17, 2006 low-tide monitoring event for well clusters MW36, MW37, MW40, and MW41 (FWDA), and well clusters MW44 and MW45 (TFA). During the August monitoring event vertical gradients inside the barrier wall were generally down between the shallow to deep, shallow to intermediate, and intermediate to deep wells; with the exception of a slight upward gradient between the MW-40 intermediate to deep wells. Outside the barrier wall vertical gradients were down between the shallow to deep, shallow to intermediate wells, and intermediate to deep wells. Vertical gradients from August 17, 2006 are summarized in Table 5.

3.2 Transducer Plots

Groundwater elevation monitoring using automated pressure transducers continued during the August reporting period in select groundwater monitoring wells; the majority of these wells (14) are located along the riverfront portion of the barrier wall. This includes well clusters MW-36, MW-37, MW-44, and MW-45; and the shallow wells in clusters MW-40 and MW-41. Transducers were also installed at two locations upland, MW-52s and MW-53s.

Transducer plots were prepared for select monitoring wells (MW-36s, MW-37s, MW-44s and MW-45s) inside and outside the barrier wall and are shown in Figures 4 through 9. The transducer plot compares water-level elevations inside the barrier wall versus water-level elevations outside the barrier wall, river elevation, and precipitation data. Figure 4 shows transducer data from October 2003, when transducers were initially installed to present for the shallow wells in the FWDA. Figure 5 shows transducer data for shallow wells in the FWDA for the last year, and Figure 6 shows data for the last month, including elevation data for the intermediate and deep wells. Similarly, figures 7 through 9 show transducer data for the TFA.

Water elevations in shallow wells outside the wall correlate well with river stage fluctuations along the riverfront portion of the barrier wall. Generally, shallow water elevations inside the wall in the TFA appear to reflect gradual seasonal fluctuations in precipitation, while shallow water elevations in the FWDA appear to be more influenced by precipitation and river stage compared to the TFA. Figure 6 shows shallow water elevations for the FWDA and figure 9 shows shallow water elevations for the TFA.

River stage data were recorded on a half hour basis from USGS station number 14211720, located on the upstream side of the Morrison Bridge, and corrected to river stage adjacent to the McCormick and Baxter site [(Morrison Bridge data)-(0.1 ft)]. River stage elevation data were collected relative to the Portland River Datum and is corrected to NAVD88 (+5.001 feet).

4.0 Summary Observations / Planned Activities

Shallow groundwater elevation and gradient during this reporting period at the McCormick and Baxter site are generally consistent with conditions observed during previous reporting periods. Groundwater flow inside the barrier wall remains flattened, while outside the wall, shallow groundwater flow is diverted around the barrier wall to the northwest, and south.

NAPL gauging and extraction continues to be conducted on a weekly basis. During the month of July, LNAPL was extracted from four wells, three located within the barrier wall in the FWDA, and one located within the barrier wall in the TFA. DNAPL was extracted from two wells, both located outside the barrier wall in the FWDA.

For the month of September 2006, E & E plans to complete the following activities as part of the barrier wall performance monitoring and routine O&M activities:

- Conduct the monthly low-tide groundwater and NAPL gauging event,
- Conduct weekly NAPL gauging in 17 wells, with extraction per the established criteria,
- Prepare a monthly monitoring report for the month of September, and
- Continue evaluating alternative methods for drum gauging that may alleviate the erroneous meter readings.

FIGURES

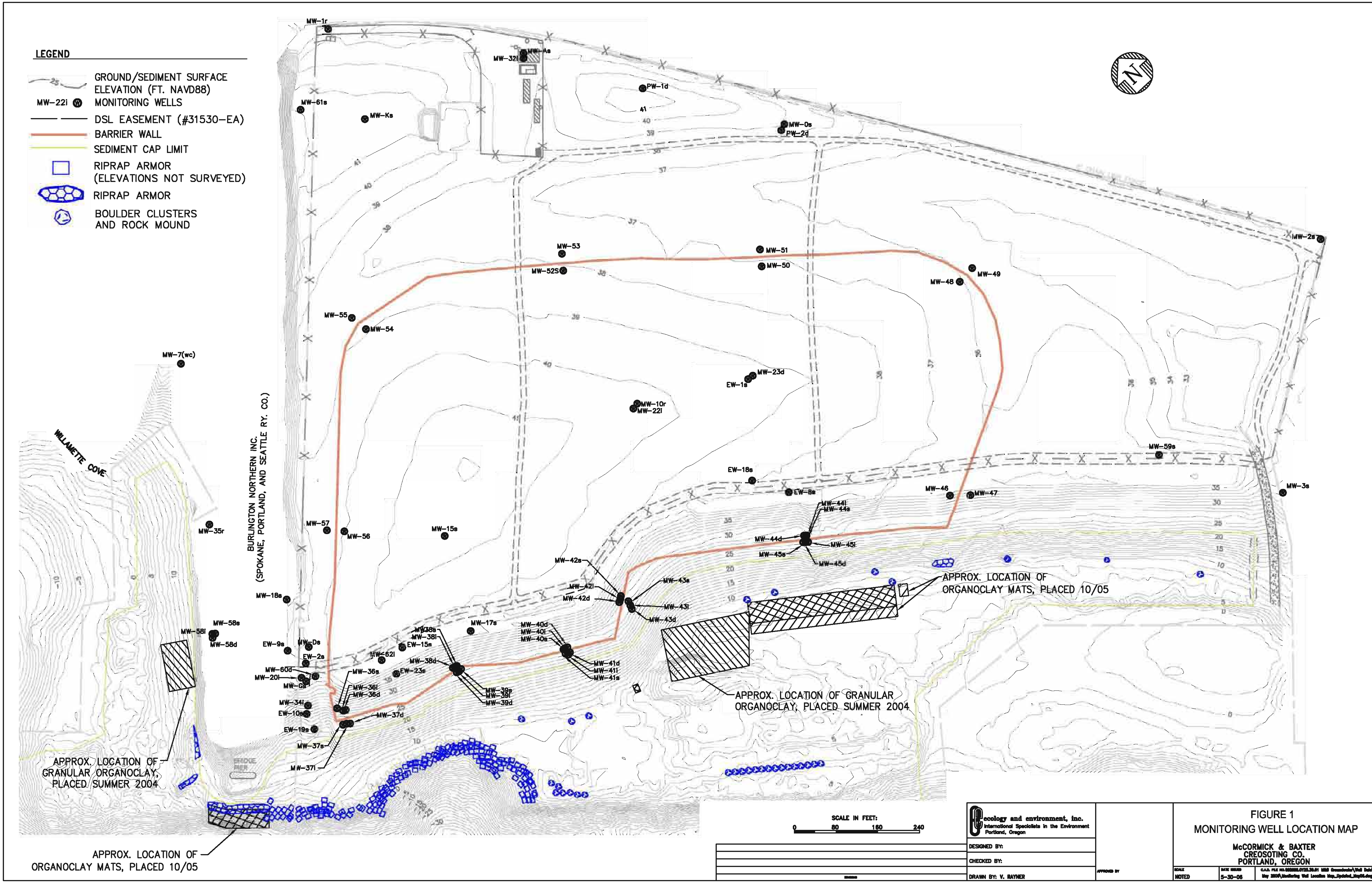


FIGURE 1
MONITORING WELL LOCATION MAP

McCORMICK & BAXTER CREOSOTING CO.
PORTLAND, OREGON

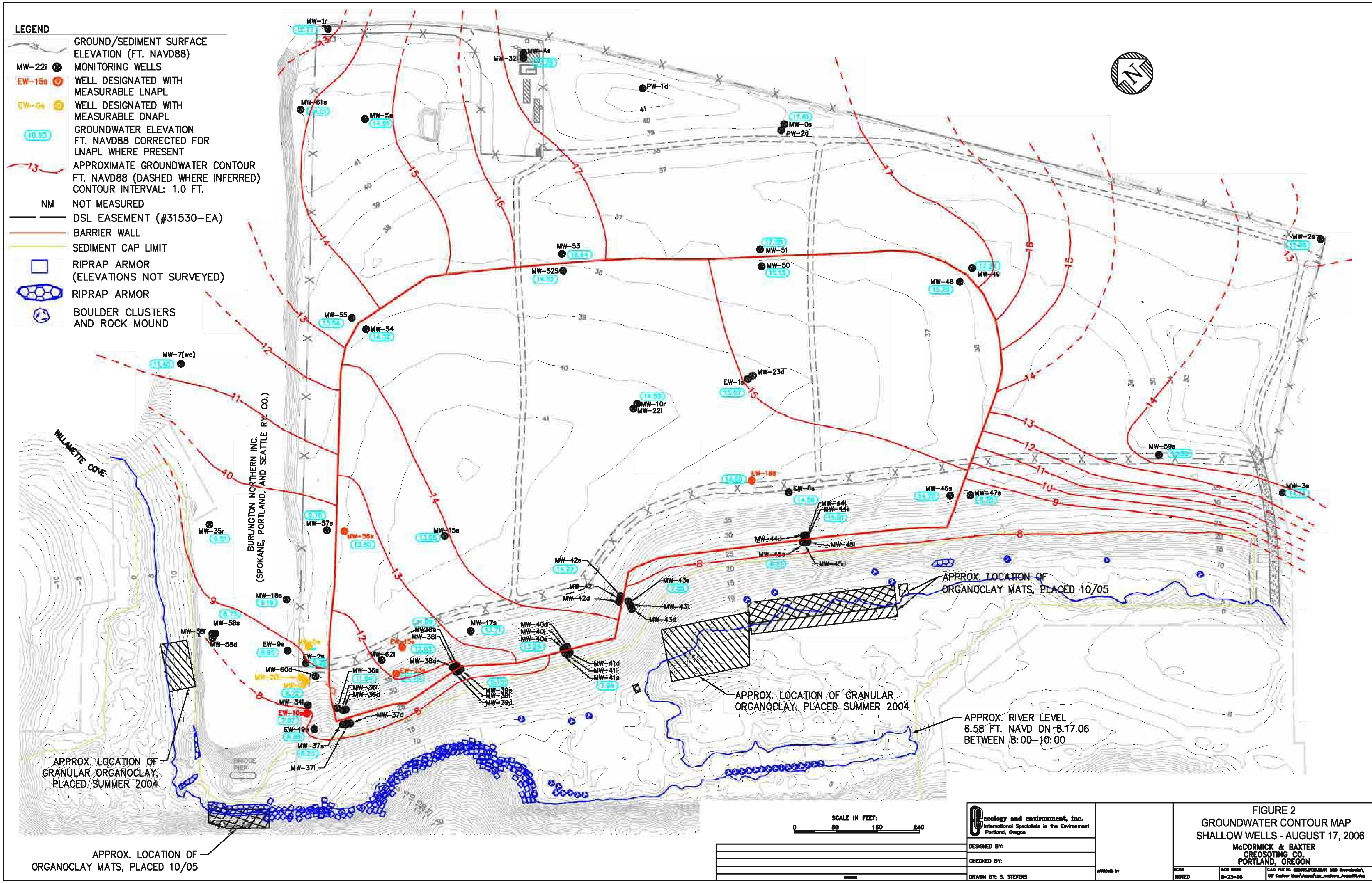

LEGEND
GROUND/SEDIMENT SURFACE ELEVATION (FT. NAVD88)
MW-22i MONITORING WELLS
EW-15s WELL DESIGNATED WITH MEASURABLE LNAPL
EW-Gs WELL DESIGNATED WITH MEASURABLE DNAPL
10.93 GROUNDWATER ELEVATION FT. NAVD88 CORRECTED FOR LNAPL WHERE PRESENT
13 APPROXIMATE GROUNDWATER CONTOUR FT. NAVD88 (DASHED WHERE INFERRED) CONTOUR INTERVAL: 1.0 FT.
NM NOT MEASURED
DSL EASEMENT (#31530-EA)
BARRIER WALL
SEDIMENT CAP LIMIT
RIPRAP ARMOR (ELEVATIONS NOT SURVEYED)
RIPRAP ARMOR
BOULDER CLUSTERS AND ROCK MOUND
WILLAMETTE COVE
BURLINGTON NORTHERN INC. (SPOKANE, PORTLAND, AND SEATTLE RY. CO.)
APPROX. LOCATION OF ORGANOCLAY MATS, PLACED 10/05
APPROX. LOCATION OF GRANULAR ORGANOCLAY, PLACED SUMMER 2004
APPROX. RIVER LEVEL 6.58 FT. NAVD ON 8.17.06 BETWEEN 8:00-10:00
APPROX. LOCATION OF GRANULAR ORGANOCLAY, PLACED SUMMER 2004
APPROX. LOCATION OF ORGANOCLAY MATS, PLACED 10/05
SCALE IN FEET:
0 80 160 240
ecology and environment, inc.
International Specialists in the Environment
Portland, Oregon
DESIGNED BY:
CHECKED BY:
DRAWN BY: S. STEVENS
FIGURE 2
GROUNDWATER CONTOUR MAP
SHALLOW WELLS - AUGUST 17, 2006
McCORMICK & BAXTER CREOSOTING CO.
PORTLAND, OREGON
NOTED
8-23-06

FIGURE 3

Cummulative NAPL Recovery as of August 25, 2006
McCormick and Baxter Creosoting Company
Portland, Oregon

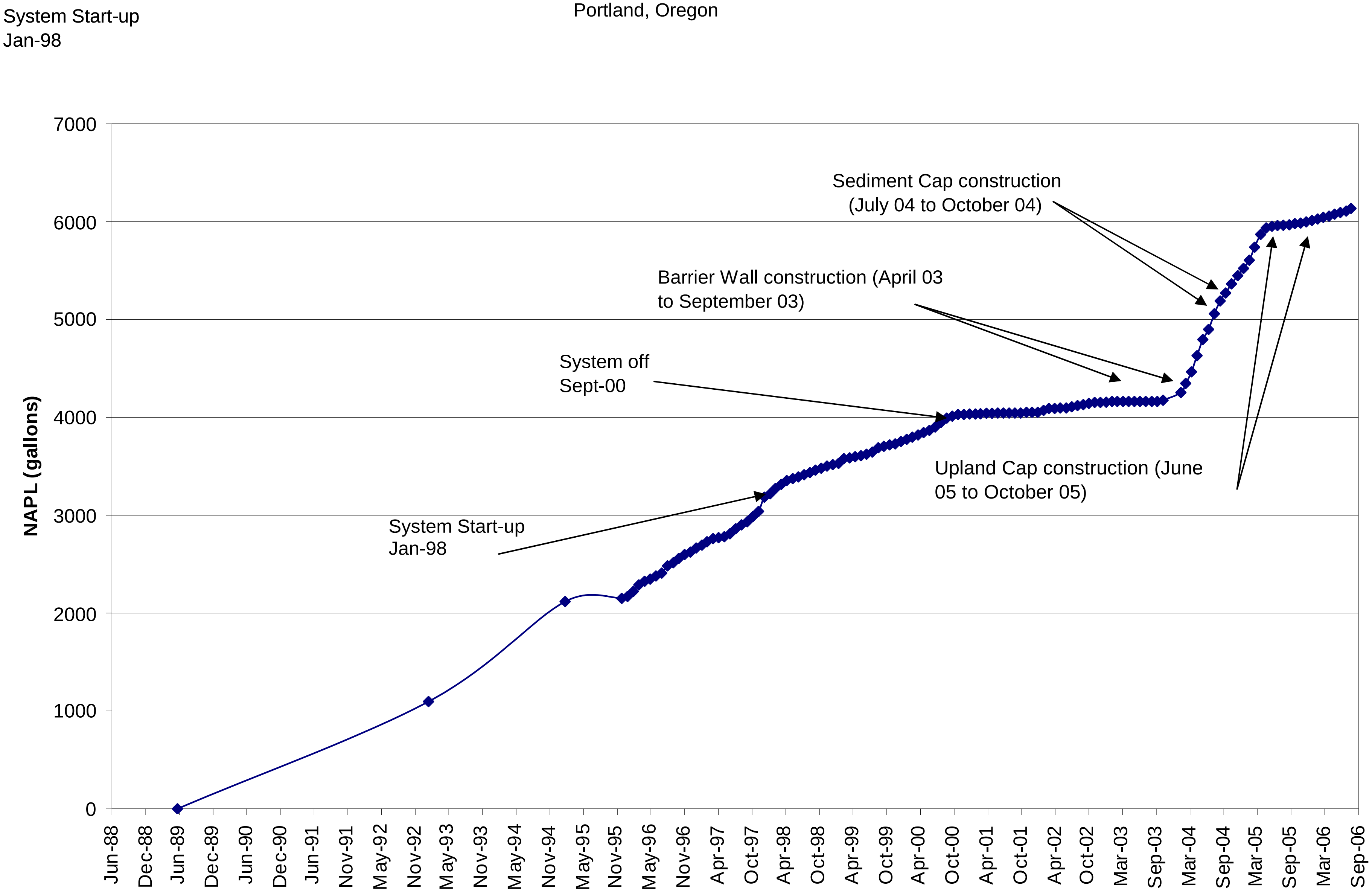


Figure 4
FWDA SHALLOW GROUNDWATER INSIDE THE BARRIER WALL vs OUTSIDE THE BARRIER WALL
October 20, 2003 through August 17, 2006
McCORMICK and BAXTER CREOSOTING COMPANY
PORTLAND, OREGON

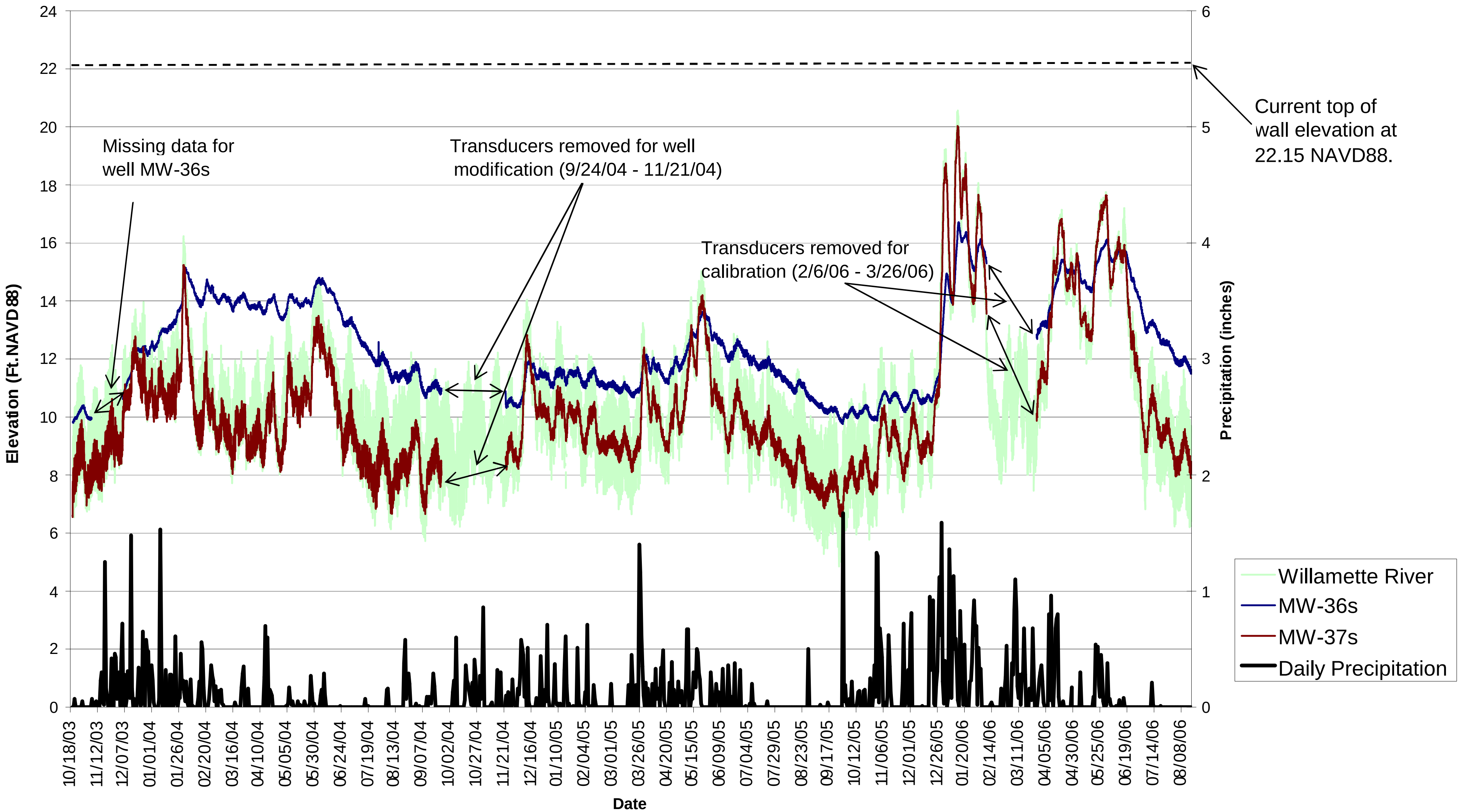


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Figure 5
FWDA SHALLOW GROUNDWATER INSIDE THE BARRIER WALL vs OUTSIDE THE BARRIER WALL
August 17, 2005 through August 17, 2006
McCORMICK and BAXTER CREOSOTING COMPANY
PORTLAND, OREGON

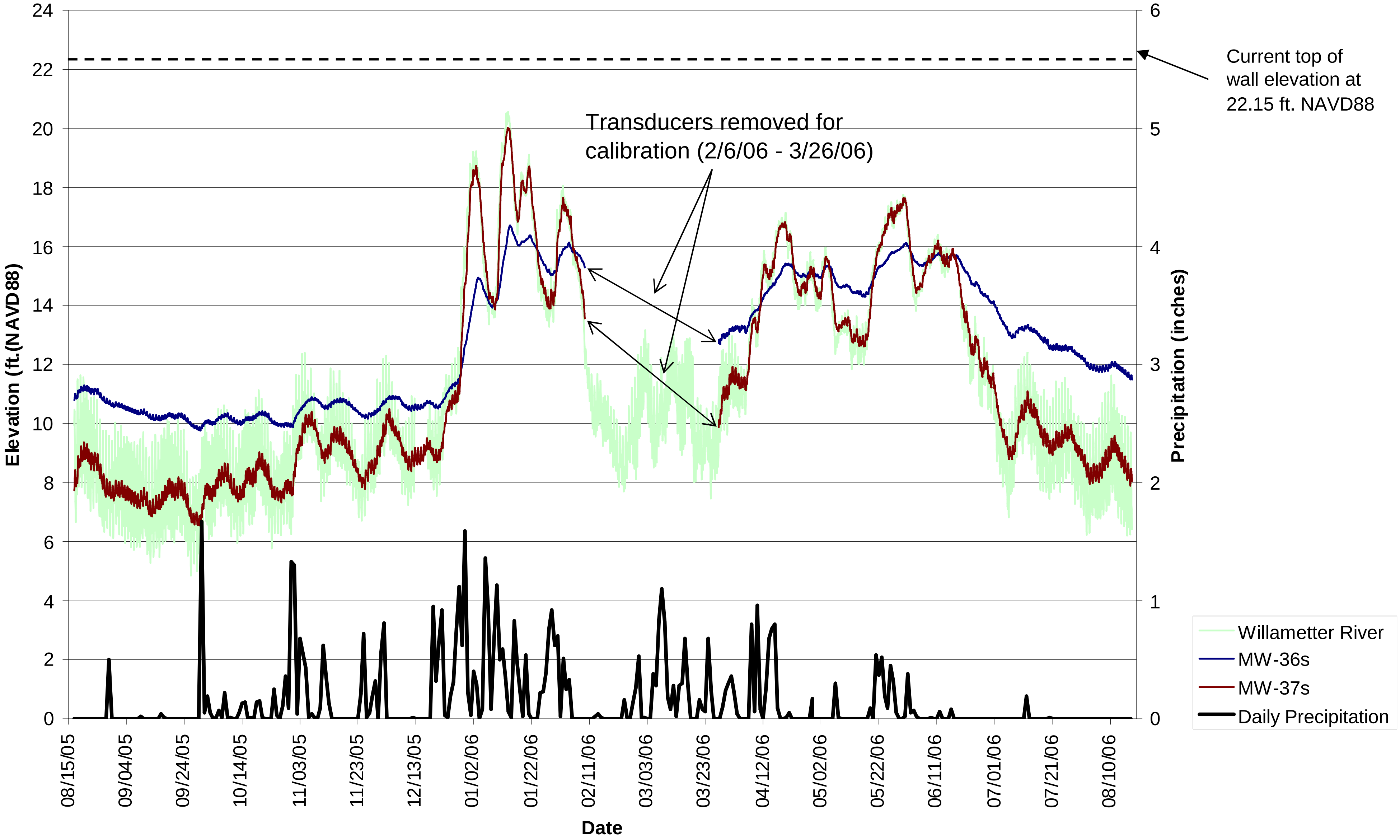

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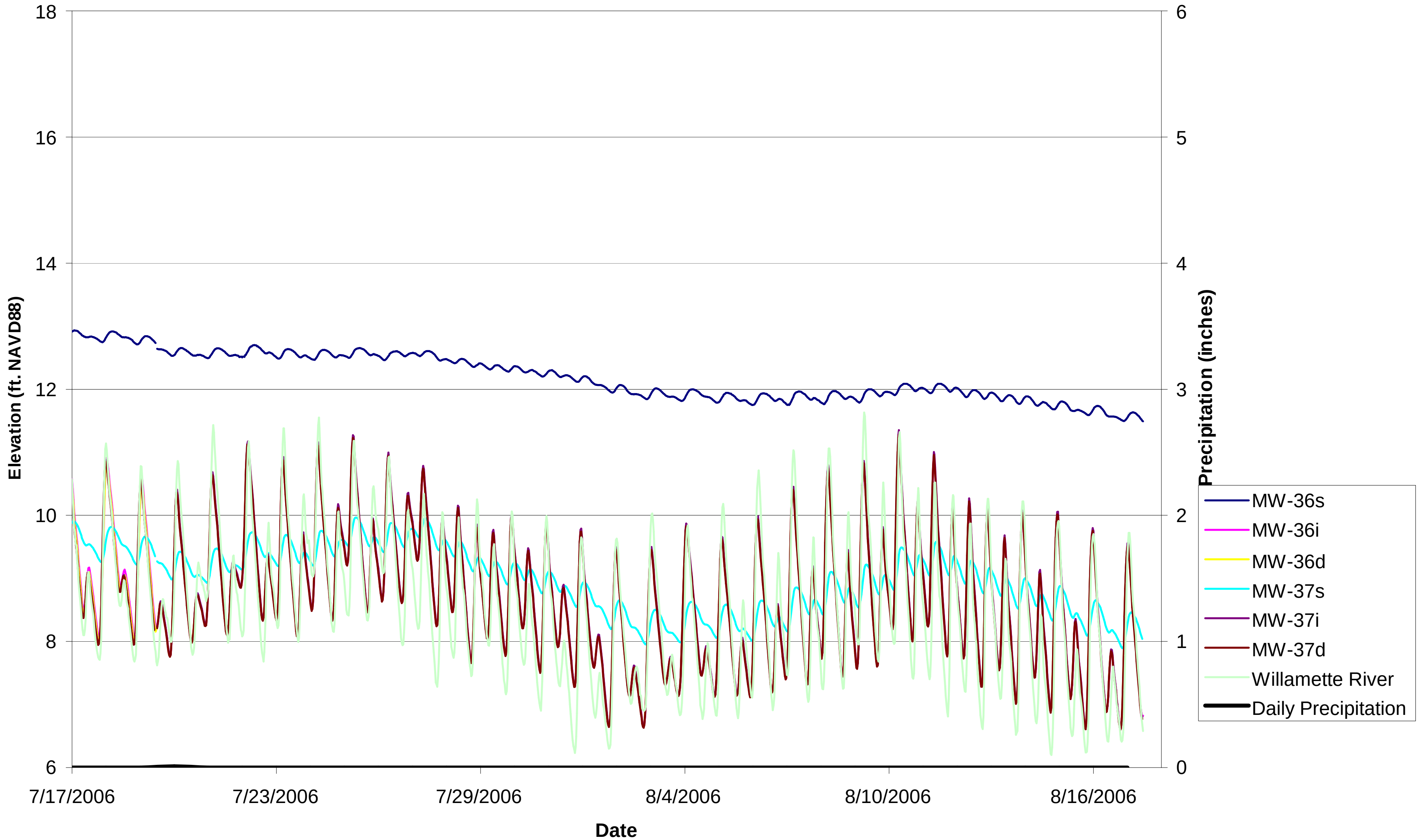
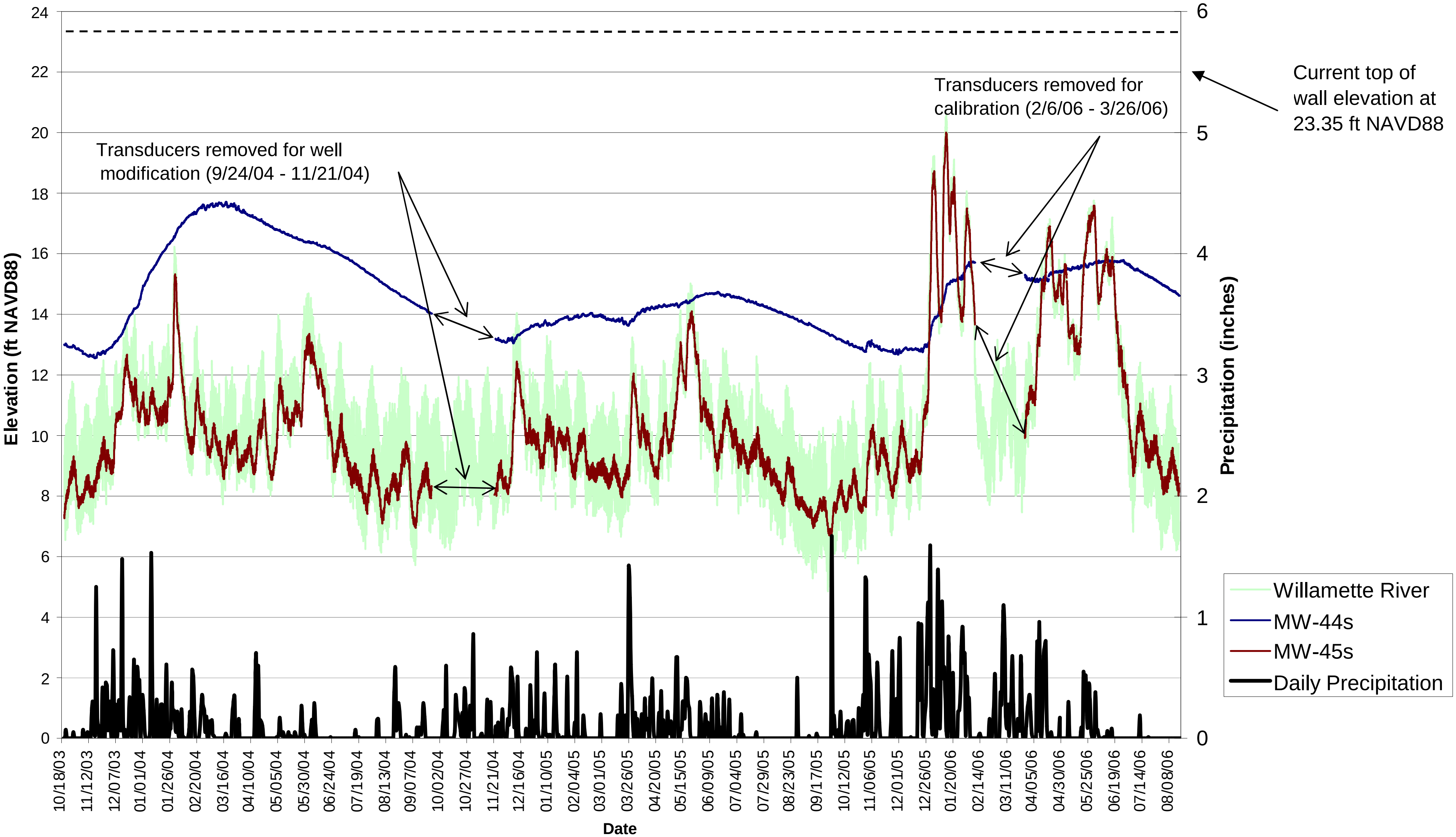
Figure 6
FWDA GROUNDWATER ELEVATIONS INSIDE THE BARRIER WALL vs OUTSIDE THE BARRIER WALL
July 17, 2006 through August 17, 2006
McCORMICK and BAXTER CREOSOTING COMPANY
PORTLAND, OREGON



O:\McCormick\McCormick OY25 O&F\Barrier Wall Monitoring\August 2006\Figures\Figure 6 August_FWDA_1_Mo.xls

Figure 7
TFA SHALLOW GROUNDWATER INSIDE THE BARRIER WALL vs OUTSIDE THE BARRIER WALL
October 20, 2003 through August 17, 2006
McCORMICK and BAXTER CREOSOTING COMPANY
PORTLAND, OREGON



O:\McCormick\McCormick OY25 O&F\Barrier Wall Monitoring\August 2006\Figures\Figure 7 August_TFA_All.xls

Figure 8
TFA SHALLOW GROUNDWATER INSIDE THE BARRIER WALL vs OUTSIDE THE BARRIER WALL
August 17, 2005 through Augsut 17, 2006
McCORMICK and BAXTER CREOSOTING COMPANY
PORTLAND, OREGON

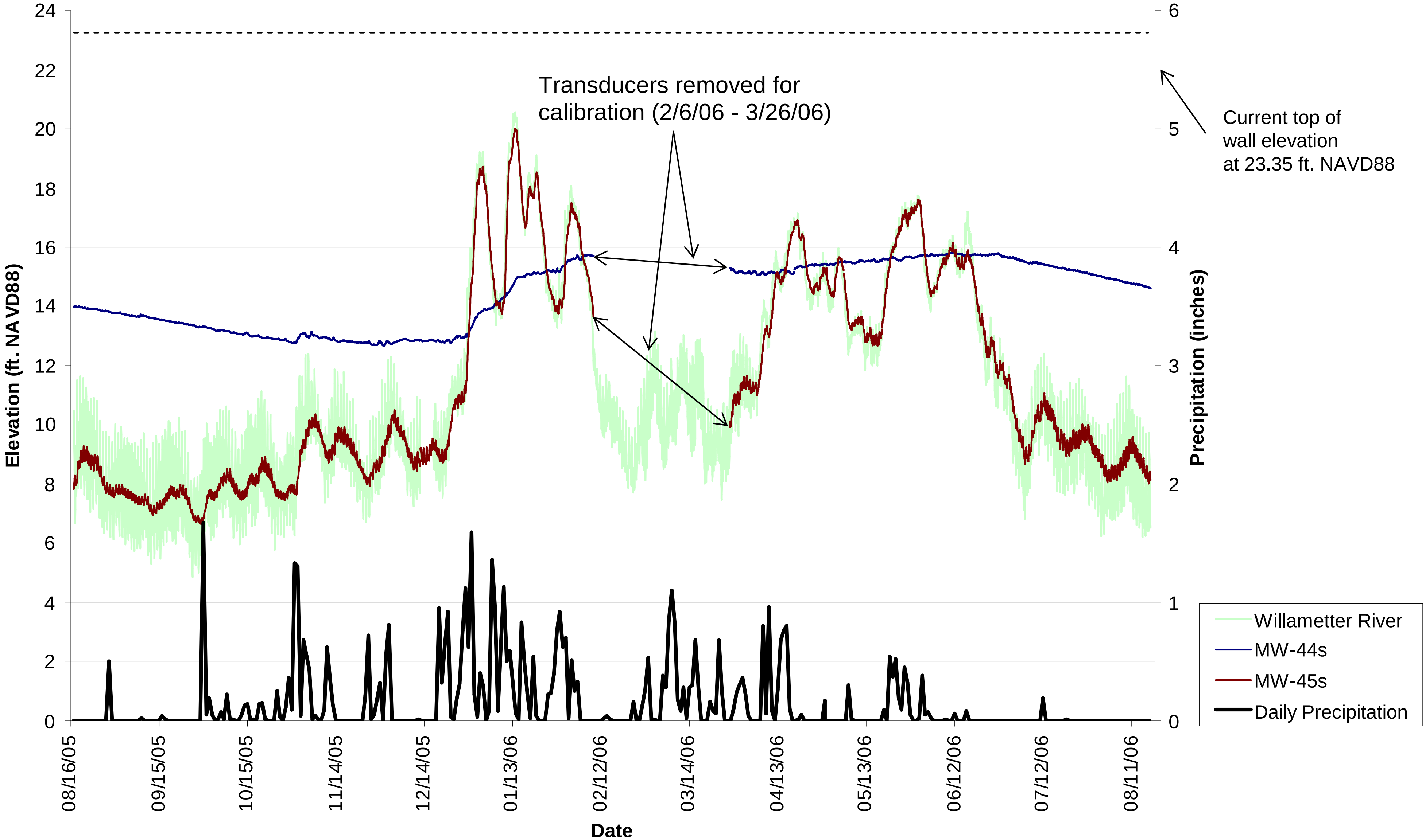


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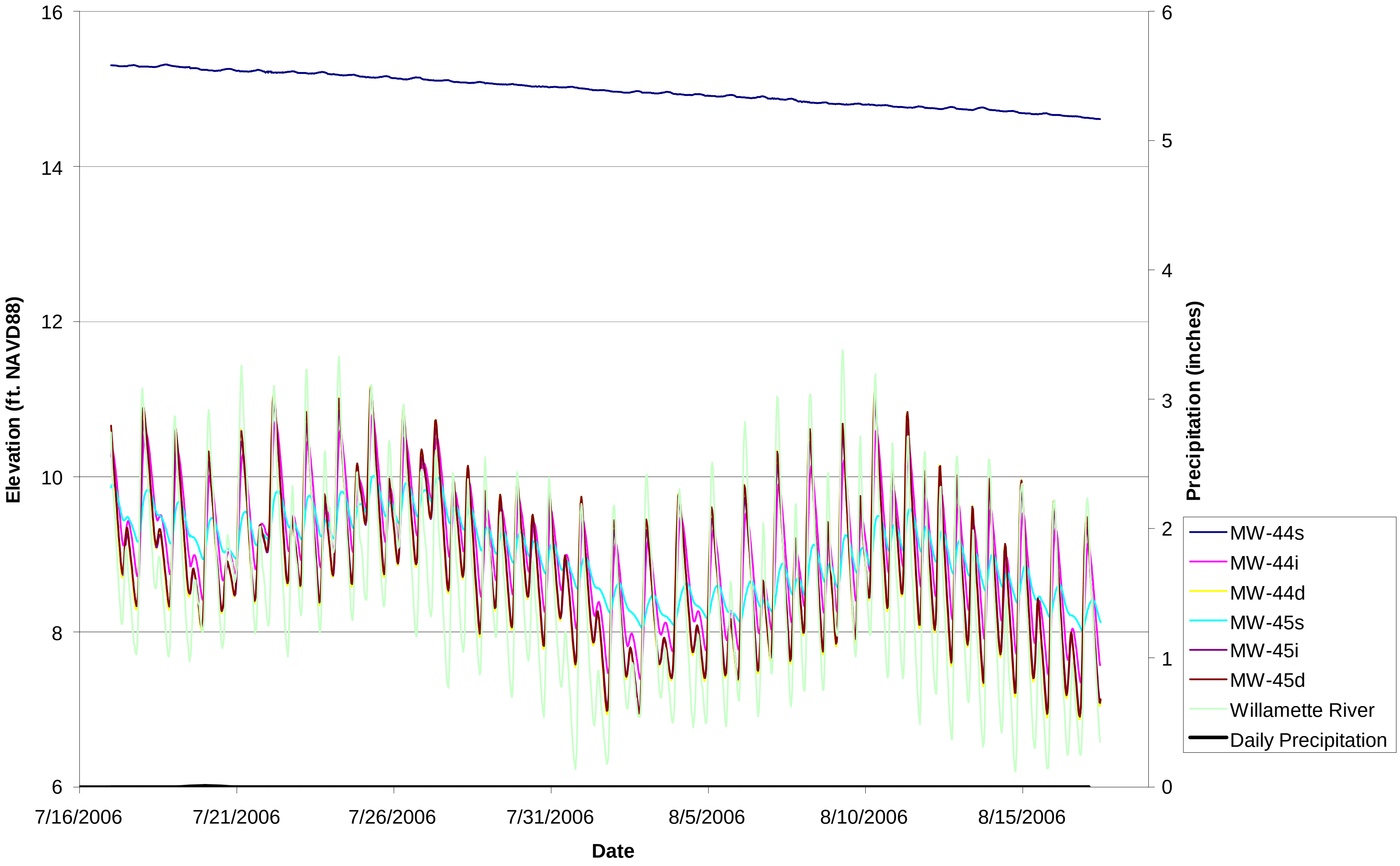
Figure 9
TFA GROUNDWATER ELEVATION INSIDE THE BARRIER WALL vs OUTSIDE THE BARRIER WALL
July 17, 2006 through August 17, 2006
McCORMICK and BAXTER CREOSOTING COMPANY
PORTLAND, OREGON



O:\McCormick\McCormick OY25 O&F\Barrier Wall Monitoring\August 2006\Figures\Figure 9 August_TFA_1_Mo.xls

TABLES

TABLE 1
LNAPL and DNAPL Measurement Summary
July 22 through August 25, 2006
McCormick and Baxter Creosoting Company

Date Measured	Well Number	Thickness (feet)	Extracted (Gallons)
LNAPL			
07/25/06	EW-10s	0.38	0
07/31/06	EW-10s	0.5	7.64
08/07/06	EW-10s	0.36	0.83
08/17/06	EW-10s	1.13	1.65
08/21/06	EW-10s	0.26	0
07/25/06	EW-15s	0.49	0.72
07/31/06	EW-15s	0.67	a
08/07/06	EW-15s	0.67	1.03
08/17/06	EW-15s	0.63	1.45
08/21/06	EW-15s	0.55	1.03
07/25/06	EW-18s	0.29	0
07/31/06	EW-18s	0.39	0
08/07/06	EW-18s	0.37	0
08/17/06	EW-18s	0.44	a
08/21/06	EW-18s	0.22	0
07/25/06	EW-23s	0.34	0
07/31/06	EW-23s	0.24	0
08/07/06	EW-23s	0.93	5.17
08/17/06	EW-23s	0.93	a
08/21/06	EW-23s	0.77	2.68
07/25/06	MW-56s	1.47	b
07/31/06	MW-56s	2.09	5.17
08/07/06	MW-56s	1.62	a
08/17/06	MW-56s	1.93	a
08/21/06	MW-56s	1.38	a
LNAPL Total			**27.37**
DNAPL			
07/25/06	MW-20i	1.81	a
07/31/06	MW-20i	2.80	a
08/07/06	MW-20i	2.56	a
08/17/06	MW-20i	1.33	0
08/21/06	MW-20i	2.18	a
07/25/06	MW-Ds	1.75	a
07/31/06	MW-Ds	1.77	a
08/07/06	MW-Ds	1.68	a
08/17/06	MW-Ds	1.87	a
08/21/06	MW-Ds	1.15	0
07/25/06	MW-Gs	0.93	0
07/31/06	MW-Gs	1.10	0
08/07/06	MW-Gs	1.14	0
08/17/06	MW-Gs	1.13	0
08/21/06	MW-Gs	1.44	0
DNAPL Total			**0**
NAPL Total			**27.37**

Footnotes:
a. Extraction was performed, but drum gauging resulted in a net negative volume or all water volume due to weekly water separation, minor measurement discrepancies, and instrument sensitivity.
b. MW-56s was inadvertently not extracted on 7/25/06.

Extraction Criteria: minimum of 0.4 feet for LNAPL and 1.5 feet for DNAPL
Extraction quantities based on drum gauging

TABLE 2
Cumulative NAPL Extraction Summary
McCormick Baxter Creosoting

Date	Manual NAPL Extracted (DNAPL + LNAPL)	Total Monthly Treatment System NAPL Extracted (DNAPL & LNAPL)	Monthly Total NAPL Extracted	Total NAPL Extracted
Pre-Barrier Wall Extraction Volumes				
Jun-89			*0*	*0*
Feb-93			*1097*	*1097*
Feb-95			*1021*	*2118*
Dec-95	31.03	0	31.03	*2149*
Jan-96	20.8	0	20.8	*2170*
Feb-96	52.4	0	52.4	*2222*
Mar-96	66.05	0	66.05	*2288*
Apr-96	35.87	0	35.87	*2324*
May-96	23.36	0	23.36	*2348*
Jun-96	31.68	0	31.68	*2379*
Jul-96	29.8	0	29.8	*2409*
Aug-96	73.02	0	73.02	*2482*
Sep-96	33.5	0	33.5	*2516*
Oct-96	43.8	0	43.8	*2559*
Nov-96	39	0	39	*2598*
Dec-96	25.3	0	25.3	*2624*
Jan-97	40.36	0	40.36	*2664*
Feb-97	31.04	0	31.04	*2695*
Mar-97	34.18	0	34.18	*2729*
Apr-97	32.04	0	32.04	*2761*
May-97	8.64	0	8.64	*2770*
Jun-97	11.6	0	11.6	*2781*
Jul-97	28.29	0	28.29	*2810*
Aug-97	52.33	0	52.33	*2862*
Sep-97	38.9	0	38.9	*2901*
Oct-97	32.3	0	32.3	*2933*
Nov-97	53.8	0	53.8	*2987*
Dec-97	53.3	0	53.3	*3040*
Jan-98	33.17	112.32	145.49	*3186*
Feb-98	27.05	5.9	32.95	*3219*
Mar-98	51.1	3.83	54.93	*3274*
Apr-98	33.37	7.67	41.04	*3315*
May-98	31.45	7.67	39.12	*3354*
Jun-98	12.08	7.67	19.75	*3374*
Jul-98	9.34	8.11	17.45	*3391*
Aug-98	14.95	8.11	23.06	*3414*
Sep-98	14.17	8.11	22.28	*3436*
Oct-98	16	8.11	24.11	*3461*
Nov-98	11.3	8.11	19.41	*3480*
Dec-98	5.2	16.15	21.35	*3501*
Jan-99	15.28	0	15.28	*3517*
Feb-99	14.12	0	14.12	*3531*
Mar-99	47.74	0	47.74	*3578*
Apr-99	7.44	0	7.44	*3586*
May-99	12.82	0	12.82	*3599*
Jun-99	10.7	0	10.7	*3609*
Jul-99	6.6	7.85	14.45	*3624*
Aug-99	13.84	7.85	21.69	*3646*
Sep-99	35.88	7.85	43.73	*3689*
Oct-99	6.85	7.85	14.7	*3704*
Nov-99	7.47	7.85	15.32	*3719*
Dec-99	2.15	7.85	10	*3729*
Jan-00	3.46	21.17	24.63	*3754*
Feb-00	1.75	21.17	22.92	*3777*
Mar-00	0.98	21.17	22.15	*3799*
Apr-00	1.05	21.17	22.22	*3821*
May-00	1.9	21.17	23.07	*3844*
Jun-00	0.41	21.17	21.58	*3866*
Jul-00	14.5	21.7	36.2	*3902*
Aug-00	25.36	21.7	47.06	*3949*
Sep-00	21.83	21.6	43.43	*3993*
Oct-00	18.63	0	18.63	*4011*
Nov-00	17.38	0	17.38	*4029*

TABLE 2
Cumulative NAPL Extraction Summary
McCormick Baxter Creosoting

Date	Manual NAPL Extracted (DNAPL + LNAPL)	Total Monthly Treatment System NAPL Extracted (DNAPL & LNAPL)	Monthly Total NAPL Extracted	Total NAPL Extracted
Dec-00	1.53	0	1.53	*4030*
Jan-01	4.09	0	4.09	*4034*
Feb-01	0.56	0	0.56	*4035*
Mar-01	2.64	0	2.64	*4037*
Apr-01	4.19	0	4.19	*4042*
May-01	1.36	0	1.36	*4043*
Jun-01	0.41	0	0.41	*4043*
Jul-01	0.64	0	0.64	*4044*
Aug-01	1.15	0	1.15	*4045*
Sep-01	0	0	0	*4045*
Oct-01	0	0	0	*4045*
Nov-01	5.98	0	5.98	*4051*
Dec-01	0.519	0	0.519	*4052*
Jan-02	0.46	0	0.46	*4052*
Feb-02	19.28	0	19.28	*4071*
Mar-02	18.66	0	18.66	*4090*
Apr-02	0.31	0	0.31	*4090*
May-02	5.065	0	5.065	*4095*
Jun-02	0	0	0	*4095*
Jul-02	13.81	0	13.81	*4109*
Aug-02	11.59	0	11.59	*4121*
Sep-02	8.76	0	8.76	*4130*
Oct-02	12.34	0	12.34	*4142*
Nov-02	10.19	0	10.19	*4152*
Dec-02	0.851	0	0.851	*4153*
Jan-03	1.514	0	1.514	*4154*
Feb-03	7.45	0	7.45	*4162*
Mar-03	1.73	0	1.73	*4164*
Apr-03	0	0	0	*4164*
May-03	0	0	0	*4164*
Jun-03	0	0	0	*4164*
Jul-03	0	0	0	*4164*
Aug-03	0	0	0	*4164*
Sep-03	0	0	0	*4164*
Oct-03	0	0	0	*4164*
Nov-03	10	0	10	*4174*
Feb-04	79.5	0	79.5	*4253*
Mar-04	94.5	0	94.5	*4348*
Post Barrier Wall Extraction Volume				
Apr-04	118.33	0	118.33	*4466*
May-04	163.6	0	163.6	*4630*
Jun-04	165.6	0	165.6	*4795*
Jul-04	103.3	0	103.3	*4898*
Aug-04	127	34.1	161.1	*5060*
Sep-04	98.4	32.84	131.24	*5191*
Oct-04	50.2	28.76	78.96	*5270*
Nov-04	61.44	34.3	95.74	*5366*
Dec-04	59.12	23.51	82.63	*5448*
Jan-05	49.1	24.1	73.2	*5521*
Feb-05	83.86	0	83.86	*5605*
Mar-05	132.7	0	132.7	*5738*
Apr-05	131.2	0	131.2	*5869*
May-05	66.2	0	66.2	*5935*
June-05 through Oct-05	45	0	45	*5980*
Nov-05	5.16	0	5.16	*5985*
Dec-05	12.33	0	12.33	*5998*
Jan-06	13.43	0	13.43	*6011*
Feb-06	14.68	0	14.68	*6026*
Mar-06	17.17	0	17.17	*6043*
Apr-06	13.24	0	13.24	*6056*
May-06	19.43	0	19.43	*6076*
Jun-06	16.72	0	16.72	*6092*
Jul-06	14.98	0	14.98	*6107*
Aug-06	27.37	0	27.37	*6135*
Total Extracted Volume				*6135*

TABLE 3
Groundwater and LNAPL Elevations
August 17, 2006
McCormick and Baxter Creosoting Company
Portland, OR

Well ID	Date	Time	Measuring Point Elevation (ft NAVD88)	Depth to LNAPL (ft)	LNAPL Elevation (ft NAVD88)	LNAPL Thickness (ft)	Specific Gravity of LNAPL	Depth to water (ft)	Groundwater Elevation (ft NAVD88)	Groundwater Elevation LNAPL Corrected (ft NAVD88)
EW-10s	8/17/2006	0902	29.52	21.83	7.69	1.13	0.98135	22.96	6.56	7.67
EW-15s	8/17/2006	0928	43.12	31.08	12.04	0.63	0.98135	31.71	11.41	12.03
EW-18s	8/17/2006	0933	40.82	26.21	14.61	0.44	0.98135	26.65	14.17	14.60
EW-19s	8/17/2006	0845	26.06					17.68	8.38	
EW-1s	8/17/2006	0943	41.41					26.34	15.07	
EW-23s	8/17/2006	0925	38.63	26.51	12.12	0.93	0.98135	27.44	11.19	12.10
EW-2s	8/17/2006	0853	42.48					33.49	8.99	
EW-8s	8/17/2006	0940	40.57					25.98	14.59	
EW-9s	8/17/2006	0849	40.83					31.88	8.95	
MW-10r	8/17/2006	0946	42.01					27.48	14.53	
MW-15s	8/17/2006	0925	43.30					29.35	13.95	
MW-17s	8/17/2006	0935	41.35					27.64	13.71	
MW-18s	8/17/2006	0833	43.18					33.99	9.19	
MW-1r	8/17/2006	0835	38.19					25.42	12.77	
MW-20i	8/17/2006	0858	41.55					34.46	7.09	
MW-22i	8/17/2006	0939	42.35					34.59	7.76	
MW-23d	8/17/2006	0954	41.68					34.24	7.44	
MW-2s	8/17/2006	0952	38.37					25.38	12.99	
MW-32i	8/17/2006	0827	39.37					27.09	12.28	
MW-34i	8/17/2006	0843	32.75					25.62	7.13	
MW-35r	8/17/2006	0848	32.27					22.76	9.51	
MW-36d	8/17/2006	0847	30.52					23.45	7.07	
MW-36i	8/17/2006	0846	30.26					23.14	7.12	
MW-36s	8/17/2006	0845	30.83					19.29	11.54	
MW-37d	8/17/2006	0844	26.15					19.12	7.03	
MW-37i	8/17/2006	0842	25.99					18.89	7.10	
MW-37s	8/17/2006	0847	24.97					16.74	8.23	
MW-38d	8/17/2006	0853	31.92					24.80	7.12	
MW-38i	8/17/2006	0852	32.18					24.86	7.32	
MW-38s	8/17/2006	0851	32.38					20.39	11.99	
MW-39d	8/17/2006	0857	29.89					22.81	7.08	
MW-39i	8/17/2006	0856	30.20					23.07	7.13	
MW-39s	8/17/2006	0855	29.85					21.70	8.15	
MW-3s	8/17/2006	0940	30.65					16.52	14.13	
MW-40d	8/17/2006	0901	29.00					21.60	7.40	
MW-40i	8/17/2006	0900	28.49					21.38	7.11	
MW-40s	8/17/2006	0859	28.35					15.07	13.28	
MW-41d	8/17/2006	0904	27.49					20.37	7.12	
MW-41i	8/17/2006	0903	27.17					20.00	7.17	
MW-41s	8/17/2006	0902	27.49					19.55	7.94	
MW-42d	8/17/2006	0915	32.24					25.13	7.11	
MW-42i	8/17/2006	0914	32.71					25.54	7.17	
MW-42s	8/17/2006	0913	32.39					18.17	14.22	
MW-43d	8/17/2006	0919	28.37					21.25	7.12	
MW-43i	8/17/2006	0918	30.36					23.20	7.16	
MW-43s	8/17/2006	0917	31.08					23.23	7.85	
MW-44d	8/17/2006	0928	29.37					22.17	7.20	
MW-44i	8/17/2006	0927	29.62					21.74	7.88	
MW-44s	8/17/2006	0926	29.71					15.10	14.61	
MW-45d	8/17/2006	0931	27.94					20.70	7.24	
MW-45i	8/17/2006	0930	28.05					20.73	7.32	
MW-45s	8/17/2006	0929	28.23					20.02	8.21	
MW-46s	8/17/2006	0936	35.58					20.88	14.70	
MW-47s	8/17/2006	0938	35.57					26.82	8.75	
MW-48s	8/17/2006	0957	38.96					23.67	15.29	
MW-49s	8/17/2006	0958	37.78					20.54	17.24	
MW-50s	8/17/2006	0958	39.49					24.34	15.15	
MW-51s	8/17/2006	0959	39.68					22.10	17.58	
MW-52s	8/17/2006	1010	40.80					26.28	14.52	
MW-53s	8/17/2006	1011	40.58					23.94	16.64	
MW-54s	8/17/2006	0915	41.86					27.54	14.32	
MW-55s	8/17/2006	0913	41.14					27.60	13.54	
MW-56s	8/17/2006	0920	43.52	30.99	12.53	1.93	0.98135	32.92	10.60	12.50
MW-57s	8/17/2006	0920	42.12					32.36	9.76	
MW-58d	8/17/2006	0839	41.43					34.29	7.14	
MW-58i	8/17/2006	0837	40.99					34.81	6.18	
MW-58s	8/17/2006	0838	41.51					32.78	8.73	
MW-59s	8/17/2006	0948	35.76					22.11	13.65	
MW-60d	8/17/2006	0835	40.15					23.93	16.22	
MW-61s	8/17/2006	0902	43.67					29.66	14.01	
MW-62i	8/17/2006	0932	42.71					35.72	6.99	
MW-7 WC	8/17/2006	0856	36.69					25.29	11.40	
MW-As	8/17/2006	1016	39.33					22.07	17.26	
MW-Ds	8/17/2006	0915	43.02					33.85	9.17	
MW-Gs	8/17/2006	0909	40.33					31.61	8.72	
MW-Ks	8/17/2006	0908	44.23					29.72	14.51	
MW-Os	8/17/2006	1005	41.02					23.41	17.61	
PW-1d	8/17/2006	1008	44.07					31.82	12.25	
PW-2d	8/17/2006	1002	41.85					25.55	16.30	

TABLE 4

Horizontal Groundwater Elevation Gradients
August 17, 2006
McCormick and Baxter Creosoting Company
Portland, Oregon

Well ID	Date	Horizontal Distance (ft)	Angle of Flowpath Deviation (degrees)	Horizontal Gradient (ft/ft)
Inside Barrier Wall				
MW-50s to MW-36s	8/17/06 Low Tide	1104	33	0.0033
MW-48s to EW-23s	8/17/06 Low Tide	1208.0	9	0.0026
TFA Monitoring Wells				
MW-48s to MW-44s	8/17/06 Low Tide	536.0	12	0.0013
MW-48s to EW-1s	8/17/06 Low Tide	416.0	0	0.0005
FWDA Monitoring Wells				
MW-15s to MW-36s	8/17/06 Low Tide	368.0	29	0.0065
Outside Barrier Wall				
MW-45s to River[1]	8/17/06 Low Tide	124.0	-	0.0145
TFA Monitoring Wells				
MW-49s to MW-47s	8/17/06 Low Tide	387.5	36	0.0220
FWDA Monitoring Wells				
MW-55s to MW-58s	8/17/06 Low Tide	624.0	15	0.0077

Note:

[1] The distance from the Willamette River to the well is the corresponding ground surface elevation for the river stage at low tide (6.58 NAVD88), perpendicular from the MW-45s to the river.

Key:

ft = Feet.
ft/ft = Feet per foot.
FWDA = Former waste disposal area.
TFA = Tank farm area.

TABLE 5

Vertical Gradients
Low Tide Event August 17, 2006
McCormick and Baxter Creosoting Company
Portland, Oregon

Well ID	Mid-point value	Direction
MW-36s to MW-36d	0.00092	down
MW-36s to MW-36i	0.07313	down
MW-36i to MW-36d	0.00147	down
MW-37s to MW-37d	0.05125	down
MW-37s to MW-37i	0.02100	down
MW-37i to MW-37d	0.00200	down
MW-40s to MW-40d	0.22730	down
MW-40s to MW-40i	0.09603	down
MW-40i to MW-40d	0.00851	up
MW-41s to MW-41d	0.04403	down
MW-41s to MW-41i	0.01967	down
MW-41i to MW-41d	0.00147	down
MW-44s to MW-44d	0.24460	down
MW-44s to MW-44i	0.11870	down
MW-44i to MW-44d	0.01948	down
MW-45s to MW-45d	0.03729	down
MW-45s to MW-45i	0.01620	down
MW-45i to MW-45d	0.00222	down

Notes:

1. Gradients calculated using EPA vertical gradient calculator.
   http://www.epa.gov/athens/learn2model/part-two/onsite/vgradient02.htm

Attachment 4 – Risk Assessment Evaluation

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TECHNICAL MEMORANDUM

To:	Kevin Parrett, Oregon Department of Environmental Quality
From:	Stephanie Pingree, Ecology & Environment, Inc.
Through:	John Montgomery, Ecology & Environment, Inc.
Date:	September 15, 2006
Re:	McCormick and Baxter Creosoting Company Superfund Site, Second 5-Year Review, Risk Assessment Evaluation

Per your request, Ecology and Environment, Inc. (E & E) has reviewed the Baseline Human Health Risk Assessment (HHRA; Section 7.1) of the *McCormick & Baxter Creosoting Company Remedial Investigation Report* (RI; 1992) and preformed a cursory review of the Ecological Risk Assessment (ERA; Section 7.2). E & E's review focused on answering the question: ***Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?*** This evaluation is consistent with the Environmental Protection Agency's (EPA's) *Comprehensive Five-Year Review Guidance* (2002). This memorandum describes the results of the review.

Exposure Assumptions

The following receptors and exposure routes were quantitatively evaluated in the HHRA:

- Onsite Visitor (adult and child) – soil ingestion, dermal contact with soil, and inhalation of particulates;
- Onsite Worker - soil ingestion, dermal contact with soil, and inhalation of particulates;
- Onsite Resident (adult and child) - soil ingestion, dermal contact with soil, and inhalation of particulates;
- Beach Visitor – Inhalation of particulates, ingestion of sediments, and dermal contact with sediments; and
- Recreational Angler - Inhalation of particulates, ingestion of sediments, dermal contact with sediments, and consumption of fish and crayfish.

The receptors and exposure pathways are still valid for the site. Note exposure to groundwater was not assessed in the RI. This pathway was evaluated in the revised Feasibility Study but was not reviewed in this exercise.

Exposure estimates were developed using equations and exposure assumptions presented in Tables B-3 through B-10 for the HHRA. E & E evaluated if the exposure parameters used in the HHRA are still valid and currently recommended by EPA. A comparison of exposure parameters used in the HHRA with current recommendations from EPA is presented in Table 1.

Site-specific exposure assumptions, such as exposure duration and fraction of exposure from the contaminated site, that were based on best professional judgment are identified in the table. These site-specific assumptions are reasonable and consistent with the intended use of the site.

To estimate the dermal absorbed dose, a chemical-specific dermal absorption factor (ABS_d) is used. Chemical-specific ABS_d are presented in Table B-6 of the HHRA. Table 2 compares the ABS_d to current values obtained from EPA's *Risk Assessment Guidelines for Superfund, Volume I: Human Health Evaluation Manual: Part E, Supplemental Guidance for Dermal Risk Assessment* (2004b).

Exposure assumptions that are currently more conservative than values used in the 1992 HHRA are summarized below. Please note some changes in variables could result in a less conservative estimate of dose and are not included in this summary:

- Skin surface area for onsite visitors (adults), onsite worker, and onsite residents (adults) increased less than a factor of 2;
- Ingestion rate for onsite workers doubled; and
- Dermal absorption factors for chlorinated phenols (except pentachlorophenol), hexachlorobenzene, and dioxins/furans increased slightly (i.e. less than or equal to a factor of 10). The ABS_d for pentachlorophenol increased by a factor of 25. An ABS_d is currently available for arsenic.

Exposure assumptions used in the 1992 HHRA are not significantly different from those currently recommended for the ingestion and inhalation pathways. Currently used values would result in less than an order magnitude change in dose estimates for these exposure pathways. Exposure assumptions, including surface area and dermal absorption factors, may result in more than a magnitude difference in the dose estimates for this pathway. Further evaluation of the dermal pathway is provided in this technical memorandum.

Toxicity Data

The toxicity values, reference doses (RfDs) and slope factors (SFs), for the ingestion and inhalation routes of exposure used in the HHRA are presented in Tables 7-3 and 7-4 of the RI. Tables 3 and 4 compare the toxicity values used in the HHRA to current recommended values based on EPA's *Integrated Risk Information System* (EPA 2006), unless otherwise indicated.

EPA has not developed toxicity values for dermal exposure. Oral toxicity values can be adjusted based on the fractional gastro-intestinal absorption (ABS_{GI}) to derive estimates for dermal toxicity values. An ABS_{GI} of 100% assumes chemicals are fully absorbed across the gastro-intestinal tract. The derivation of dermal toxicity values including the ABS_{GI} and adjusted dermal RfD and SF are presented in Table B-11 of the HHRA. The ABS_{GI} values are shown as "Oral Absorption Factor" in Table B-11. Table 5 compares the ABS_{GI} used in the HHRA to current values obtained from EPA's *Risk Assessment Guidelines for Superfund, Volume I: Human Health Evaluation Manual: Part E, Supplemental Guidance for Dermal Risk Assessment* (2004b). Note for compounds with percent absorption less than 50%, EPA does not recommend adjusting the oral toxicity values. In these cases the ABS_{GI} is assumed to be 100% and the oral toxicity values are used to evaluate dermal exposure.

Dioxins and furans were evaluated in the 1992 HHRA by using the toxicity equivalence factor (TEF) approach that quantifies the toxicity of 2,3,7,8-substituted polychlorinated dibenzo-p-dioxin (PCDD) and polychlorinated dibenzofurans (PCDF) congeners relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The TEF values used in the HHRA are provided in

Table B-12 of the RI. The TEF approach is valid for assessment of exposure to dioxins and furans, although the currently accepted source of TEFs is Vanden Berg *et al.* (1998). Table 6 compares the TEFs used in the 1992 HHRA to TEFs obtained from Vanden Berg *et al.* (1998).

Toxicity data currently more conservative than values used in the 1992 HHRA are summarized below. Please note some changes could result in a less conservative estimate of risk or hazard and are not included in this summary:

- Oral slope factor for carcinogenic polyaromatic hydrocarbons (PAHs), based on benzo(a)pyrene equivalence, and inhalation slope factors for carcinogenic PAHs and hexavalent chromium increased slightly (i.e. highest increase is 25%);
- Inhalation reference dose for naphthalene was added;
- Oral absorption factors for chromium were added; and
- TEF for pentachlorodibenzo-p-dioxin (PeCDD) increased by a factor of 2.

Oral and inhalation toxicity data used in the 1992 HHRA are not significantly different from those currently recommended. Current slope factors and reference doses would result in less than an order of magnitude change in the risk or hazard estimates for each compound. Further evaluation of the dermal pathway is provided in this technical memorandum. Updated TEFs are not significantly different from those current recommended.

Cleanup Levels and Remedial Action Objectives

The target risk-based cleanup goals for soil and sediment specified in the record of decision (ROD) for the site are summarized below:

- Maintain contaminant concentrations in surface soil below the following risk-based cleanup goals, as specified in the ROD:
  Arsenic – 8 mg/kg
  Pentachlorophenol – 50 mg/kg
  Total Carcinogenic PAHs – 1 mg/kg
  Dioxins/furans – 0.00004 mg/kg
- Maintain contaminant concentrations in surface sediments below the following risk-based cleanup goals, as specified in the ROD:
  Arsenic – 12 mg/kg, dry weight
  Pentachlorophenol – 100 mg/kg, dry weight
  Total Carcinogenic PAHs – 2 mg/kg, dry weight
  Dioxins/furans – 0.008 mg/kg, dry weight
  Protection of benthic organisms based on sediment bioassay tests resulting in a mortality rate less than or equal to upstream reference conditions

Draft remedial action objectives (RAOs) based on risk for an occupational, recreational, and residential scenario are provided in Tables 2-11 and 2-12 for the RI. RAOs presented in Section 2 of the RI are consistent with the cleanup goals provided above with the following exceptions:

- Arsenic cleanup goals are based on background reference concentrations in the ROD; and
- Sediment cleanup goal for dioxins/furans is 0.00008 mg/kg dry weight in the RI.

Cleanup goals were developed using the exposure assumptions and toxicity data presented in the HHRA of the RI and discussed in this memorandum. Cleanup goals for individual compounds corresponded to 1 x 10^{-6} excess cancer risk for ingestion of soil and sediment for the most exposed receptor (onsite worker for soil and recreational scenario for sediment). Cleanup goals for noncarcinogenic effects were calculated based on a hazard quotient of 1. For those compounds listed above, cleanup goals based on carcinogenic effects were significantly lower that those based on noncarcinogenic effects. Cleanup goals were not calculated for all compounds of potential concern but only those compounds that pose the greatest risk.

Dermal exposure was not included in the final cleanup goals for two reasons: 1) the high degree of uncertainty in the assessment of effects from dermal exposure, and 2) use of the conservative end of EPA's acceptable risk range (10^{-4} to 10^{-6}) allows for additive risks associated with exposure to multiple carcinogens and potential risks associated with dermal exposure. Uncertainty in the assessment of dermal exposure has been reduced since development of the HHRA.

Cleanup goals used in the 1992 RI are not significantly different from those currently recommended for the ingestion and inhalation pathways. Based on changes in dermal exposure assumptions and toxicity data, cleanup goals that include exposure via this pathway may be warranted. Further evaluation of the dermal pathway is provided in this technical memorandum.

Sediment cleanup goal for dioxins/furans presented in the ROD are inconsistent with the 1992 RI. The ROD cleanup goal for dioxins/furans should be 0.00008 mg/kg dry weight. The value presented in the ROD appears to be a typographical error.

Further Evaluation of Dermal Exposure

Exposure assumptions and toxicity data used to evaluate dermal exposure to contaminants in soil and sediment have been updated since the RI, as described above. To evaluate the effect of these changes, updated risks, hazards, and risk-based protective levels were calculated for the compounds, receptors, and exposure routes of interest.

Carcinogenic and noncarcinogenic effects from dermal exposure to compounds of potential concern in soil for the future onsite worker are presented in Table 7. Effects from dermal exposure to compounds in shallow sediments for the beach visitor scenario are presented in Table 8. The carcinogenic risk and noncarcinogenic hazard index shown in Tables 7 and 8 include updated exposure assumptions and toxicity data[1]. The risks and hazards shown in Tables 7 and 8 may not represent current conditions at the site and are used for comparison purposes only. For consistency, soil and sediment contaminant concentrations from the RI were used in these tables. These values may not represent current contaminant concentrations at the site. The calculated carcinogenic risks and noncarcinogenic hazard index using the updated exposure assumptions and toxicity data are not significantly different (i.e. less than one order of magnitude) than presented in the RI.

The resulting risk-based protective levels using the updated exposure and toxicity data for carcinogenic PAHs, pentachlorophenol, dioxins/furans, and arsenic are presented in Tables 9 and 10. Table 9 shows the risk-based protective levels associated with an excess cancer risk of 1 x 10^{-6} for the most conservative receptors for soil (i.e. occupational scenario) and sediment (i.e.

[1] Note dermal exposure to arsenic was included in the updated evaluation based on the availability of a dermal absorption factor for this compound.

recreational scenario). Table 10 shows the risk-based protective levels associated with an excess cancer risk of 1 x 10^{-4}. The cleanup levels presented in the ROD fall within the calculated risk-based protective levels (Tables 9 and 10) associated with EPA's excess cancer risk range of 1 x 10^{-6} to 1 x 10^{-4}.

The cleanup levels presented in the ROD are protective of exposure to soil and sediment through ingestion and dermal contact considering updated exposure parameters and toxicity data.

Ecological Risk Assessment

A cursory review of the ERA, Section 7.2 of the RI, was conducted. No major deficiencies in the risk assessment protocol were noted, although more recent sources of toxicity information and sediment criteria for the compounds of potential ecological may be available. Risks to benthic invertebrates and fish were evaluated using sediment toxicity tests and available histopathological data, respectively. The sediment RAO specified in the ROD is based on the results of toxicity tests, which is consistent with the evaluation methodology used in the ERA.

Conclusion for Second 5-Year Review

In developing the ROD, DEQ and EPA determined that cleanup to protective levels for industrial uses was appropriate for this site considering the former use (industrial) and the potential anticipated future use (industrial or recreational). RAOs protective of exposure to hypothetical future onsite residents, provided in the 1992 RI, were not carried through to the ROD based on the current and future land use assumptions. The exposure assumptions used to develop the Human Health and Ecological Risk Assessment cleanup goals include:

- Exposure through direct contact (ingestion, inhalation, or dermal contact) of an industrial worker to contaminated surface and near-surface soil for arsenic, pentachlorophenol, carcinogenic PAHs, and dioxins/furans.
- Exposure through direct contact (ingestion or dermal contact) of a recreational user to contaminated sediments for arsenic, pentachlorophenol, carcinogenic PAHs, and dioxins/furans.
- Exposure of benthic organisms to contaminated sediments that would result in mortality as determined by bioassay tests.[2]

The RAOs and cleanup goals for soil and sediment presented in the ROD are still valid and are protective of anticipated industrial and recreational use. Although changes in exposure assumptions and toxicity data did occur, these changes did not result in significantly different risks or risk-based protective levels for industrial or recreational receptors. The ROD cleanup goal for dioxins/furans in sediment should be 0.00008 mg/kg dry weight, consistent with the RI.

References

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[2] Bioassay testing for impaired growth was also applied as a conservative element during the sediment cap design.

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Table 1. Exposure Parameters

Parameter	1992 HHRA	Current Values	Reference
Onsite Visitor – Adult			
Soil Ingestion Rate, IR (mg/d)	100	100	SSL 2002
Fraction Ingested from Contaminated Source, FI (unitless)	0.5	SS	
Skin Surface Area, SA (cm^2/event) – Soil	3,000	**5700**[a]	SSL 2002
Soil-to-skin adherence factor, AF (mg/cm^2) – Soil	1.45	**0.2**	SSL 2002
Inhalation Rate, IR (m^3/day)	16.8	**16**[c]	EFH 1997
Exposure Frequency, EF (days/year)	36	SS	
Exposure Duration, ED (years)	24/30 [b]	30	SSL 2002
Body Weight, BW (kg)	70	70	SSL 2002
Onsite Visitor – Child			
Soil Ingestion Rate, IR (mg/d)	200	200	SSL 2002
Fraction Ingested from Contaminated Source, FI (unitless)	0.5	SS	
Exposure Frequency, EF (days/year)	36	SS	
Exposure Duration, ED (years)	6	6	SSL 2002
Body Weight, BW (kg)	15	15	SSL 2002
Onsite Worker[e]			
Soil Ingestion Rate, IR (mg/d)	50	**100**	SSL 2002
Fraction Ingested from Contaminated Source, FI (unitless)	1	SS	
Skin Surface Area, SA (cm^2/event) – Soil	2,000	**3,300** [a]	SSL 2002
Soil-to-skin adherence factor, AF (mg/cm^2) – Soil	1.45	**0.2**	SSL 2002
Inhalation Rate, IR (m^3/day)	20	20	SSL 2002
Exposure Frequency, EF (days/year)	250	250	SSL 2002
Exposure Duration, ED (years)	25	25	SSL 2002
Body Weight, BW (kg)	70	70	SSL 2002
Onsite Resident – Adult			
Soil Ingestion Rate, IR (mg/d)	100	100	SSL 2002
Fraction Ingested from Contaminated Source, FI (unitless)	1	SS	
Skin Surface Area, SA (cm^2/event) – Soil	3,000	**5,700** [a]	SSL 2002
Soil-to-skin adherence factor, AF (mg/cm^2) – Soil	1.45	**0.2**	SSL 2002
Inhalation Rate, IR (m^3/day)	20	20	SSL 2002
Exposure Frequency, EF (days/year)	350	350	SSL 2002
Exposure Duration, ED (years)	24/30 [a]	30	SSL 2002
Body Weight, BW (kg)	70	70	SSL 2002
Onsite Resident – Child			
Soil Ingestion Rate, IR (mg/d)	200	200	SSL 2002
Fraction Ingested from Contaminated Source, FI	1	SS	

Parameter	1992 HHRA	Current Values	Reference
(unitless)			
Exposure Frequency, EF (days/year)	350	350	SSL 2002
Exposure Duration, ED (years)	6	6	SSL 2002
Body Weight, BW (kg)	15	15	SSL 2002
Beach Visitor – Adult			
Sediment Ingestion Rate, IR (mg/d)	100	100	SSL 2002
Fraction Ingested from Contaminated Source, FI (unitless)	0.5	SS	
Skin Surface Area, SA (cm^2/event) – Beach Sediments	15,000	**12,000**[d]	EFH 1997
Skin Surface Area, SA (cm^2/event) – River Sediments	5,000	5,000[d]	EFH 1997
Soil-to-skin adherence factor, AF (mg/cm^2) – Sediment	2.77	SS	
Inhalation Rate, IR (m^3/day)	16.8	**16** [c]	EFH 1997
Exposure Frequency, EF (days/year)	36	SS	
Exposure Duration, ED (years)	24/30 [b]	30	SSL 2002
Body Weight, BW (kg)	70	70	SSL 2002
Beach Visitor – Child			
Sediment Ingestion Rate, IR (mg/d)	200	200	SSL 2002
Fraction Ingested from Contaminated Source, FI (unitless)	0.5	SS	
Exposure Frequency, EF (days/year)	36	SS	
Exposure Duration, ED (years)	6	6	SSL 2002
Body Weight, BW (kg)	15	15	SSL 2002
Recreational Angler			
Ingestion Rate, IR (kg/day) – Fish	0.054	SS	
Ingestion Rate, IR (kg/day) – Crayfish	0.022	SS	
Fraction ingested from contaminated source, FI (unitless)	0.33	SS	
Exposure Frequency, EF (days/year)	365	SS	
Exposure Duration, ED (years)	30	30	SSL 2002
Body Weight, BW (kg)	70	70	SSL 2002

Bolded text indicates change in value from 1992 HHRA.
Shaded text indicates change is more conservative and would result in higher dose estimates.

Key:

SS = Site-specific value.
SSL 2002 = EPA's *Supplemental Guidance for Development of Soil Screening Levels for Superfund Sites* (2002).
EFH 1997 = EPA's *Exposure Factors Handbook* (1997a).

Footnote:

a – Default skin surface area from EPA 2002. Residential value assumes exposure limited to heads, hands, forearms, and lower legs. Worker value assumes exposure limited to head, hands, and forearms.
b – Exposure duration of 24 years used for soil ingestion (risk estimates adds 6 years of exposure as a child). Exposure duration of 30 years used for all other routes of exposure.
c – Ingestion rate based on Table 5-18 of EPA 1997a based on activity level for average adult.
d – Assumes exposure to arms, hands, legs, feet, and one-half of the trunk of the average adult for the beach visitor and hands, arms, and lower legs for the river scenario. Assumption consistent with RI. Surface area obtained from Table 6-4 of EPA 1997a.
e – Onsite worker is assumed to be engaged in outdoor activities.

Table 2. Dermal Absorption Factor

Compound	ABS_d (%) 1992 HHRA	ABS_d (%) 2006[1]
cPAHs (as BaP)	--	**13%**[2]
Naphthalene	50%	**13%**[2]
Acenaphthene	50%	**13%**[2]
Fluorene	50%	**13%**[2]
Fluoranthene	50%	**13%**[2]
Anthracene	50%	**13%**[2]
Pyrene	50%	**13%**[2]
2,4,5-Trichlorophenol	1%	**10%**[3]
2,4,6-Trichlorophenol	1%	**10%**[3]
2,3,4,5-Tetrachlorophenol	--	**10%**[3]
2,3,4,6-Tetrachlorophenol	1%	**10%**[3]
Pentachlorophenol	1%	**25%**
Hexachlorobenzene	6%	**10%**[3]
Dioxins/Furans (as 2,3,7,8-TCDD)	1%	**3%**
Arsenic	--	**3%**
Chromium (III)	--	**--**
Chromium (VI)	--	**--**

Bolded text indicates change in value from 1992 RI.
Shaded text indicates change is more conservative and would result in higher dose estimates.

Notes:
1 – Source: *Risk Assessment Guidelines for Superfund, Volume I: Human Health Evaluation Manual: Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004b).
2 – Value for benzo(a)pyrene and other PAHs.
3 – Value for semivolatile organic compounds.

Key:

-- = Not available or applicable.

Table 3. Carcinogenic Toxicity Data

Compound	1992 HHRA Values Slope Factor $(mg/kg\text{-}d)^{-1}$		2006 EPA Values Slope Factor $(mg/kg\text{-}d)^{-1}$			
	Oral	Inhalation	Oral	Reference	Inhalation	Reference
cPAHs (as BaP)	5.8	6.1	**7.3**	**IRIS**	**7.3**	**Reg 9**
Naphthalene	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--
Pyrene	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--
2,4,6-Trichlorophenol	1.1E-02	1.1E-02	1.10E-02	IRIS	1.1E-02	IRIS
2,3,4,5-Tetrachlorophenol	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--
Pentachlorophenol	1.20E-01	--	1.20E-01	IRIS	--	--
Hexachlorobenzene	1.6	1.6	1.6	IRIS	1.6	IRIS
Dioxins/Furans (as 2,3,7,8-TCDD)	1.50E+05	1.50E+05	1.50E+05	HEAST	1.50E+05	HEAST
Arsenic	1.75	5.00E+01	**1.5**	**IRIS**	**1.51E+01**	**IRIS**
Chromium (III)	--	--	--	--	--	--
Chromium (VI)	--	4.10E+01	--	--	**4.20E+01**	**IRIS**

Bolded text indicates change in value from 1992 RI.
Shaded text indicates change is more conservative.

Key:

-- = Not available or applicable.

IRIS = Integrated Risk Information System (EPA 2006).

HEAST = Health Effects Assessment Summary Tables (EPA 1997b).

Reg 9 = EPA Region 9 Preliminary Remediation Goal Tables (EPA 2004a).

Table 4. Noncarcinogenic Toxicity Data

Compound	1992 HHRA Values Reference Dose (mg/kg-d)		2006 EPA Values Reference Dose (mg/kg-d)			
	Oral	Inhalation	Oral	Reference	Inhalation	Reference
cPAHs (as BaP)	--	--	--	--	--	--
Naphthalene	4.00E-03	--	**2.00E-02**	**IRIS**	**8.57E-04**	**IRIS**
Acenaphthene	6.00E-02	--	6.00E-02	IRIS	--	--
Fluorene	4.00E-02	--	4.00E-02	IRIS	--	--
Fluoranthene	4.00E-02	--	4.00E-02	IRIS	--	--
Anthracene	3.00E-01	--	3.00E-01	IRIS	--	--
Pyrene	3.00E-02	--	3.00E-02	IRIS	--	--
2,4,5-Trichlorophenol	1.00E-01	--	1.00E-01	IRIS	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--
2,3,4,5-Tetrachlorophenol	--	--	--	--		
2,3,4,6-Tetrachlorophenol	3.00E-02	--	3.00E-02	IRIS	--	--
Pentachlorophenol	3.00E-02	--	3.00E-02	IRIS	--	--
Hexachlorobenzene	8.00E-04	--	8.00E-04	IRIS	--	--
Dioxins/Furans (as 2,3,7,8-TCDD)	--	--	--	--	--	--
Arsenic	3.00E-04	--	3.00E-04	IRIS	--	--
Chromium (III)	1	6.00E-07	**1.5**	**IRIS**	**--**	**--**
Chromium (VI)	5.00E-03	6.00E-07	**3.00E-03**	**IRIS**	**2.86E-05**	**IRIS**

Bolded text indicates change in value from 1992 RI.
Shaded text indicates change is more conservative.

Key:

-- = Not available or applicable.

IRIS = Integrated Risk Information System (EPA 2006).

Table 5. Gastro-Intestinal Absorption Factor

Compound	ABS_{GI} (%) 1992 HHRA	ABS_{GI} (%) 2006[1]
cPAHs (as BaP)	--	**--**
Naphthalene	50%	**100%**
Acenaphthene	50%	**100%**
Fluorene	50%	**100%**
Fluoranthene	50%	**100%**
Anthracene	50%	**100%**
Pyrene	50%	**100%**
2,4,5-Trichlorophenol	80%	**100%**
2,4,6-Trichlorophenol	80%	**100%**
2,3,4,5-Tetrachlorophenol	--	**100%**
2,3,4,6-Tetrachlorophenol	80%	**100%**
Pentachlorophenol	80%	**100%**
Hexachlorobenzene	6%	**100%**
Dioxins/Furans (as 2,3,7,8-TCDD)	50%	**100%**
Arsenic	--	**100%**
Chromium (III)	--	**1.3%**
Chromium (VI)	--	**2.5%**

Bolded text indicates change in value from 1992 RI.
Shaded text indicates change is more conservative and would result in a more conservative toxicity value.

Notes:
1 – Source: *Risk Assessment Guidelines for Superfund, Volume I: Human Health Evaluation Manual: Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004b).

Key:
-- = Not available or applicable.

Table 6. Toxicity Equivalence Factors for Dioxins and Furans

Compound	1992 HHRA TEF	Van den Berg *et al.* (1998) TEF
TCDD	1	1
PeCDD	0.5	**1**
HxCDD	0.1	0.1
HpCDD	0.01	0.01
OCDD	0.001	**0.0001**
TCDF	0.1	0.1
1,2,3,7,8-PeCDF	0.05	0.05
2,3,4,7,8-PeCDF	0.5	0.5
HxCDF	0.1	0.1
HpCDF	0.01	0.01
OCDF	0.001	**0.0001**

Bolded text indicates change in value from 1992 RI.
Shaded text indicates change is more conservative and would result in a more conservative toxicity value.

Table 7. Carcinogenic and Noncarcinogenic Effects from Dermal Contact with Surface Soil – Future Onsite Industrial Scenario

Chemical	Absorption Factor	Concentration[1] (mg/kg)	Carcinogenic Effects: CDI (mg/kg-day)	Carcinogenic Effects: Adjusted SF (mg/kg-d)-1	Carcinogenic Effects: Risk	Noncarcinogenic Effects: CDI (mg/kg-day)	Noncarcinogenic Effects: Adjusted RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Naphthalene	0.13	4.85	1.45E-06	--	--	4.07E-06	2.00E-02	2.04E-04
Acenaphthene	0.13	80.6	2.42E-05	--	--	6.77E-05	6.00E-02	1.13E-03
Fluorene	0.13	148	4.44E-05	--	--	1.24E-04	4.00E-02	3.11E-03
Fluoranthene	0.13	318	9.53E-05	--	--	2.67E-04	4.00E-02	6.67E-03
Anthracene	0.13	269	8.07E-05	--	--	2.26E-04	3.00E-01	7.53E-04
Pyrene	0.13	202	6.06E-05	--	--	1.70E-04	3.00E-02	5.65E-03
Pentachlorophenol	0.25	633	3.65E-04	1.20E-01	4.38E-05	1.02E-03	3.00E-02	3.41E-02
Dioxins/Furans (as 2,3,7,8-TCDD)	0.03	0.168	1.16E-08	1.50E+05	1.74E-03	3.25E-08	--	--
Arsenic	0.03	521	3.60E-05	1.50E+00	5.41E-05	1.01E-04	3.00E-04	3.36E-01
Total Cancer Risk:					2.E-03			
Total Hazard Index:								4.E-01

Notes:
1 – For consistency with the RI, concentrations were obtained from Attachment B-1, Risk Characterization Tables, of the RI. Values provided in the above table represent risk at the site prior to implementation of the remedial actions. As such, these risk values do not represent the current (construction completion) conditions at the site. The above table is presented in this Risk Assessment Evaluation in order to aid the reader's understanding of how the risk-based protective levels are calculated in Table 9.

Table 8. Carcinogenic and Noncarcinogenic Effects from Dermal Contact with Shallow Sediments – Beach Visitor Scenario

Chemical	Absorption Factor	Concentration[1] (mg/kg)	Carcinogenic Effects: CDI (mg/kg-day)	Carcinogenic Effects: Adjusted SF (mg/kg-d)-1	Carcinogenic Effects: Risk	Noncarcinogenic Effects: CDI (mg/kg-day)	Noncarcinogenic Effects: Adjusted RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Naphthalene	0.13	198.55	2.59E-04	--	--	6.04E-04	2.00E-02	3.02E-02
Acenaphthene	0.13	229.93	3.00E-04	--	--	7.00E-04	6.00E-02	1.17E-02
Fluorene	0.13	251.05	3.28E-04	--	--	7.64E-04	4.00E-02	1.91E-02
Fluoranthene	0.13	188.15	2.45E-04	--	--	5.73E-04	4.00E-02	1.43E-02
Anthracene	0.13	67.92	8.86E-05	--	--	2.07E-04	3.00E-01	6.89E-04
Pyrene	0.13	125.47	1.64E-04	--	--	3.82E-04	3.00E-02	1.27E-02
Dioxins/Furans (as 2,3,7,8-TCDD)	0.03	0.00173	5.21E-10	1.50E+05	7.81E-05	1.22E-09	--	--
Arsenic	0.03	4.62	1.39E-06	1.50E+00	2.09E-06	3.25E-06	3.00E-04	1.08E-02
Total Cancer Risk:					8.E-05			
Total Hazard Index:								1.E-01

Notes:
1 – For consistency with the RI, concentrations were obtained from Attachment B-1, Risk Characterization Tables, of the RI. Values provided in the above table represent risk at the site prior to implementation of the remedial actions. As such, these risk values do not represent the current (construction completion) conditions at the site. The above table is presented in this Risk Assessment Evaluation in order to aid the reader's understanding of how the risk-based protective levels are calculated in Table 10.

Table 9. Risk-Based Protective Levels: Surface Soil and Sediment Associated with a 1 x 10^{-6} Excess Cancer Risk

		Occupational Scenario (mg/kg)			Recreational Scenario (mg/kg)		
Compound	Media	Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
Total Carcinogenic PAHs	Soil	3.9E-01	NC	3.9E-01	--	--	--
	Sediment	--	--	--	4.5E+00	NC	4.5E+00
Pentachlorophenol	Soil	2.4E+01	1.4E+01	9.0E+00	--	--	--
	Sediment	--	--	--	2.8E+02	3.3E+00	3.3E+00
Dioxins/Furans (as 2,3,7,8-TCDD)	Soil	1.9E-05	9.6E-05	1.6E-05	--	--	--
	Sediment	--	--	--	2.2E-04	2.2E-05	2.0E-05
Arsenic	Soil	1.9E+00	9.6E+00	1.6E+00	--	--	--
	Sediment	--	--	--	2.2E+01	2.2E+00	2.0E+00

Table 10. Risk-Based Protective Levels: Surface Soil and Sediment Associated with a 1 x 10^{-4} Excess Cancer Risk

		Occupational Scenario (mg/kg)			Recreational Scenario (mg/kg)		
Compound	Media	Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
Total Carcinogenic PAHs	Soil	3.9E+01	NC	3.9E+01	--	--	--
	Sediment	--	--	--	4.5E+02	NC	4.5E+02
Pentachlorophenol	Soil	2.4E+03	1.4E+03	9.0E+02	--	--	--
	Sediment	--	--	--	2.8E+04	3.3E+02	3.3E+02
Dioxins/Furans (as 2,3,7,8-TCDD)	Soil	1.9E-03	9.6E-03	1.6E-03	--	--	--
	Sediment	--	--	--	2.2E-02	2.2E-03	2.0E-03
Arsenic	Soil	1.9E+02	9.6E+02	1.6E+02	--	--	--
		--	--	--	2.2E+03	2.2E+02	2.0E+02